Restoring Habitat and Natural Systems

Lessons learned from the Upper Mississippi River

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U.S. Fish & Wildlife Service
February 16, 2023

U.S. Fish & Wildlife Service

Working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people.

Only federal government agency whose primary responsibility is to manage fish and wildlife resources in the public trust for people today and future generations.

Upper Mississippi River Partnerships

UPPER MISSISSIPPI RIVER CONSERVATION COMMITTEE

https://umrcc.org/

"UMRCC works to promote & preserve natural and recreational resources through wise use, conservation, and management."

Upper Mississippi River Restoration

Leading · Innovating · Partnering

navigation

ecosystem restoration

- integrated
- collaborative
- sustainable

Missouri Department of Conservation

DNR

mn Department of Natural Resources

Illinois Department of Natural Resources

Wisconsin Dept. of Natural Resources

UMRBA Upper Mississippi River Basin Association

Public

NGOs

U.S. Fish & Wildlife Service, Department of the Interior

USDA

USGS science for a changing world

United States Environmental Protection Agency

A River of Dual Purpose

In 1986, Congress designated the Mississippi River

"…as a nationally significant ecosystem and a nationally significant commercial navigation system…shall be administered and regulated in recognition of its several purposes."

The Mississippi is the only river with such designation.

Water Resources Development Act of 1986, Section 1103(a)(2).

Dual Purpose Challenges & Opportunities

- Effects of navigation infrastructure and ongoing operations and channel maintenance
- Systemically managing natural resources in highly altered system – rehabilitating versus restoring
- Different reaches of the river look and function differently
- Dynamic nature of the river
- Novel and emerging challenges

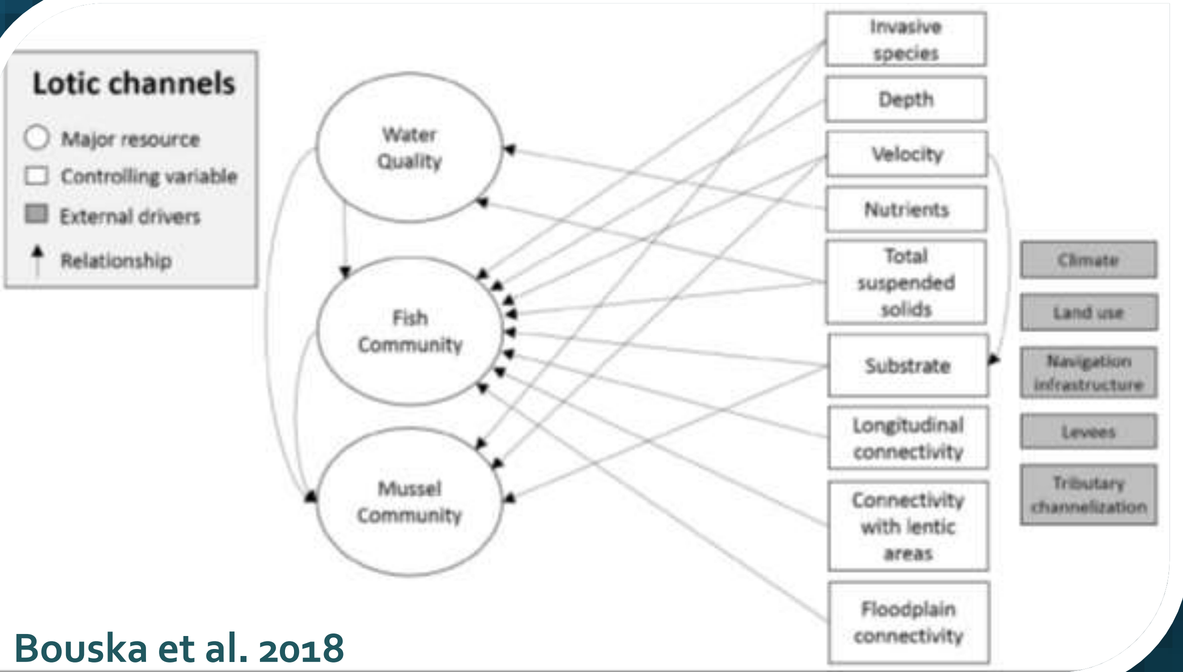
Current State of the Science

Resilience

- Ongoing effort (2018 – present)
  - Bouska et al. 2018 https://www.ecologyandsociety.org/vol23/iss2/art6/
  - Bouska et al. 2022 https://link.springer.com/article/10.1007/s00267-022-01667-y

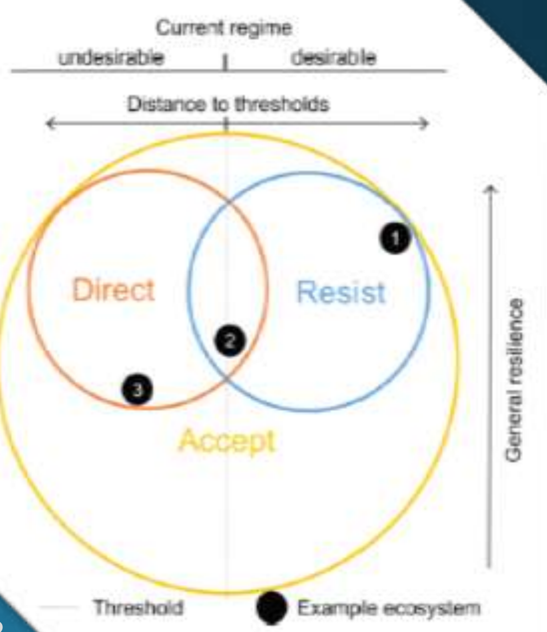
- Improve our understanding and management of the UMRS

- Design habitat projects to:
  - Maintain or shift into desired "state" or "regime"
  - Increase resilience
  - Enhance effectiveness



Bouska et al. 2018

Definition: "...capacity of a system to absorb disturbances and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks."
(Holling 1973, Walker et al. 2004, Bouska et al. 2018)



Bouska et al. 2022

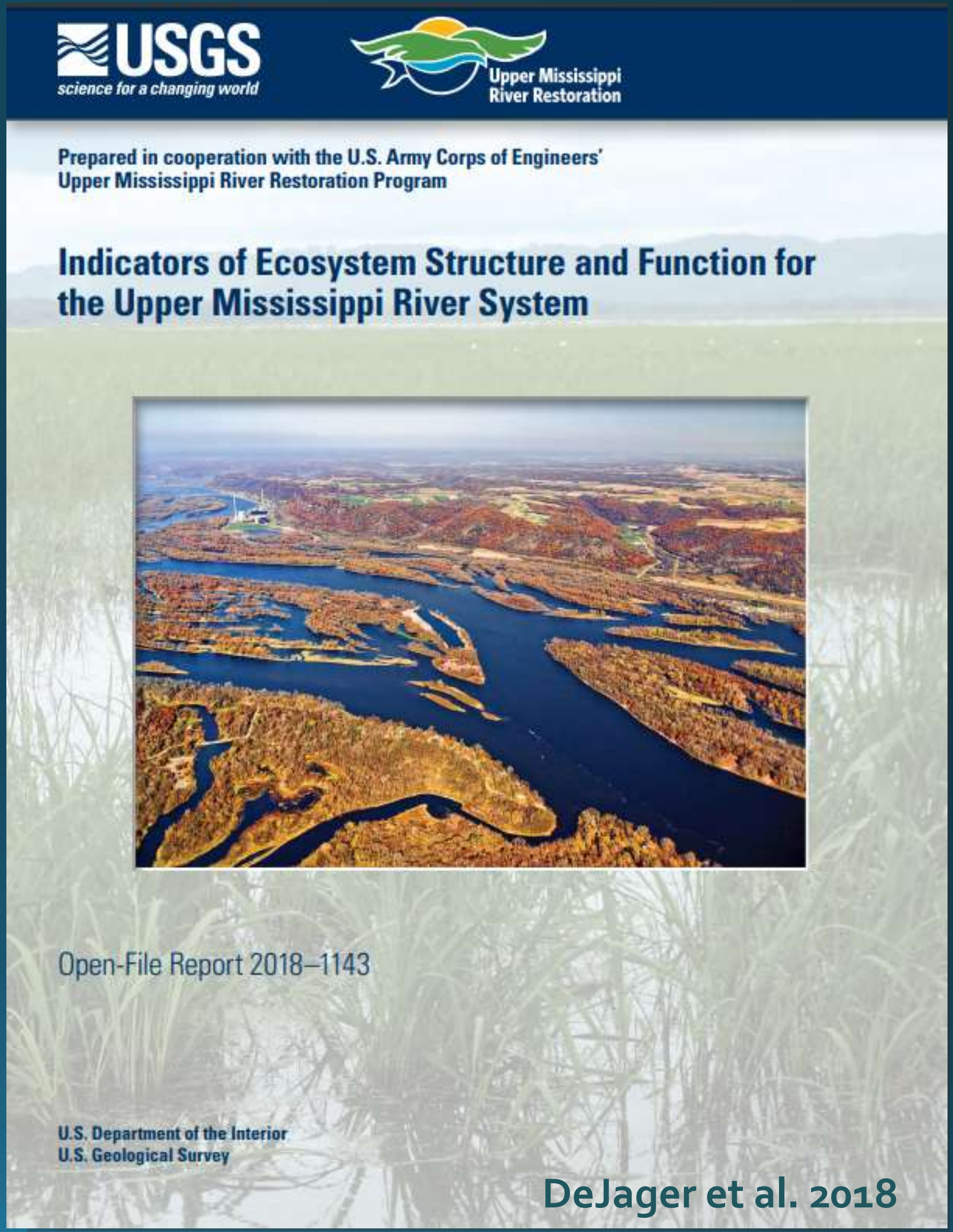
LTRM & HNA-II

Upper Mississippi River Restoration (UMRR) Program's Long-term Resource Monitoring (LTRM)

- Collected 1990s – present
- Ecological Status and Trends
    - Houser, J.N., ed., 2022 https://pubs.er.usgs.gov/publication/ofr20221039

Habitat Needs Assessment, 2nd edition (HNA-II)

- Leverages LTRM & other systemic data
- Comprised of 2 parts
    - DeJager et al. 2018 https://pubs.er.usgs.gov/publication/ofr20181143
    - McCain et al. 2018 https://usace.contentdm.oclc.org/utils/getfile/collection/p266001coll1/id/8323



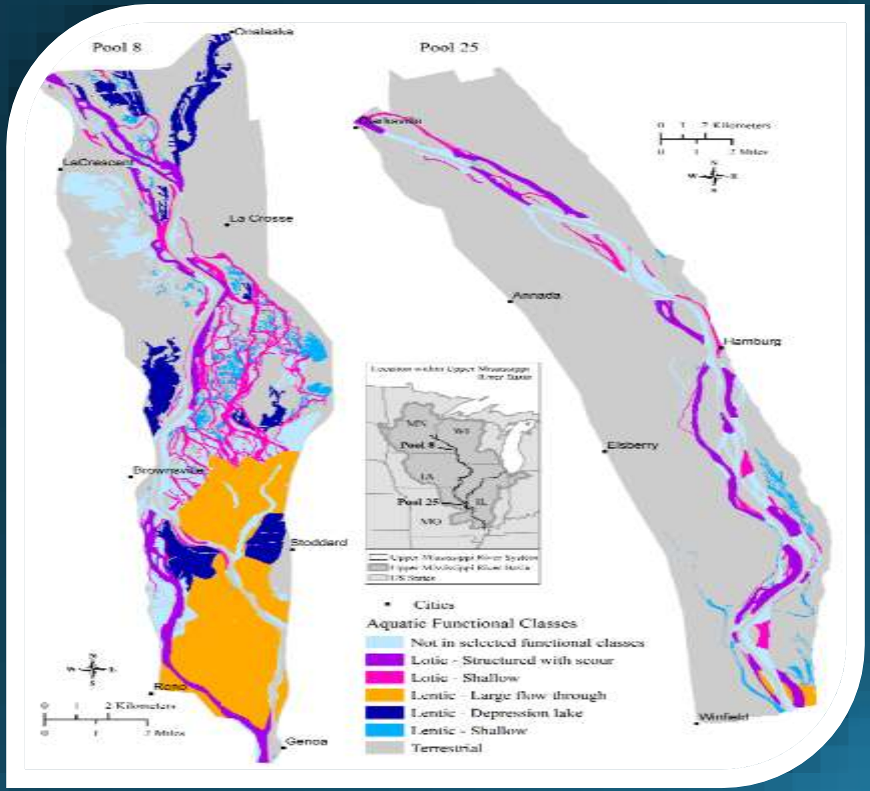
DeJager et al. 2018

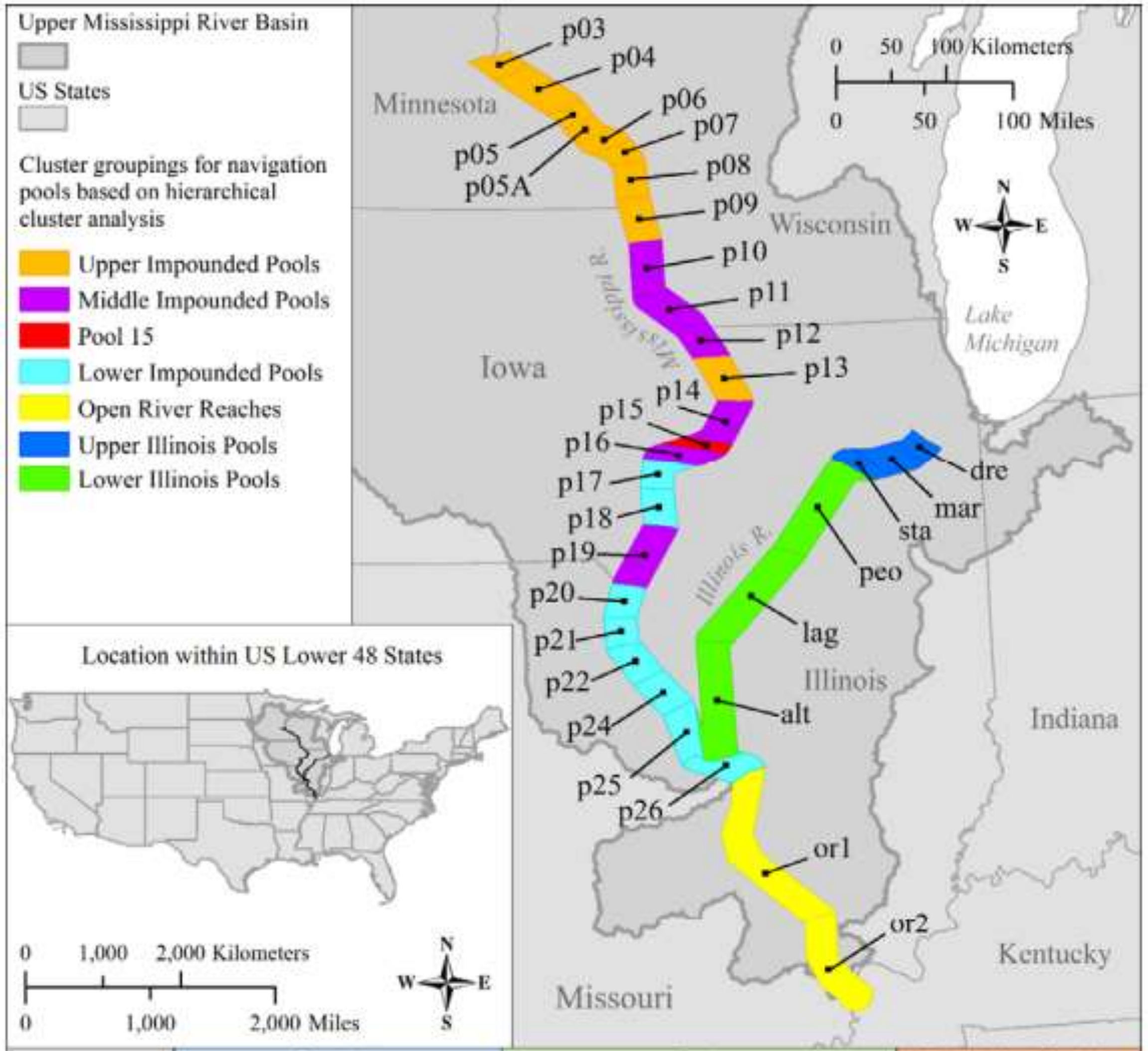
Essential Ecosystem Characteristic (Lubinski & Barko, 2003)	Ecosystem Objective (USACE, 2011)	HNA-II Indicator (De Jager et al, 2018)	General Theme of Resilience (Bouska et al., In Review)
Hydraulics and Hydrology	A more natural stage hydrograph	Water Surface Elevation Fluctuations (Tailwater and Pool Flux)	Controlling Variable
	Restored hydraulic connectivity	Lateral (River-Floodplain) Connectivity (Leveed and Open Water Areas)	Connectivity
	Increase storage and conveyance of flood water on the floodplain		
Biogeochemistry	Improved water clarity	Total Suspended Solids Concentrations	Controlling Variable
	Reduce sediment loading		
	Water quality conditions sufficient to support native species		
Geomorphology	Restore sediment transport regime	Sedimentation in Off-Channel Areas	Long-term Successional Processes
	Restore bathymetric diversity		
	Restore floodplain topographic diversity	Floodplain Functional Class	Diversity and Redundancy
	Restore lateral hydraulic connectivity	Lateral (River-Floodplain) Connectivity (Leveed and Open Water Areas)	Connectivity
		Floodplain Functional Class	Diversity and Redundancy
Habitat	Restore habitat connectivity	Longitudinal Floodplain Connectivity (Natural Area)	Connectivity
	Restore riparian/floodplain habitat	Floodplain Functional Class	Diversity and Redundancy
		Floodplain Vegetation Diversity	
		Floodplain Forest Succession	Long-term successional processes
	Restore aquatic off-channel areas	Aquatic Functional Classes (1 & 2)	Diversity and Redundancy
		Sedimentation in Off-Channel Areas	Long-term Successional Processes
	Restore channel areas (including side channels	Aquatic Functional Classes (1 & 2)	Diversity and Redundancy
	Restore native aquatic vegetation	Aquatic Vegetation Diversity	
	Restore a floodplain corridor	Longitudinal Floodplain Connectivity (Natural Area)	Connectivity
	Restore floodplain wetlands (including floodplain lakes)	Floodplain Vegetation Diversity	Diversity and Redundancy

McCain et al. 2018, DeJager et al. 2018

HNA-II Indicators Report

- Identified quantitative measures (indicators) of ecosystem structure and function.
- Clustered pools together based on similar ecological attributes.
- Provided current indicator status by pool and cluster.



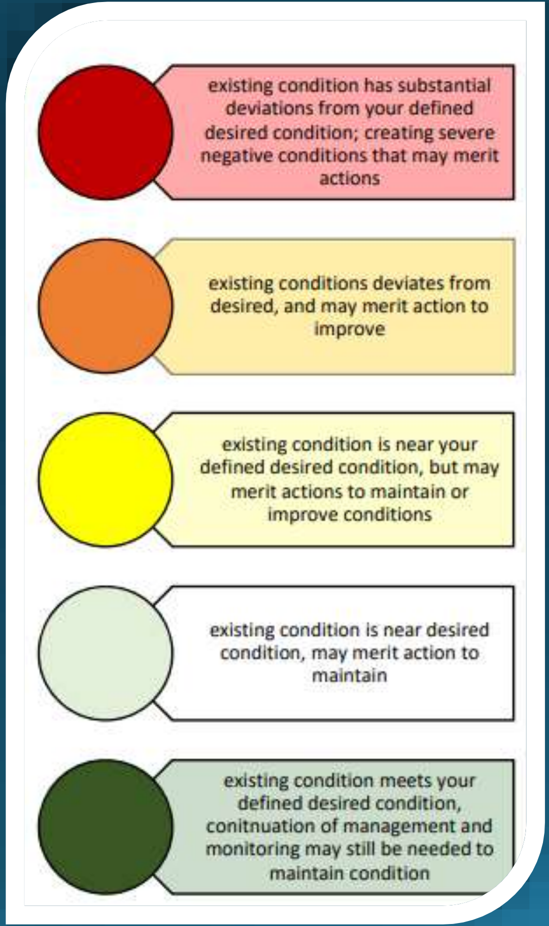


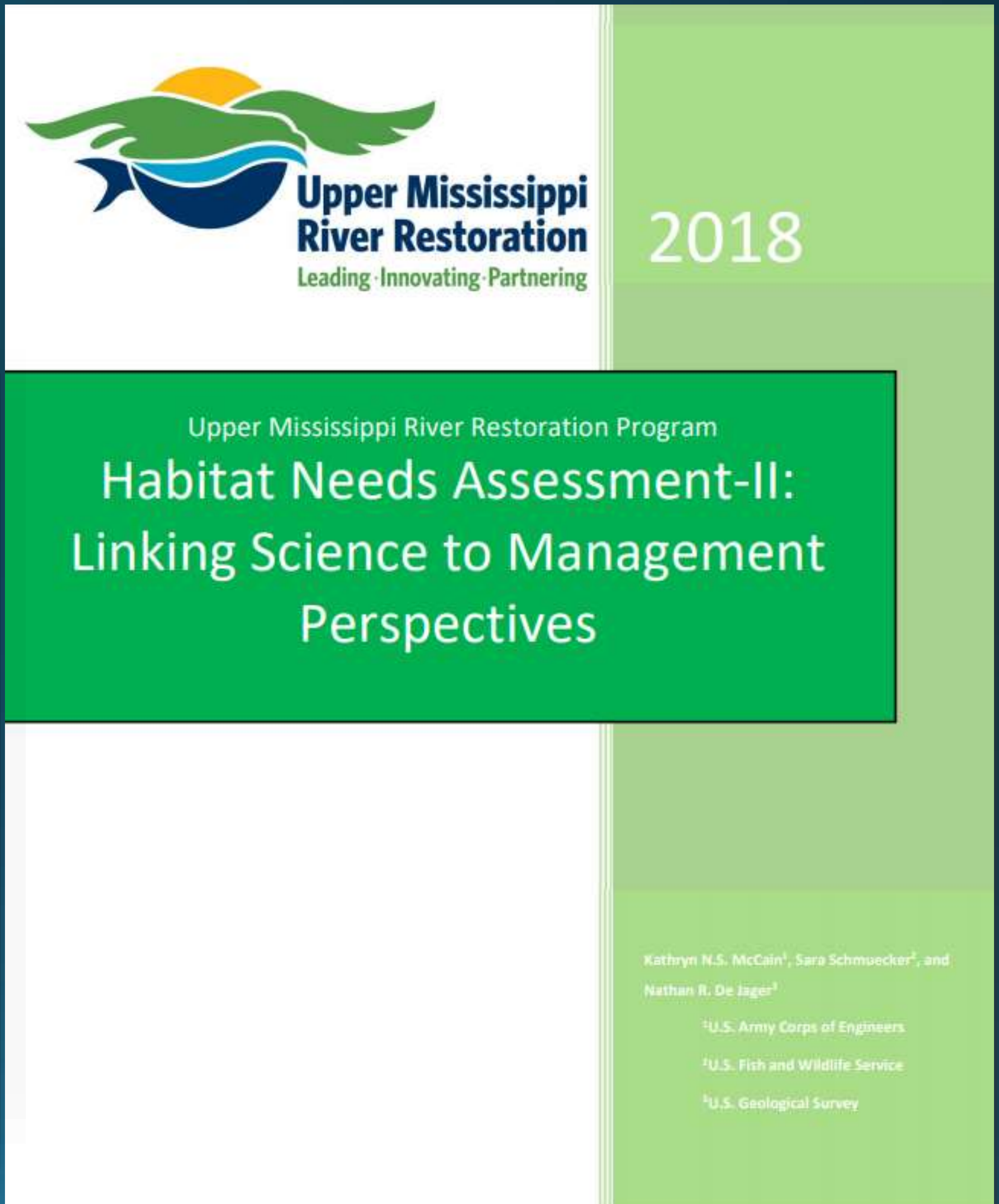
Label	Connectivity				Diversity					Slow Variables and Feedbacks		
	Longitudinal Aquatic Connectivity	Longitudinal Floodplain Connectivity	Lateral River-Floodplain Connectivity		Aquatic Functional Class Composition		Aquatic Vegetation Diversity	Floodplain Vegetation Diversity	Floodplain Functional Class Diversity	Water Surface Elevation Fluctuations		Total Suspended Solids
	% Time Gates Open	Natual Area (ha/rm)	Leveed Area (ha/rm)	Open Water (ha/rm)	AFCS1 (unitless)	AFCS2 (unitless)	Simpson's (unitless)	Simpson's (unitless)	Simpson's (unitless)	Tailwater fluctuations (m)	Pool fluctuations (m)	Average TSS (mg/L)
Upper Impounded Pools	9.91	234.32	44.32	300.40	0.49	0.49	0.57	0.69	0.79	-0.24	1.71	32.93
Middle Impounded Pools	11.22	125.58	60.46	212.32	-0.05	0.04	0.30	0.48	0.84	0.32	1.78	44.80
Pool 15	7.15	26.57	44.74	137.32	-1.28	0.82	0.03	0.73	0.60	-0.95	2.17	38.26
Lower Impounded Pools	29.70	247.93	579.88	178.63	-0.76	0.03	0.07	0.68	0.82	0.84	1.22	76.92
Open River Reaches	100.00	189.40	420.60	115.63	-1.25	0.20	0.10	0.76	0.79	4.83		209.97
Upper Illinois Pools	0.79	102.66	0.65	84.55	0.70	0.81	0.20	0.76	0.32			
Lower Illinois Pools	40.81	193.73	283.23	146.86	1.20	0.71	0.13	0.73	0.87	3.27	1.03	64.24

DeJager et al. 2018

HNA-II
Linking Science to Management Perspectives

- Combined quantitative data with qualitative assessments
- Prioritized future actions by indicator importance
- Identified desired future conditions




Upper Mississippi River Restoration
Leading·Innovating·Partnering

2018

Upper Mississippi River Restoration Program

Habitat Needs Assessment-II: Linking Science to Management Perspectives

Kathryn N.S. McCain[1], Sara Schmuecker[2], and Nathan R. De Jager[3]

[1]U.S. Army Corps of Engineers

[2]U.S. Fish and Wildlife Service

[3]U.S. Geological Survey

McCain et al. 2018

HNA-II
Linking Science to Management Perspectives

Upper Impounded[A]	Middle Impounded[B]	Poo 15[B]	Lower Impounded[B]	Open River[C]	Upper Illinois[B]	Lower Illinois[B]
Aquatic Functional Class (AFC1)	Aq Veg	Aq Veg	Open Water	AFC1	Aq Veg	TSS
Aquatic Functional Class 2 (AFC2)	FP Fxnal Class	FP Veg	AFC1	AFC2	FP Veg	FP Veg
Floodplain Functional Class Diversity (FP Fxnal Class)	AFC1	FP Fxnal Class	AFC2	FP Fxnal Class	FP Fxnal Class	FP Fxnal Class
Floodplain Vegetation Diversity (FP Veg)	AFC2	TSS	FP Fxnal Class	FP Veg	AFC1	AFC1
Aquatic Vegetation Diversity (Aq Veg)	FP Veg	Nat Area	FP Veg	Open Water	AFC2	AFC2
Longitudinal Connectivity – Natural Area (Nat Area)	Nat Area	AFC1	Aq Veg	Leveed Area	TSS	Leveed Area
Total Suspended Solids Concentrations (TSS)	Open Water	AFC2	Leveed Area	Nat Area	TW Flux	Aq Veg
Lateral Connectivity – Open Water (Open Water)	TSS	TW Flux	Nat Area	Aq Veg	Nat Area	Open Water
Pool Flux Difference (Pool Flux)	TW Flux	Open Water	TSS	% Time	Leveed Area	TW Flux
Tailwater Flux Difference (TW Flux)	Pool Flux	Leveed Area	TW Flux	TW Flux	Open Water	Pool Flux
Lateral Connectivity – Leveed Area (Leveed Area)	Leveed Area	Pool Flux	Pool Flux	TSS	Pool Flux	Nat Area
% Time Gates Open (% Time)	% Time	% Time	% Time	Pool Flux (n/a)	% Time	% Time

High
Order of Importance
Low

McCain et al. 2018

HNA-II

Linking Science to Management Perspectives

	Desired Future Conditions as Identified by the River Teams
Upper Impounded	• Improve function and diversity of aquatic habitat types by improving quality, depth and distribution of lotic and lentic habitats • Maintain and enhance aquatic vegetation diversity • Maintain and enhance floodplain vegetation diversity, including hard-mast trees • Restore floodplain topographic diversity and diversify inundation periods
Middle Impounded	• Maintain and enhance aquatic vegetation diversity • Restore floodplain topographic diversity and diversify inundation periods • Restore function and diversity of aquatic habitat types by improving quality, depth and distribution of lotic and lentic habitats • Restore, maintain and enhance floodplain vegetation diversity, including hard-mast (nut-producing) trees
Pool 15	• Maintain and enhance aquatic vegetation diversity
Lower Impounded	• Improve open water connectivity conditions, including island restoration • Restore function and diversity of aquatic habitat types by improving quality, depth and distribution of lotic and lentic habitats • Restore, maintain and enhance floodplain vegetation diversity, including hard-mast (nut-producing) trees
Open River	• Restore function and diversity of aquatic habitat types by improving quality, depth and distribution of lotic and lentic habitats • Restore floodplain topographic diversity (including ridge and swale) and diversify inundation periods to mimic pre-dam conditions • Restore, maintain and enhance floodplain vegetation diversity, including hard-mast (nut-producing) trees
Upper Illinois	• Maintain, enhance and restore aquatic vegetation diversity • Restore floodplain topographic diversity and diversify inundation periods • Restore, maintain and enhance floodplain vegetation diversity, including hard-mast (nut-producing) trees, where feasible
Lower Illinois	• Reduce sedimentation and total suspended solids concentrations • Restore, maintain and enhance floodplain vegetation diversity, including hard-mast (nut-producing) trees • Restore floodplain topographic diversity and diversify inundation periods

Other Existing Plans

- Upper Mississippi River National Wildlife and Fish Refuge Habitat Management Plan (USFWS, 2019)
- A Strategic Plan for the Upper Mississippi River Restoration Program (USACE, 2015)
- Upper Mississippi River Systemic Forest Stewardship Plan (USACE, 2012)
- Upper Mississippi River System Ecosystem Restoration Objectives (USACE, 2009/2011)
- UMR National Wildlife and Fish Refuge Comprehensive Conservation Plan (USFWS, 2006)
- Final Integrated Feasibility Report and Programmatic Environmental Impact Statement for the UMR-IWW System Navigation Feasibility Study (2004, NESP)
- State Wildlife Action, Management & Strategic Plans
- Mississippi River Environmental Pool Plans (River Teams)
- Master Plans (USACE)
- Among others….

Data Gaps & Areas of Concern

Data and Science Gaps

- All of the Data and Science information needs identified in previous presentation (J. Houser)
- HNA-II Recommendations (McCain et al. 2018)
  - Develop and validate species or community-habitat models
  - Refine data layers for project-scale application and improve indicator understanding
  - Develop more specific restoration habitat objectives
  - Refine hydrologic models
  - Improve system-wide data
  - Develop model(s) to forecast future habitat conditions

Concerns

- Policy and landownership/management constraints limiting where restoration can occur on the landscape
- Ability to successfully detect and respond to emerging and future threats, such as
  - Climate change
  - Invasive species

Next Steps and Resources Needed

Moving Forward

Where & How Much?

- Continue to build on existing knowledge of the system (resilience, HNA-II) to inform what kind of work, where, and how much is necessary to achieve our desired conditions
- Continue to work towards resolving project implementation challenges, where present

Beneficial Use of Dredged Material

- Reduce impacts through seeking alternative solutions
- Work through barriers to make use of dredged material for environmental benefit a regular practice

Refine Management Toolbox

- Investigate how to achieve optimum results while minimizing negative impacts
- Continue to apply lessons learned to UMRR Environmental Design Handbook
- Monitor and learn from management installments

Natural Solutions

- Identify more natural material and environmentally friendly solutions
- Strive for solutions with low operation and maintenance needs

Build in Resilience to Climate Change and Future Threats

- Continue to build on existing knowledge of the system to inform long-term management and sustainability
- Increase our capabilities for early identification and response to emerging threats

Looking Ahead