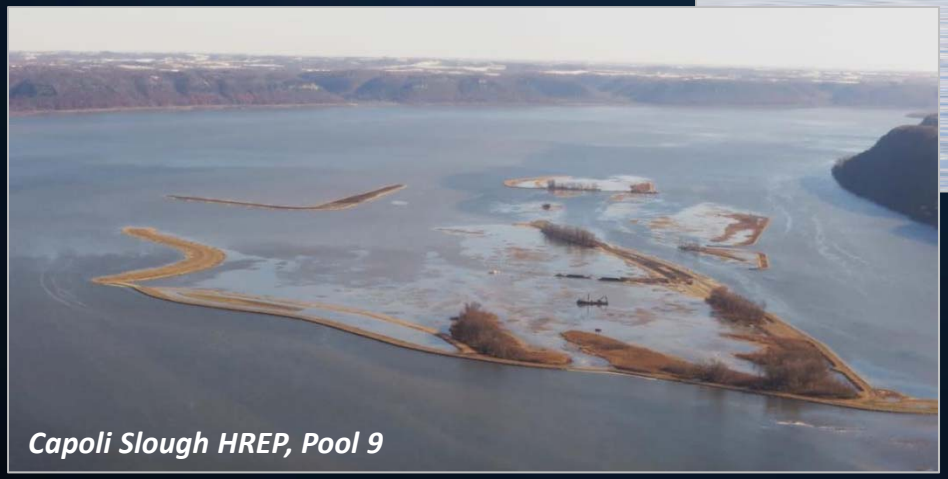
How Hydraulic Connectivity Drives Water Quality and Habitat Outcomes:

Northern Perspective



Capoli Slough HREP, Pool 9

Jeff Janvrin
Mississippi River Habitat Specialist
Wisconsin DNR, - La Crosse

Upper Mississippi River Restoration
Leading · Innovating · Partnering

US Army Corps of Engineers

ILLINOIS NATURAL HISTORY SURVEY

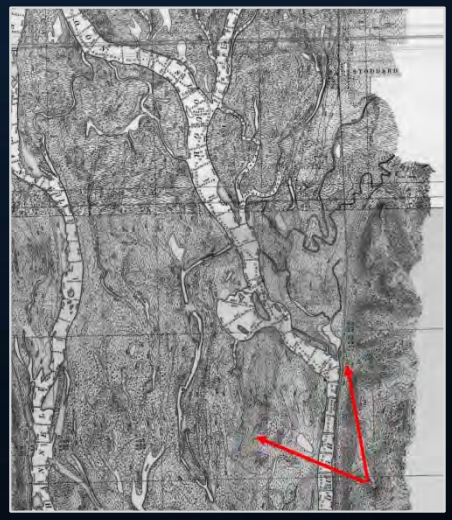
USGS

DNR

At times, it appears our data driven baseline conditions begin in the mid to late 1980's. However, the art of river restoration is enhanced by understanding baseline historic conditions and how changes in connectivity have altered habitats and rates of processes.

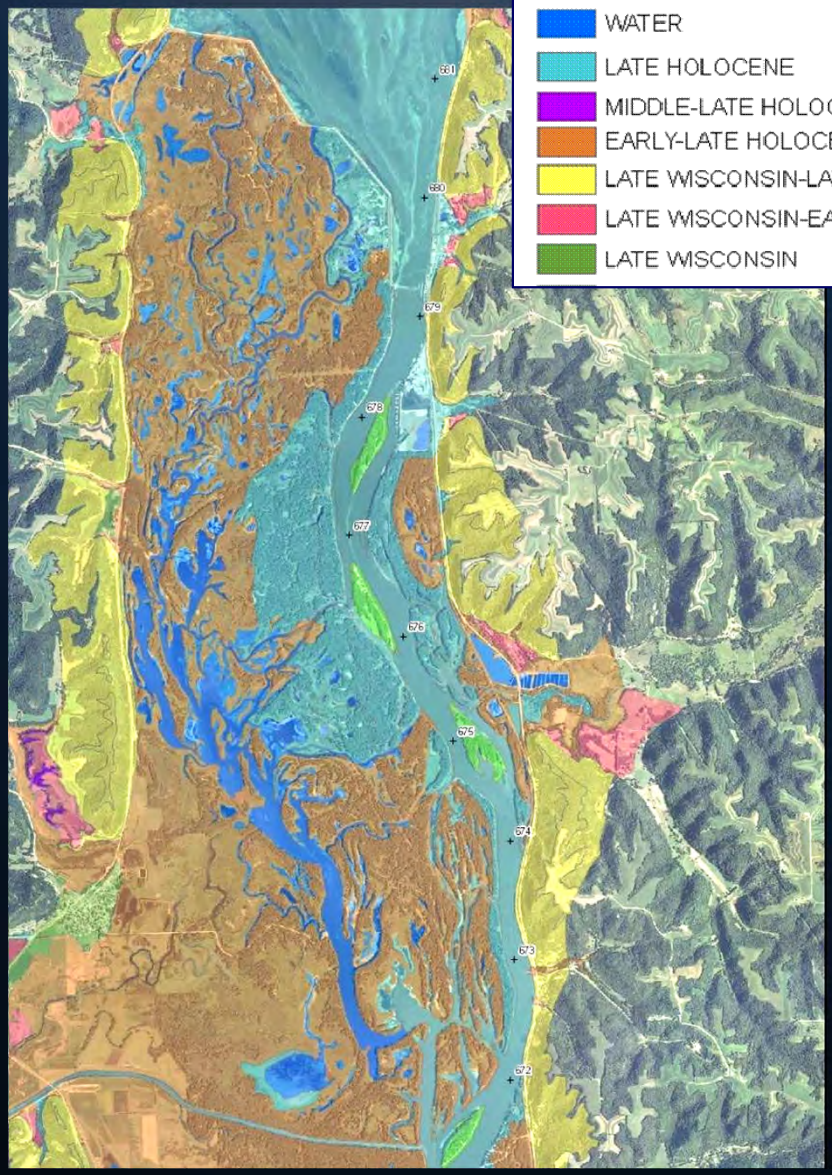
Lawrence Lake, Pool 8, circa 1890

Coon Slough, Pool 8, circa 1890



What was the "Natural" Geomorphic Template and Rate of Change?

Reno Bottoms Backwater Complex, Upper Pool 9, Upper Mississippi River



APPROXIMATE AGE	
WATER	
LATE HOLOCENE	2,500 – 3,500 yrs. BP
MIDDLE-LATE HOLOCENE	2,500 – 6,700 yrs. BP
EARLY-LATE HOLOCENE	2,500 – 10,000 yrs. BP
LATE WISCONSIN-LATE HOLOCENE	2,500 – > 10,000 yrs. BP
LATE WISCONSIN-EARLY HOLOCENE	> 10,000 yrs. BP
LATE WISCONSIN	> 10,000 yrs. BP

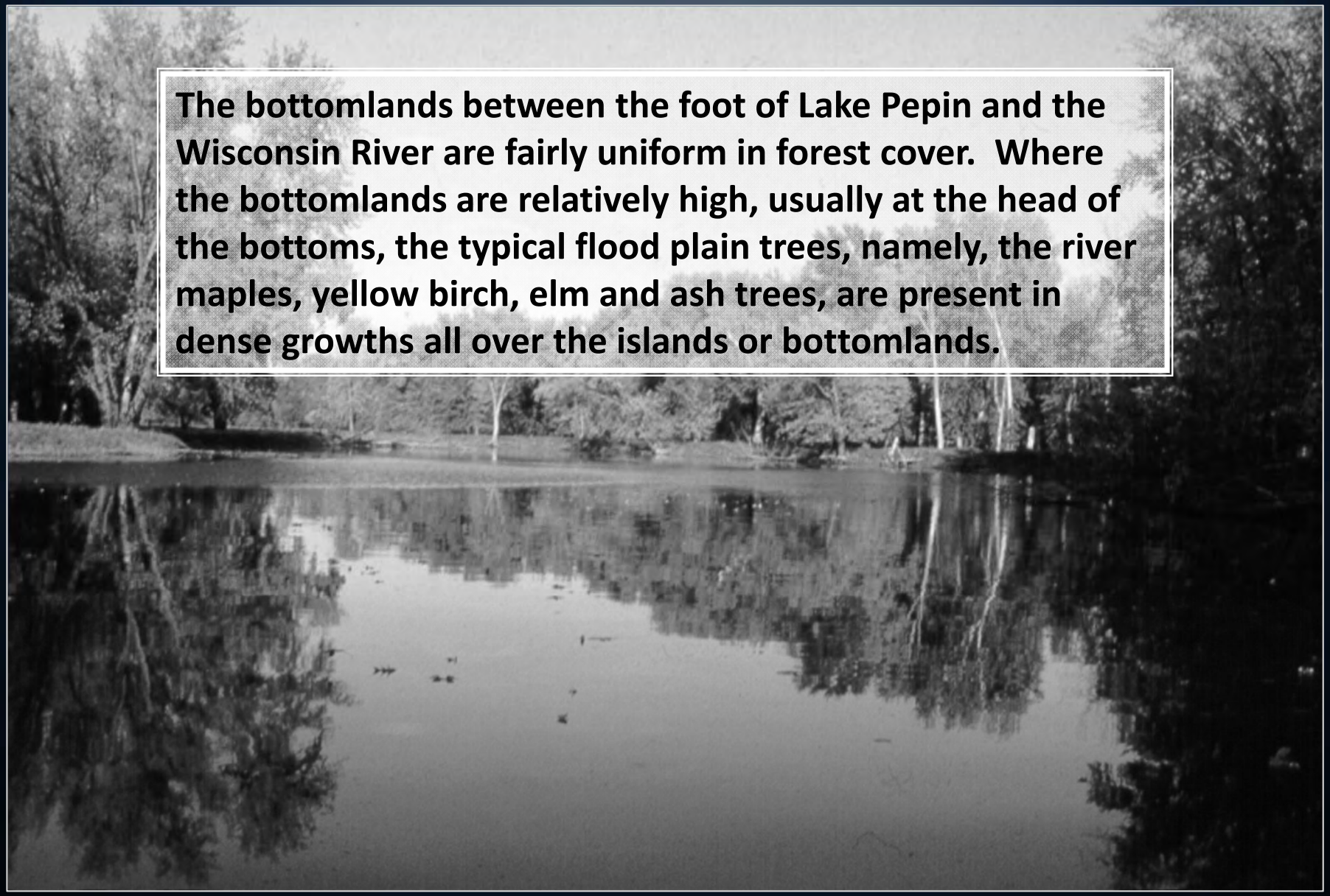
Source: USACE La Crescent – Reno Bottoms HGM Study for Reno Bottoms NESP Feasibility

The geomorphic template was a primary driver of connectivity

Geomorphology

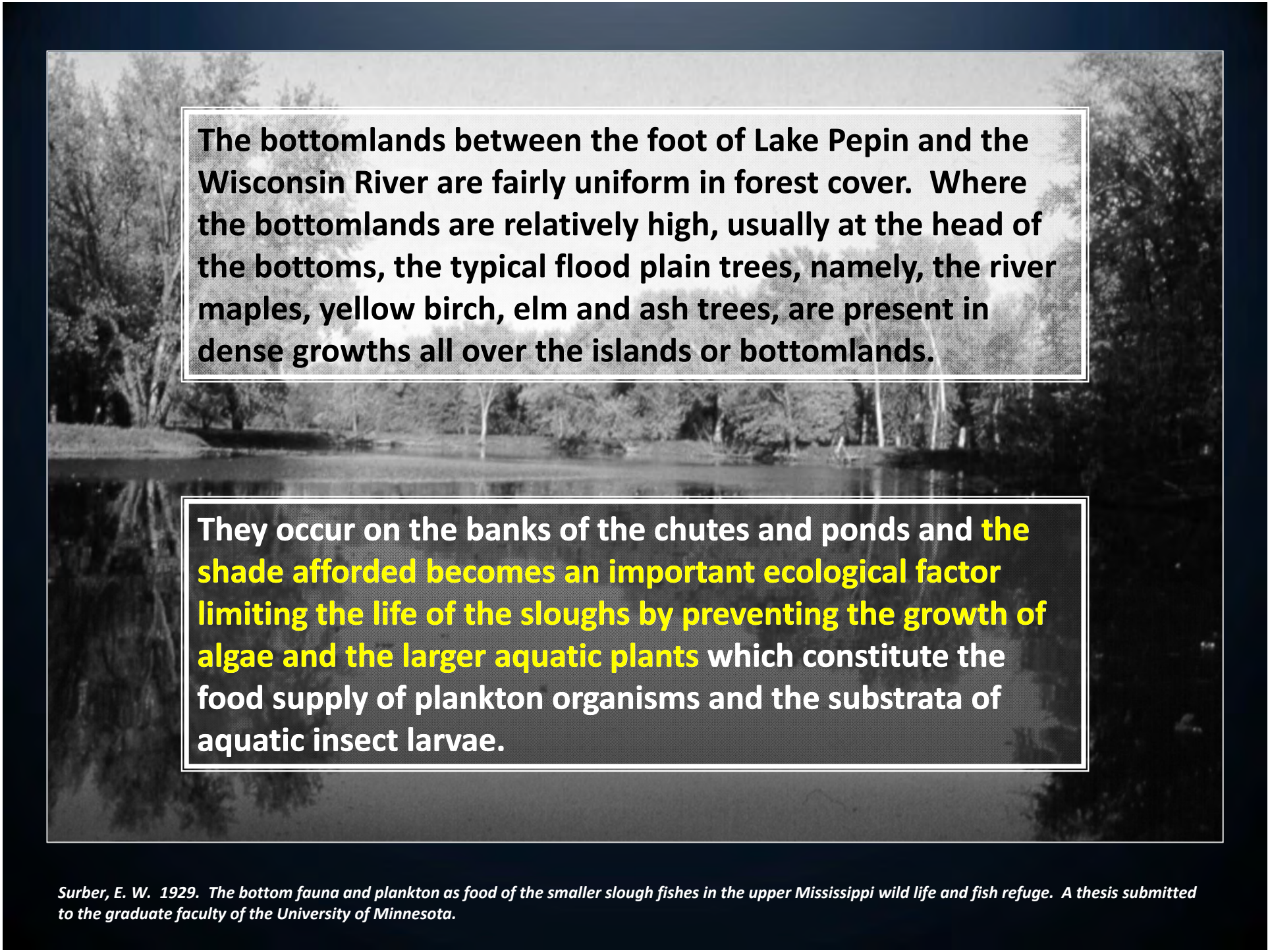
Forest Cover

- Sediment transport and deposition
- Flow distribution
- Terrestrial and aquatic communities



Surber, E. W. 1929. The bottom fauna and plankton as food of the smaller slough fishes in the upper Mississippi wild life and fish refuge. A thesis submitted to the graduate faculty of the University of Minnesota.

Forests Communities Influence Sediment Transport



The bottomlands between the foot of Lake Pepin and the Wisconsin River are fairly uniform in forest cover. Where the bottomlands are relatively high, usually at the head of the bottoms, the typical flood plain trees, namely, the river maples, yellow birch, elm and ash trees, are present in dense growths all over the islands or bottomlands.

They occur on the banks of the chutes and ponds and the shade afforded becomes an important ecological factor limiting the life of the sloughs by preventing the growth of algae and the larger aquatic plants which constitute the food supply of plankton organisms and the substrata of aquatic insect larvae.

Surber, E. W. 1929. The bottom fauna and plankton as food of the smaller slough fishes in the upper Mississippi wild life and fish refuge. A thesis submitted to the graduate faculty of the University of Minnesota.

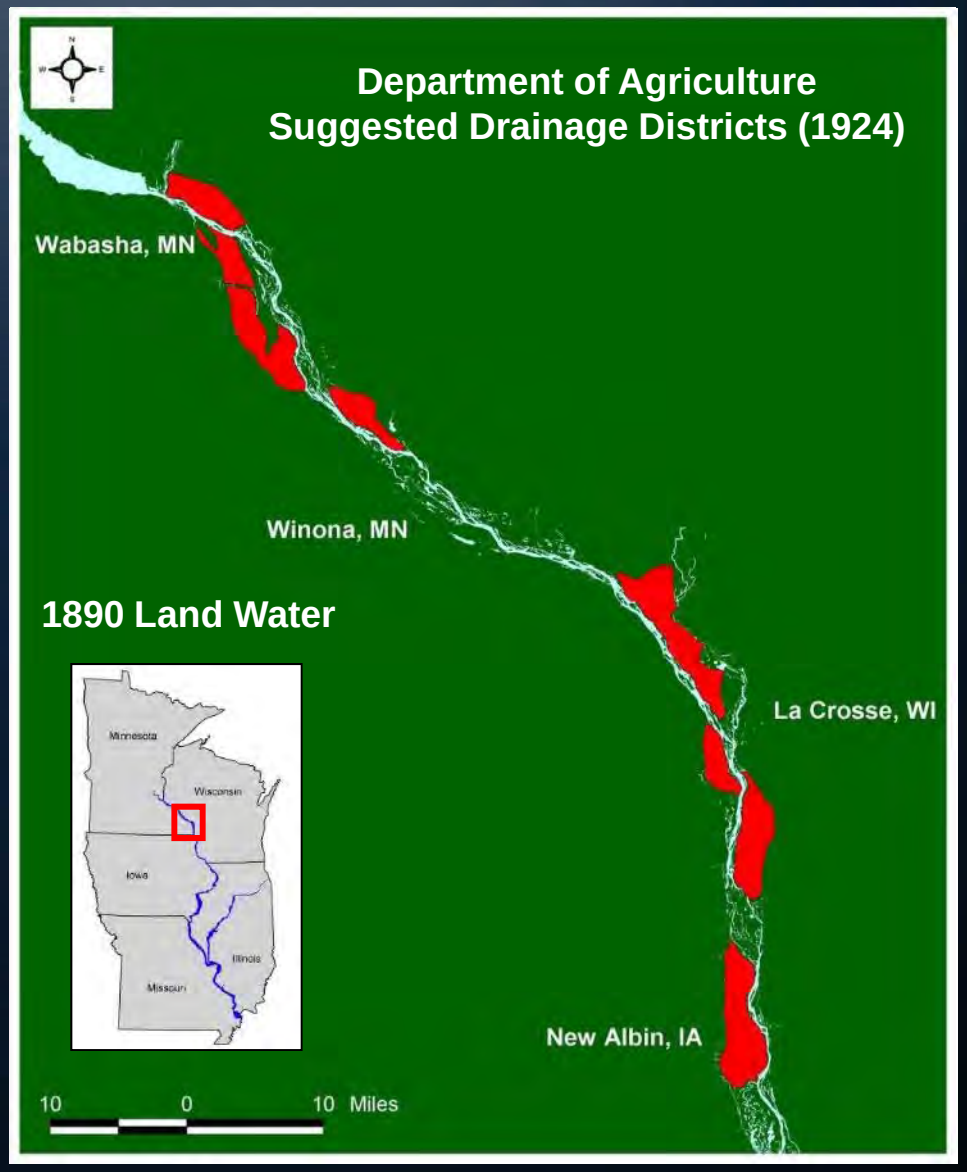
Geomorphology: Isolated Wetlands and Lakes

Geomorphology

"There are many of these lakes. Martin (1916) counted over 200 of them in an area of about 20 square miles in the Wisconsin section between Lynxville and De Soto, only the lakes that had no connection with the river being counted, the sloughs and bays being excluded. It seems that the number of lakes in the other parts of the river is not less than in this section."

Galstoff, 1924

William H. Dilg
1869 - 1927



1924

Testimony for Establishment of the Upper Mississippi Wild Life and Fish Refuge, 1924

Crooked Slough and Winnishiek Bottoms, Pool 9, circa 1890

House

"...that area represents to the wild life of the upper Mississippi River Valley the last stand, and especially the last stand of the warm water game fishes of the United States, and particularly the black bass"

(Dilg)

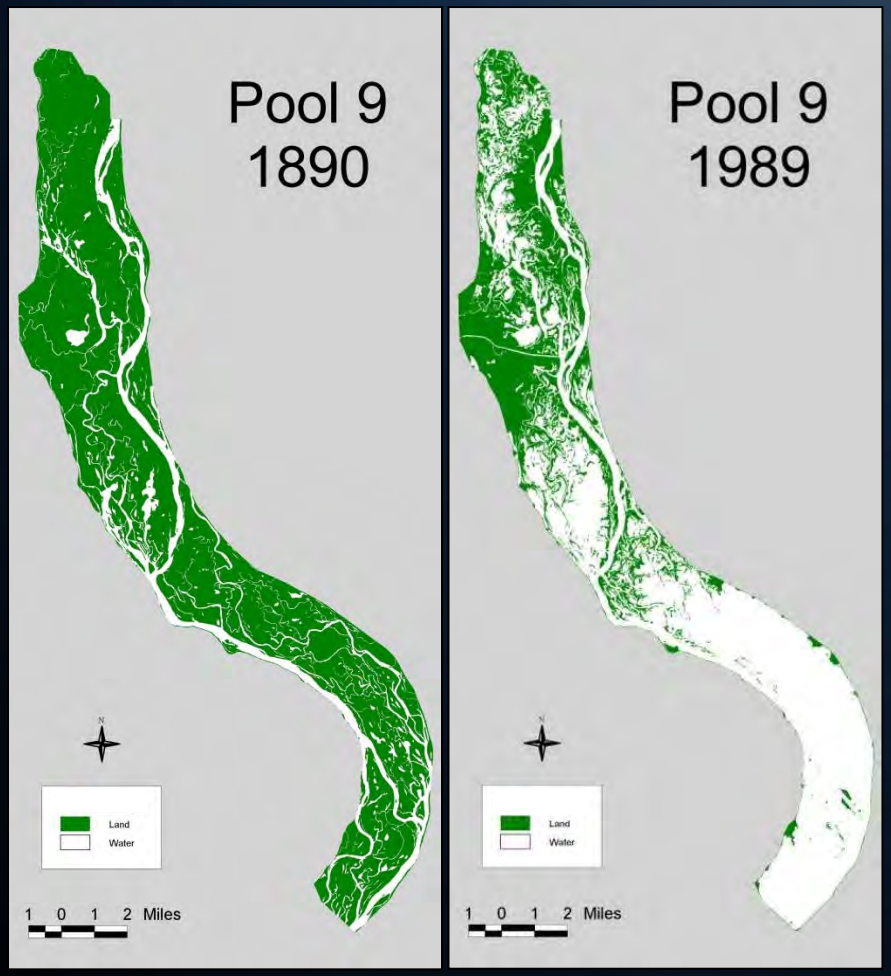
Senate

"When the water recedes the fish, with the exception of small-mouthed black bass and the channel catfish, spawn in these backwaters. The large-mouthed black bass you will find in these back stretches..."

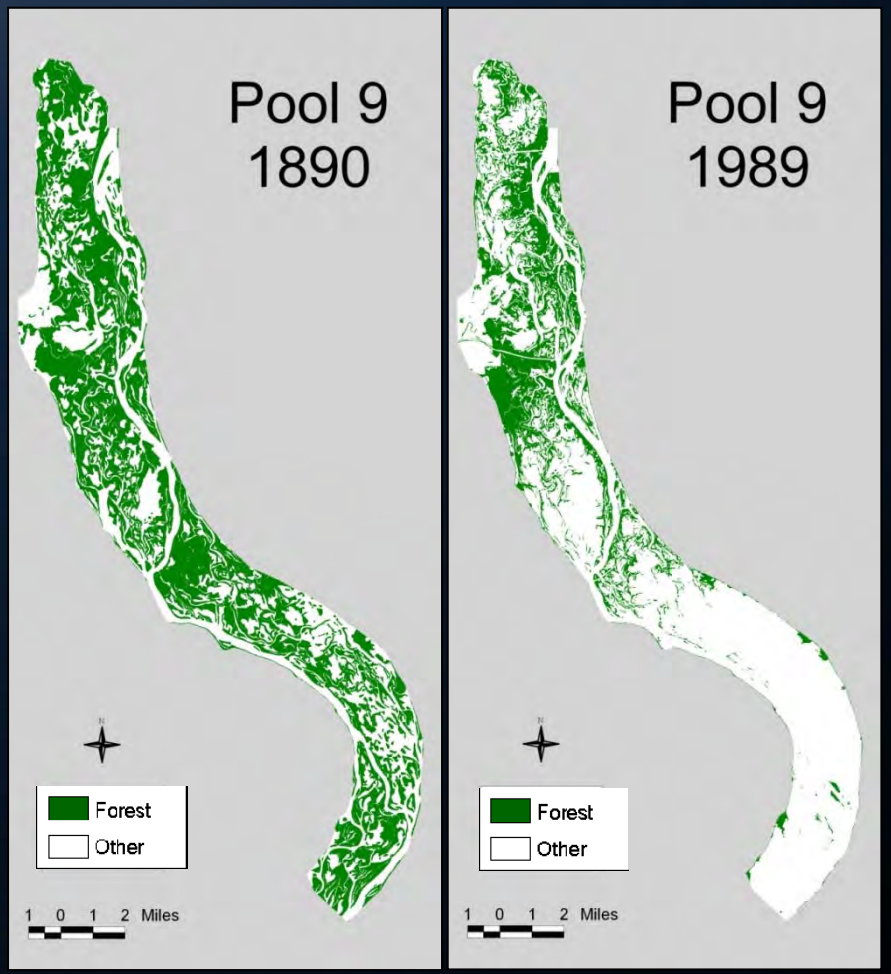
(Culler)

Impoundment has influenced connectivity and sediment transport/deposition by altering flow distribution, floodplain roughness.

Geomorphology

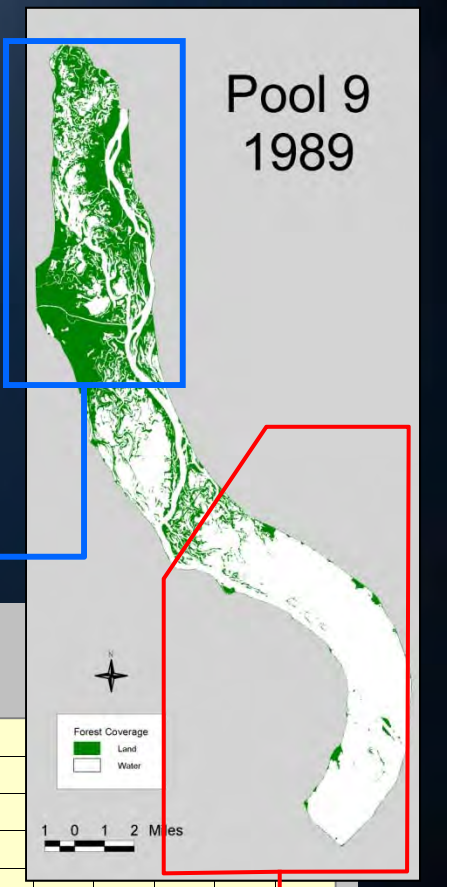


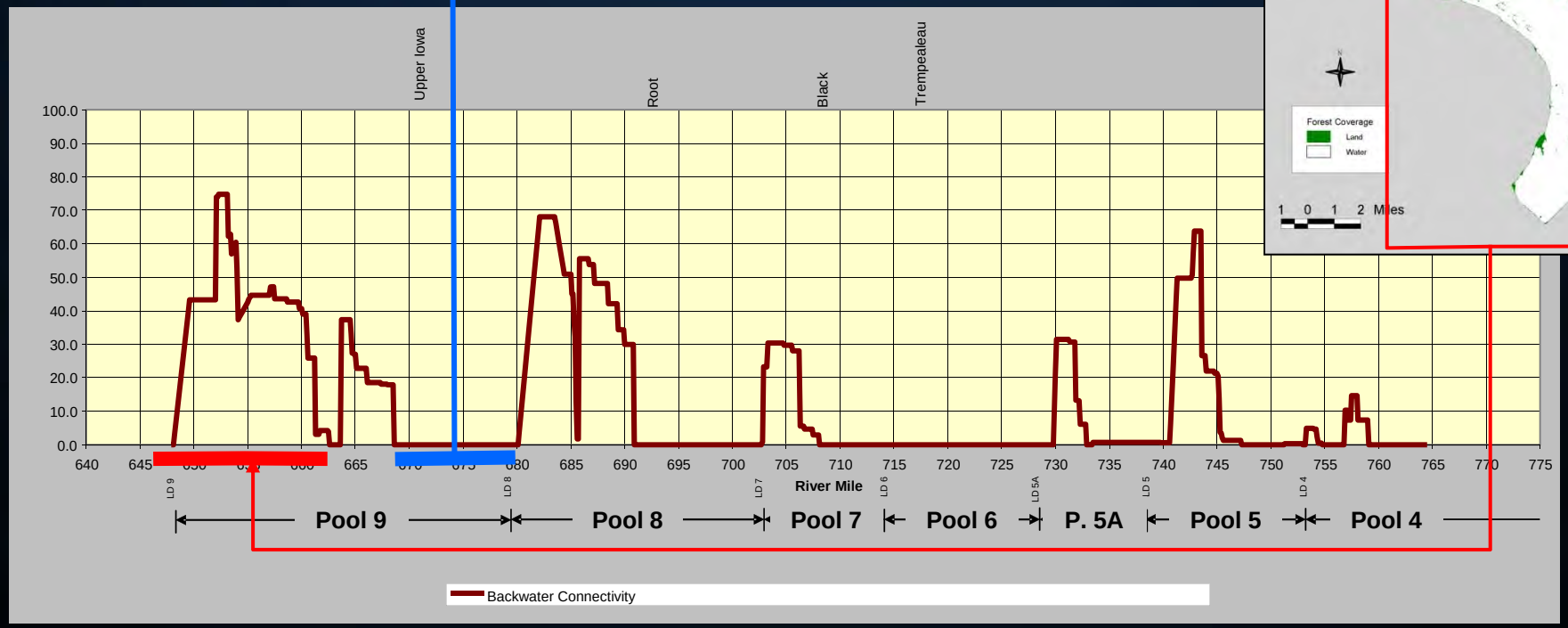
Forest Cover



Geomorphic Reach 3
Backwater Hydraulic Connectivity for Moderate Flows (25% Duration Event)

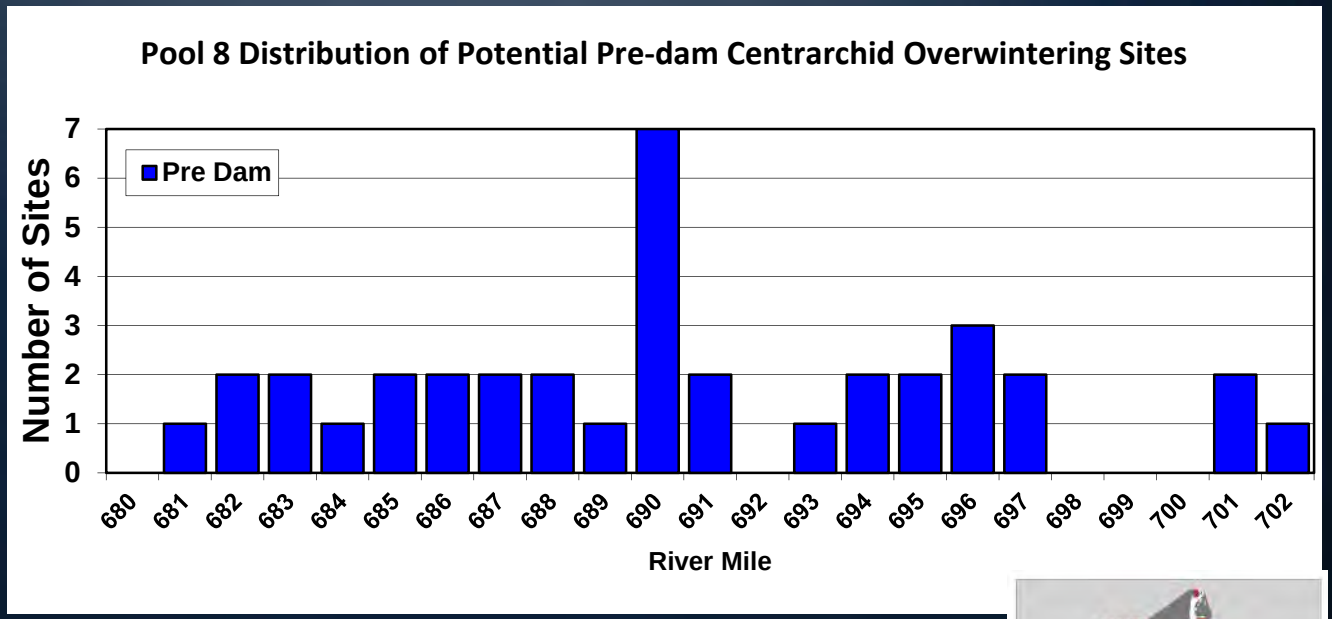
Backwater connectivity is plotted as percent of total river flow conveyed in backwaters.

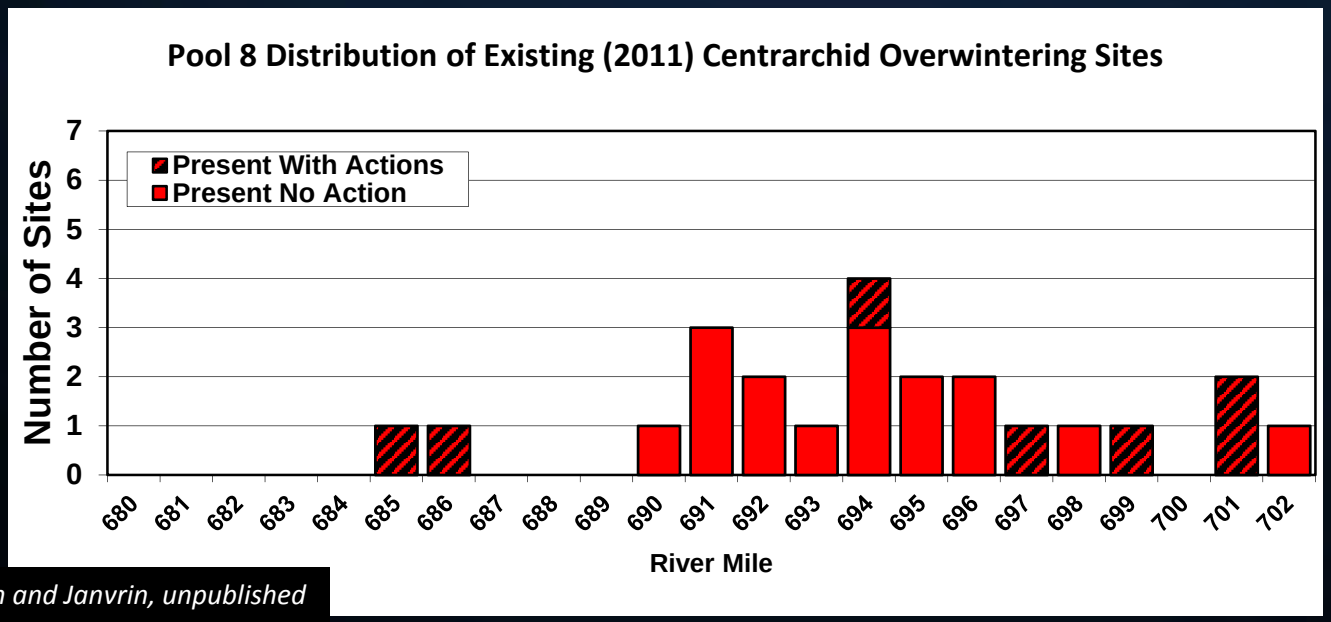


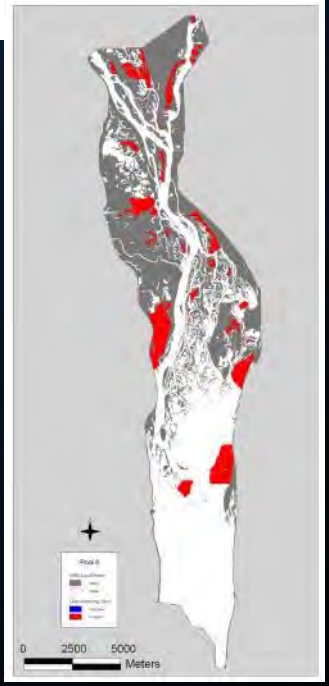


Source: Jon Hendrickson, USACE – St. Paul

Comparison of Pool 8 Potential 1890 and Known 2011 Distribution of Centrarchid OW Habitat

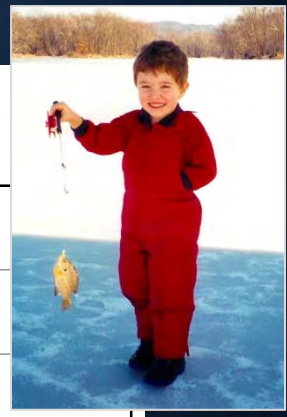


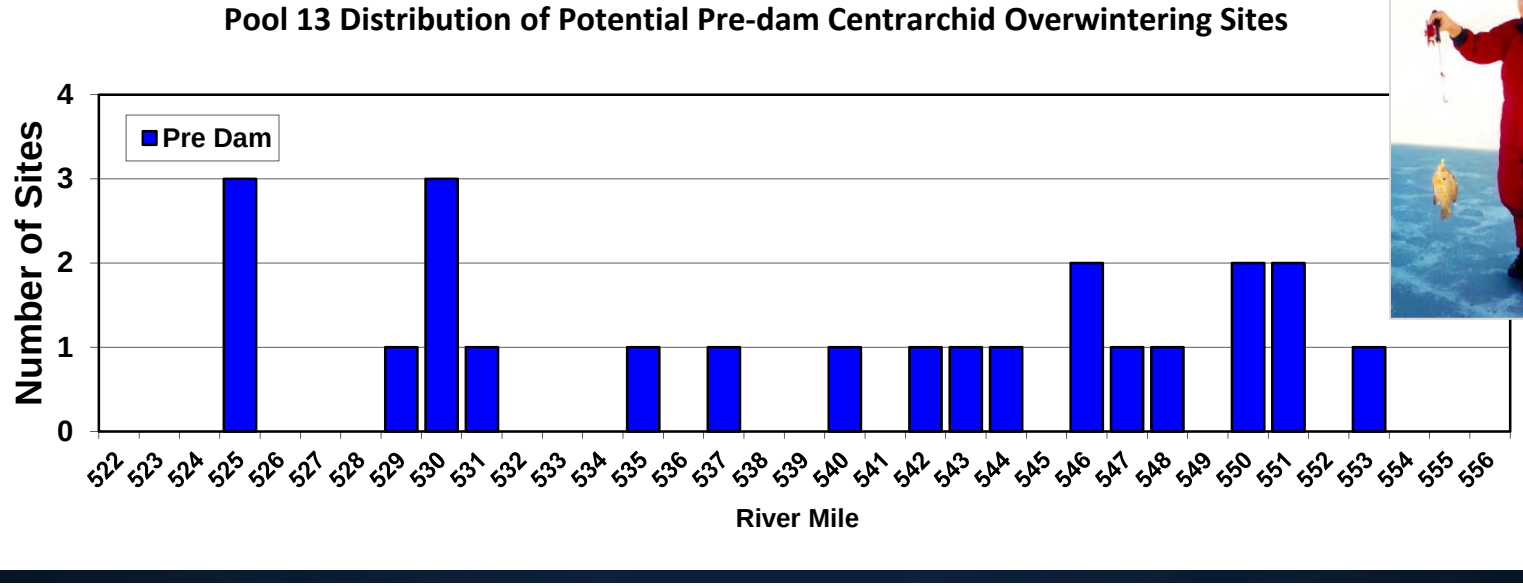


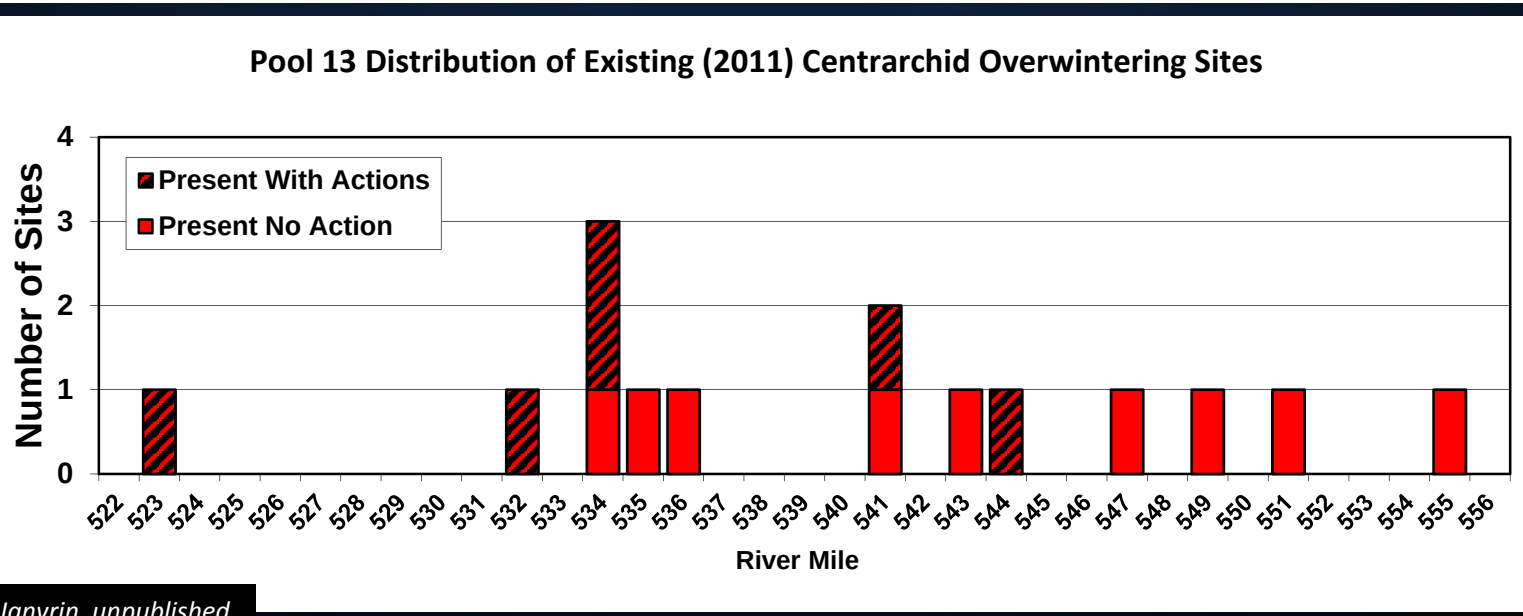


Hansen and Janvrin, unpublished

Comparison of Pool 13 Potential 1890 and Known 2011 Distribution of Centrarchid OW Habitat







Hansen and Janvrin, unpublished

Common HREP Goals/Objectives

- Increase and maintain quality dabbling duck habitat
- Increase and maintain quality diving duck habitat
- Create habitat for neotropical migrants and shorebirds
- Create turtle nesting habitat
- Create backwater fish overwintering habitat
- Enhance backwater fish spawning and summer habitat
- Enhance channel habitat for riverine fish and mussels
- Increase emergent, submersed and floating leaved aquatic vegetation
- Create sand/mud flats and isolated wetlands




Upper Mississippi River Restoration

Some Physical Factors Affecting Aquatic Vegetation

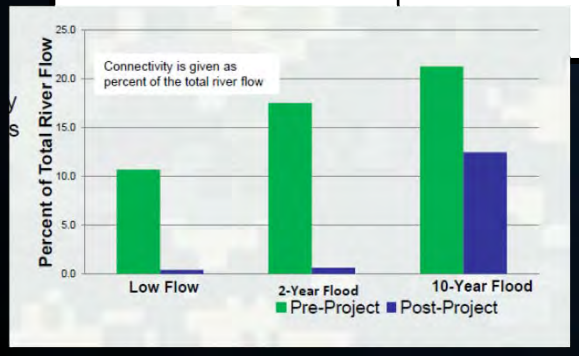
- Seed Source
- Grazing
- Overwinter Tuber Survival
- Nutrients
- Water Clarity
- Water Depth
- Sediment Type
- Hydrograph
- **Water Velocity**
- **Wind Fetch**

Criteria to Achieve Aquatic Vegetation Objectives

Source: Upper Mississippi River System Environmental Design Handbook
http://www.mvr.usace.army.mil/EMP/designhandbook.htm

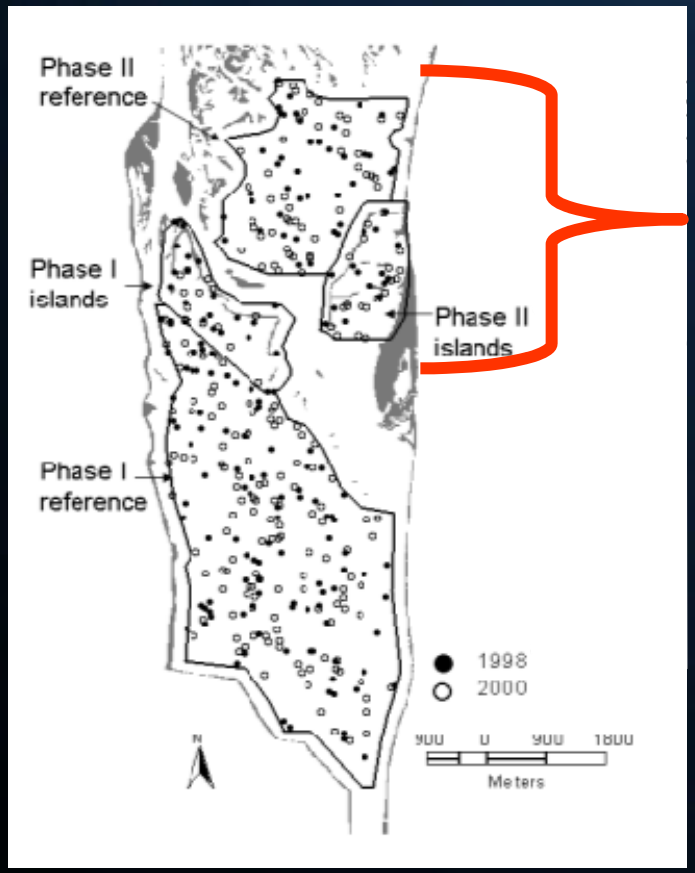
	Depth (feet)	Average Velocity (mps)	Water Clarity	Wind Fetch
Emergent Aquatics	0 - 2	< 0.03	**Secchi* > 0.5 m or Turbidity* < 20 ntu** *To be met as average during May 15 to Sept. 15 growing season **UMRCC Submersed Veg. WQ Criteria**	Wind fetch/plant growth relationship isn't clear, but can look at critical shear stress for sediment resuspension:
Submersed Aquatics	1.3 – 5.2	< 0.15		Water depth (ft) 1 2 3 4
Floating Aquatics	.6 – 2.6	< 0.06		Wind Fetch (ft) 1500 3500 6000 9000

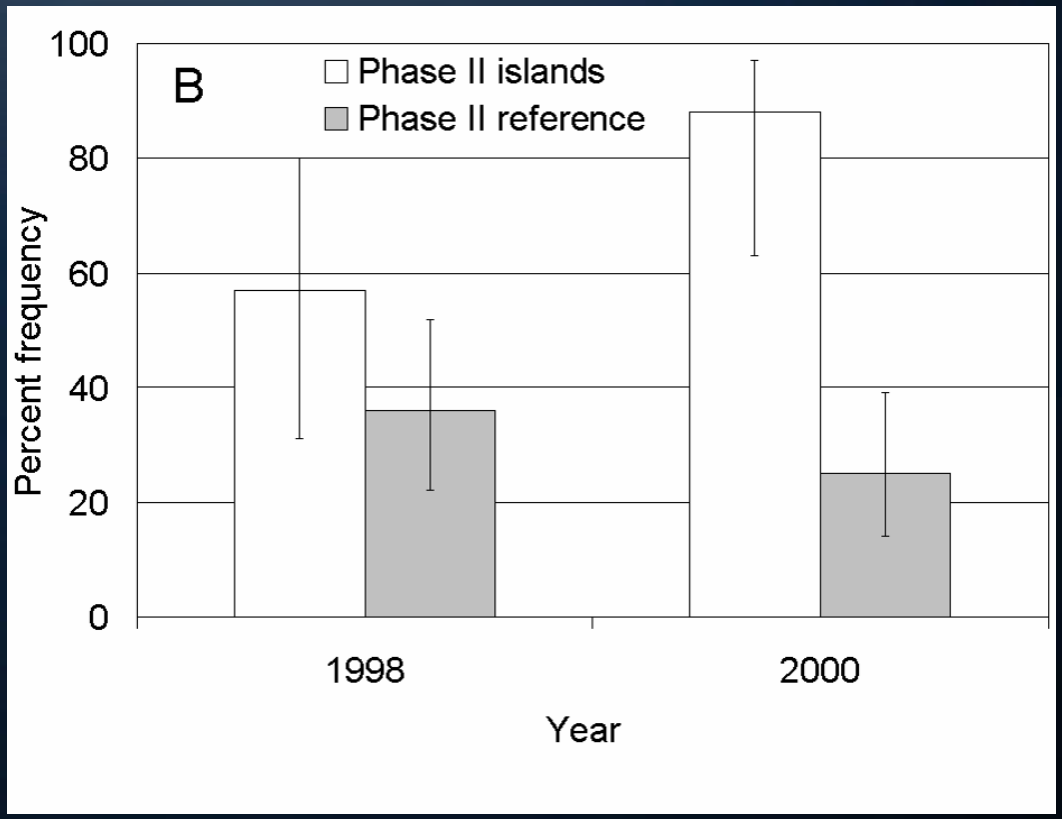
Phase II Design



Observed Increase in Aquatic Vegetation was Significant

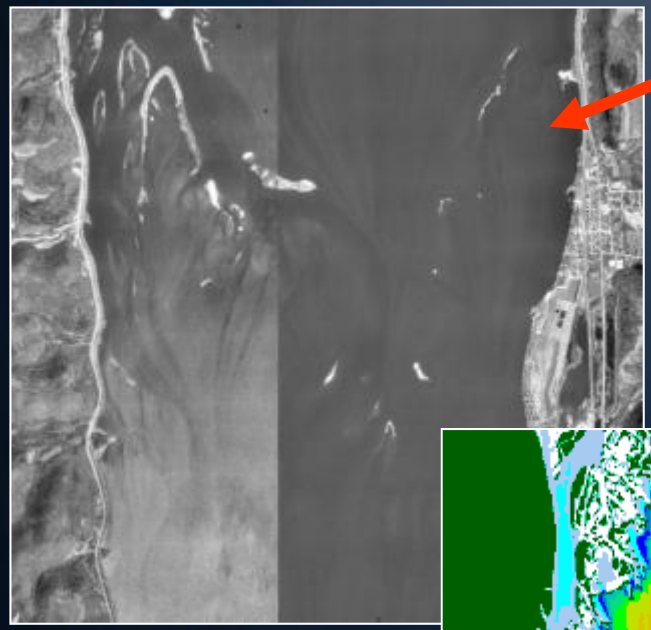

Pool 8 Islands, Phase II



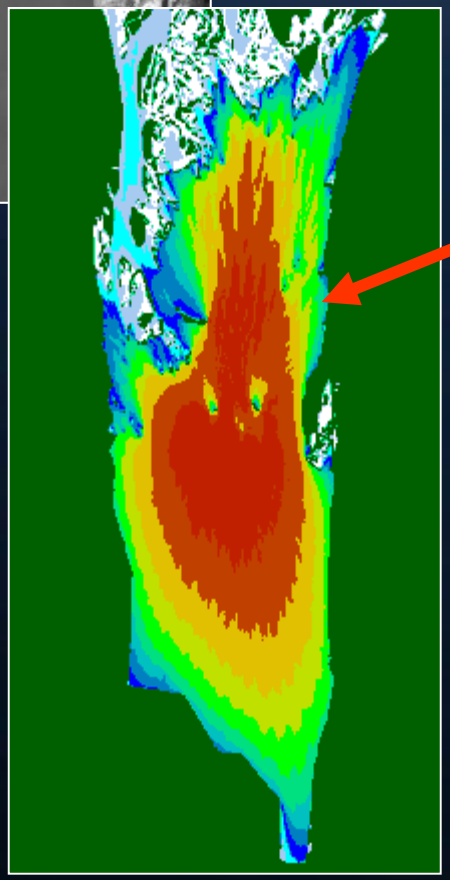


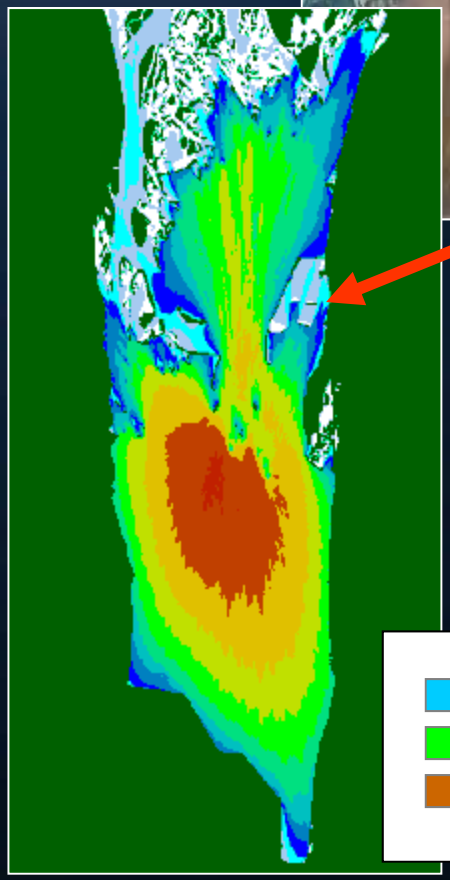
Graph and Figure from: Langrehr, Gray and Janvrin. 2007. Evaluation of Aquatic Macrophyte Community Response to Island Construction in the Upper Mississippi River. Lake and Reservoir Management 23:313-320

Upper Mississippi River Restoration



Criteria Met: Wind Fetch Reduced





Lowest fetch

Highest fetch

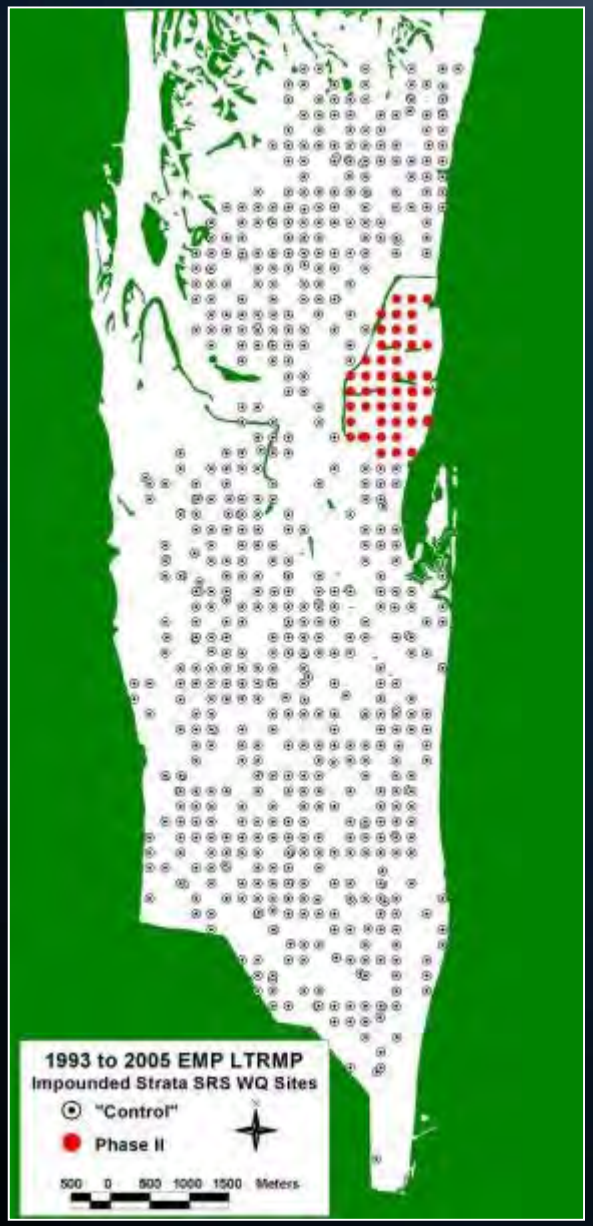
1989

1999

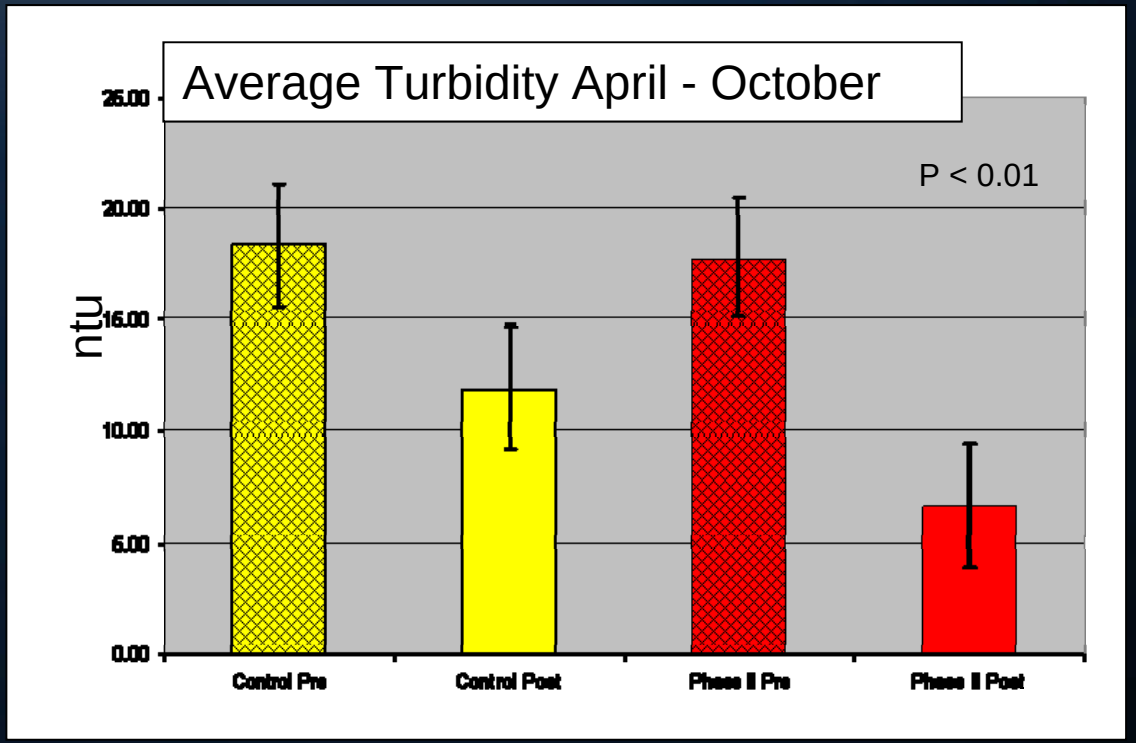
Wind fetch graphic used with permission from Jim Rogala, USGS UMESC

Upper Mississippi River Restoration

Why did vegetation increase?



Turbidity was significantly reduced
Criteria Met (<20 ntu)



Pre = 1993-1997 Post = 1999 - 2005

Source: John Sullivan and Jeff Janvrin, WDNR, unpublished

Why did vegetation increase?

Criteria Met: Velocity Significantly Reduced

Pre = 1993-1997 Post = 1999 - 2005

Source: John Sullivan and Jeff Janvrin, WDNR, unpublished

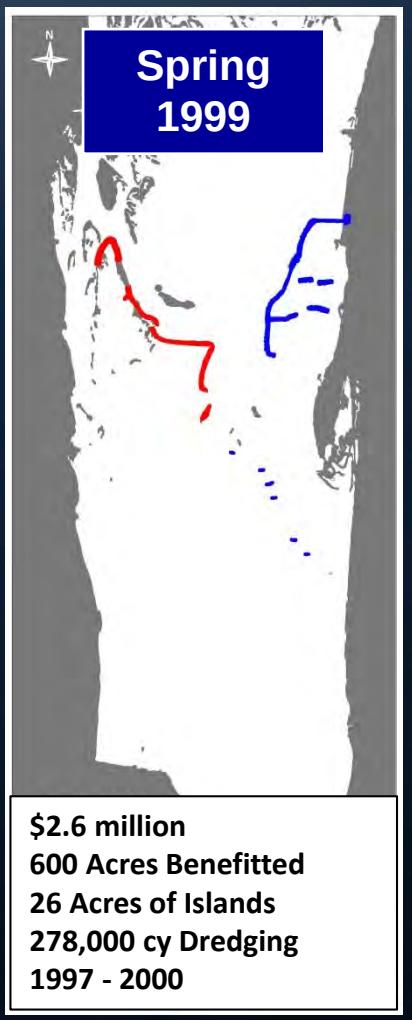
Cumulative Response to Island Restoration
Upper Mississippi River - Lower Pool 8

Pre Project

Phase I

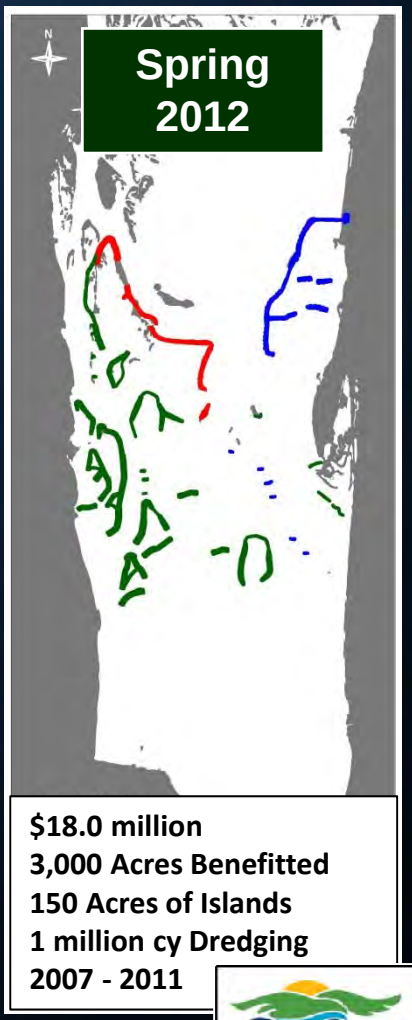
$1.8 million
1,000 Acres Benefitted
26 Acres of Islands
275,000 cy Dredging
1989 - 1993

Phase II



$2.6 million
600 Acres Benefitted
26 Acres of Islands
278,000 cy Dredging
1997 - 2000

Phase III

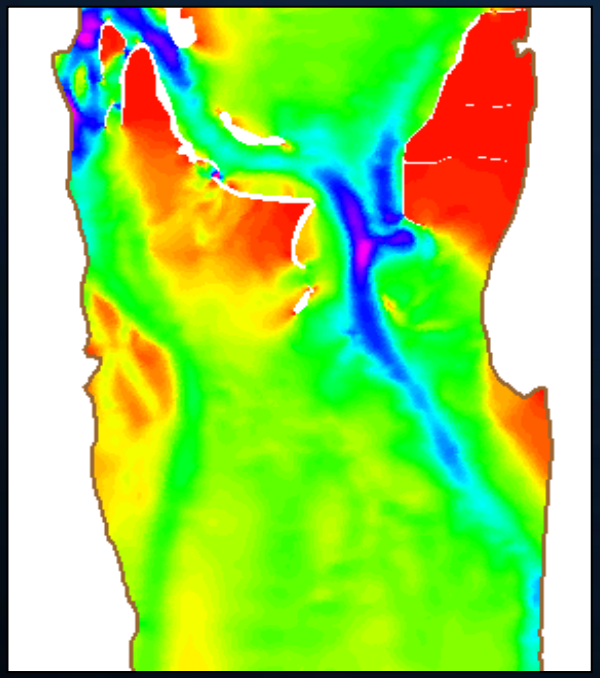


$18.0 million
3,000 Acres Benefitted
150 Acres of Islands
1 million cy Dredging
2007 - 2011

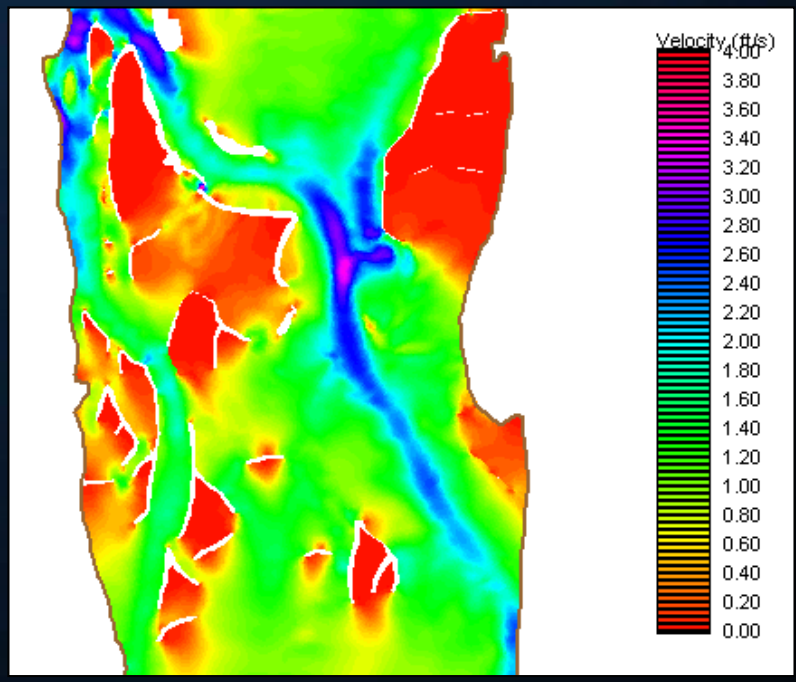
Upper Mississippi River Restoration
Leading Innovating Partnering

Hydraulic Model Results for 80,000 cfs In the Pool 8 Islands Phase III Area

2001 Conditions



Predicted Change



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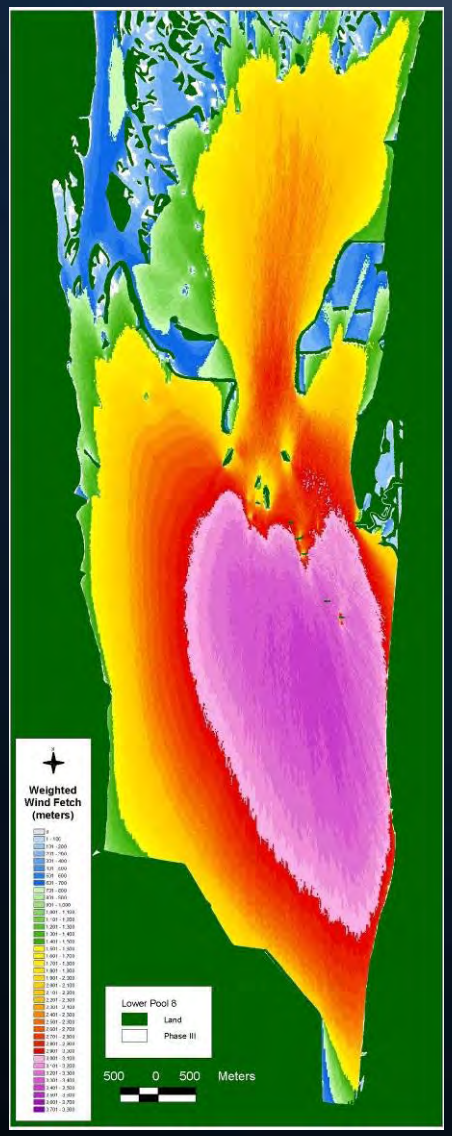
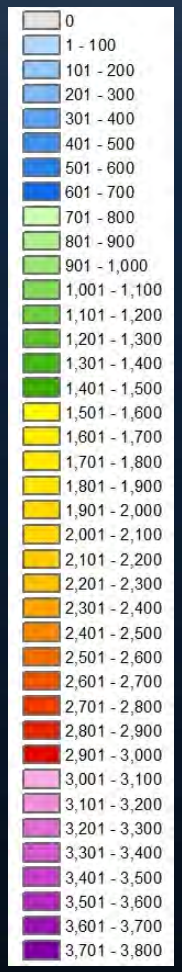
Phase III Change to Weighted Wind Fetch

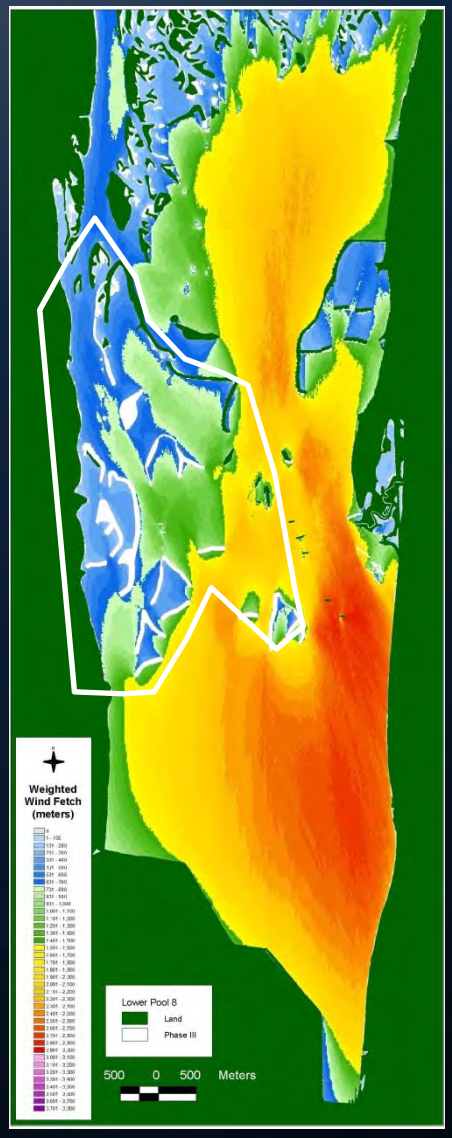
Pre Project



Weighted Wind Fetch (m)



Post Project
(2012)

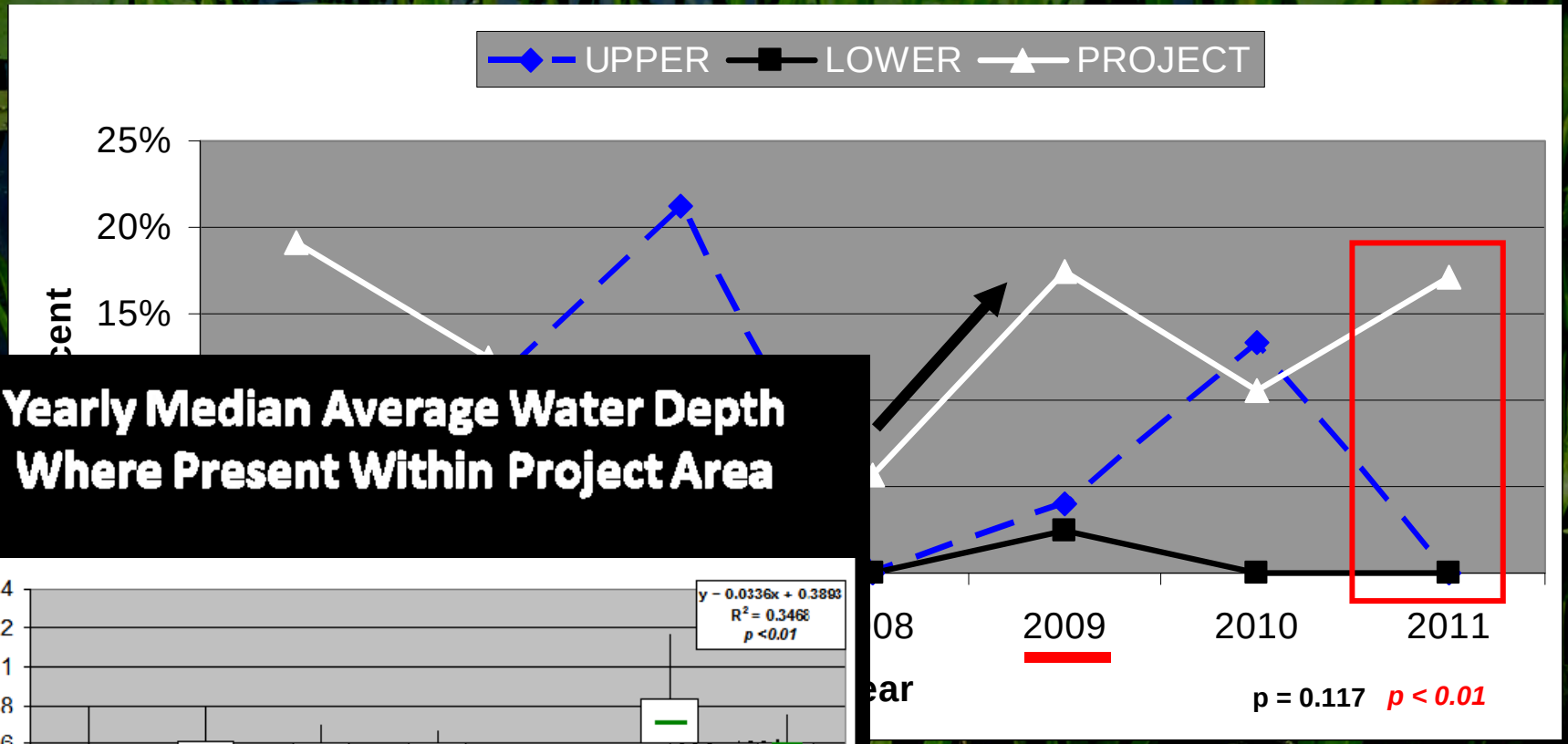


April – July, 1998 – 2007 climatological data, La Crosse, WI Municipal Airport. Model run provided by Jason Rohweder, USGS, UMESC

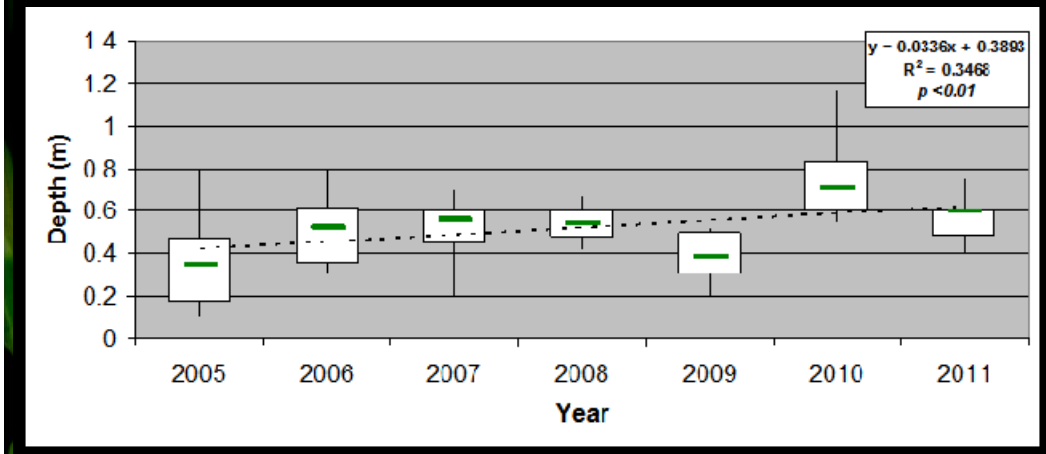
Upper Mississippi River Restoration
Leading Innovating Partnering

Perennial Emergent Aquatic Vegetation

Frequency of Occurrence



Yearly Median Average Water Depth Where Present Within Project Area



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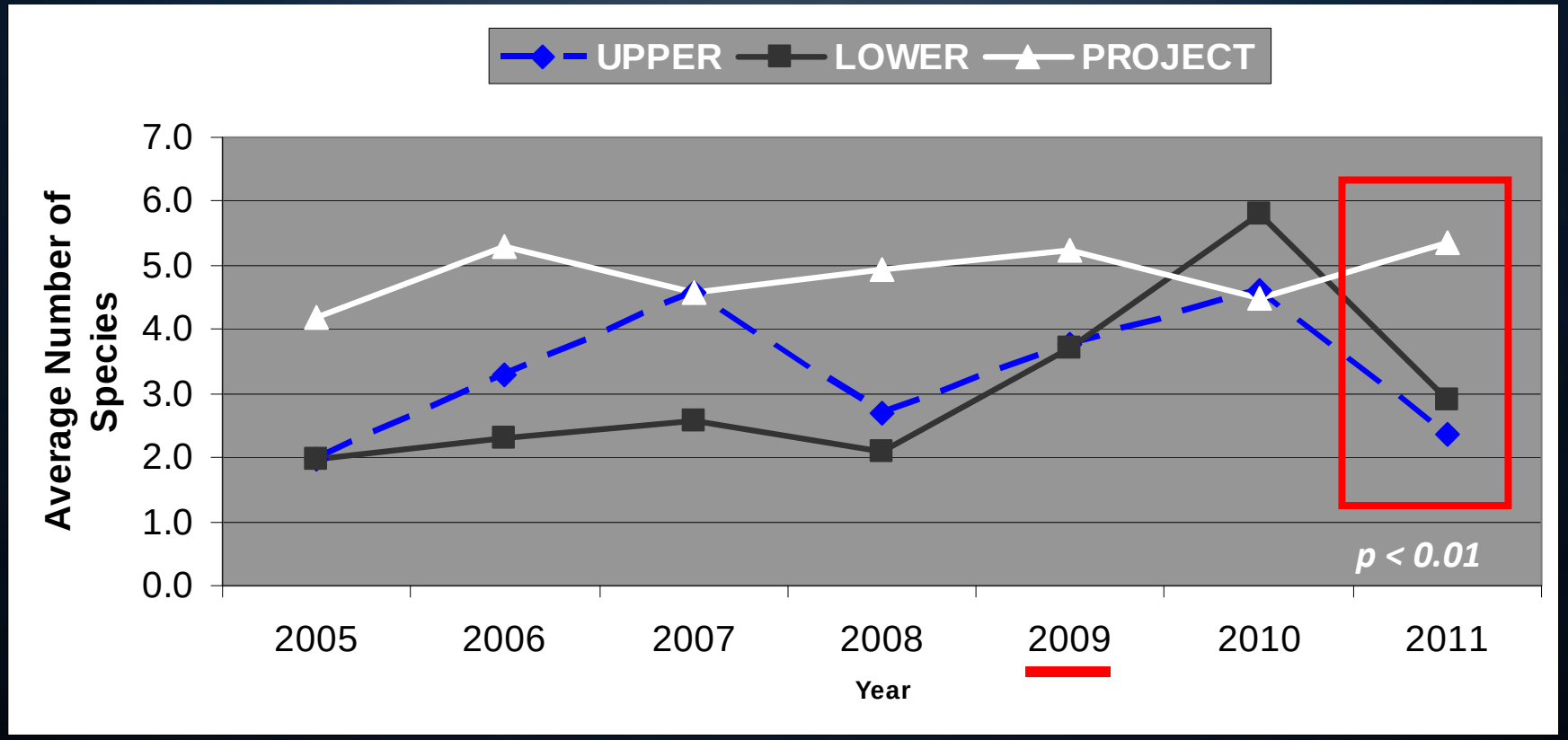
Aquatic Vegetation Species Richness

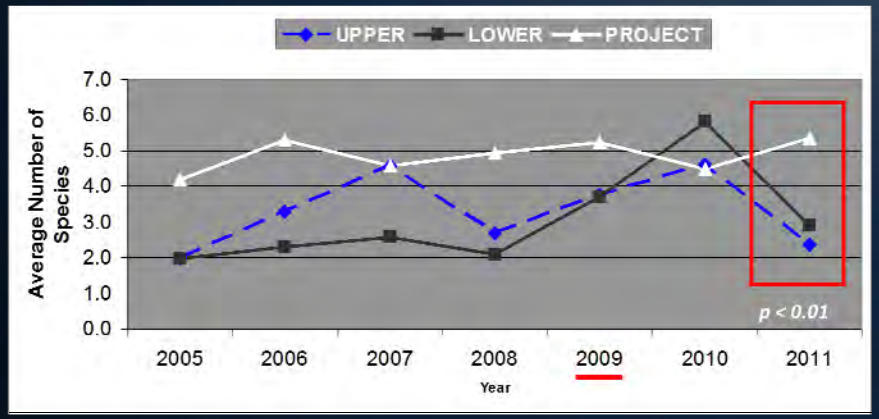
All Life Forms



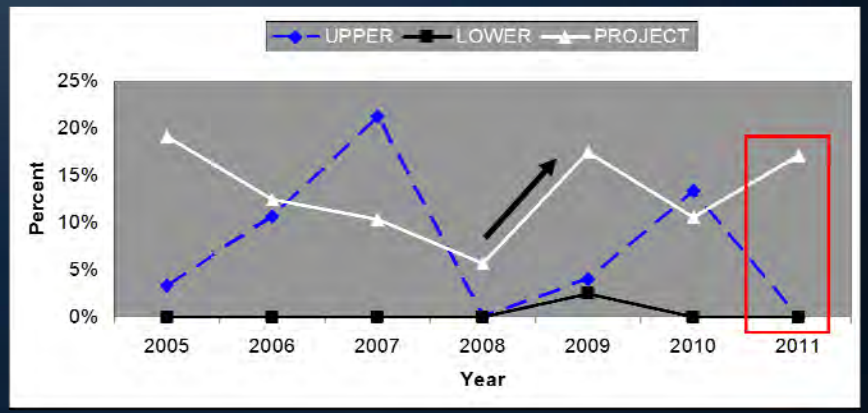
Source: Heidi Langrehr and Jeff Janvrin, WDNR, unpublished

Restoring Connectivity (and Addressing Fetch) = Resiliency!

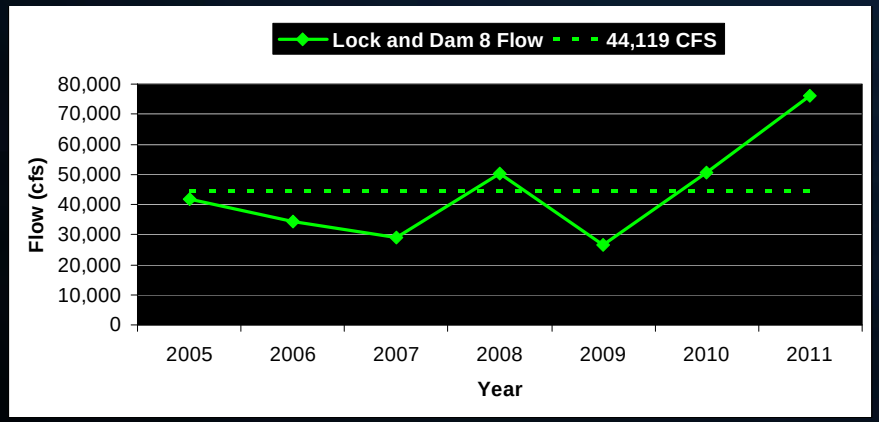
Aquatic Vegetation Species Richness
All Life Forms



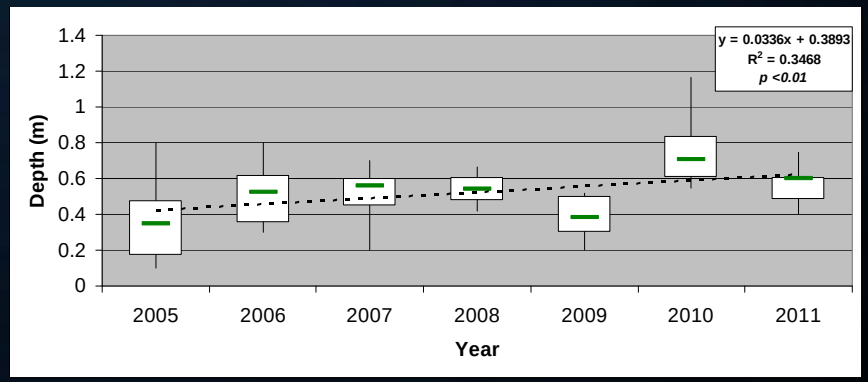
Perennial Emergent Aquatic Vegetation
Frequency of Occurrence



River Conditions During Study Period
May – August Average Flow (LD8)

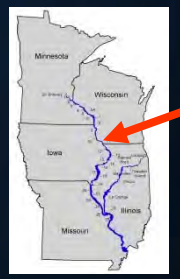


Yearly Median Average Water Depth Where Present Within Project Area

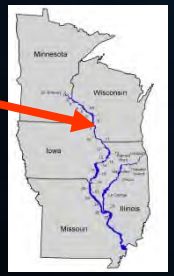


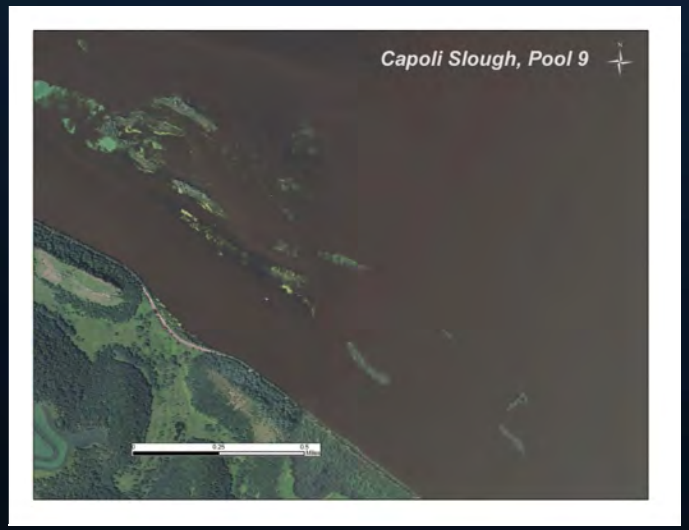
Environmental Responses are Repeatable

Pool 11 Islands, Sunfish Lake



Capoli Slough Pool 9





2011

2015

Upper Mississippi River Restoration
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Objective: Create backwater fish overwintering habitat

- Water Depths > 4 Feet
- Water Velocities < 0.01 feet per second
- Warm water temperatures (> 32 degrees Fahrenheit)
- Dissolved Oxygen ≥ 5 ppm

Criteria

Dipped in 2015 by Dr. C. Theiling, at Bertom and McCartney

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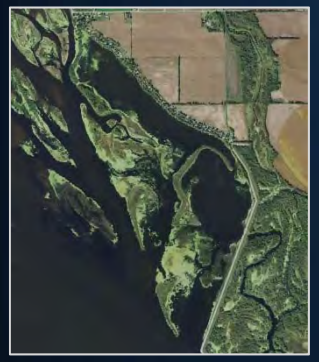
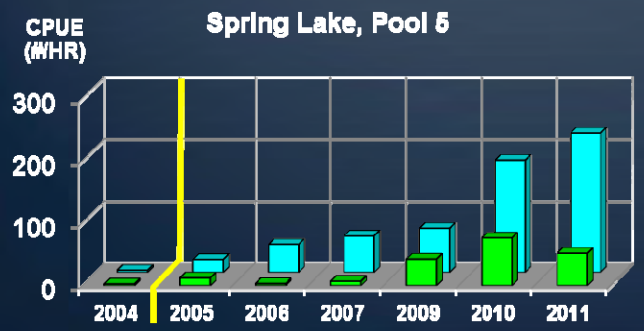
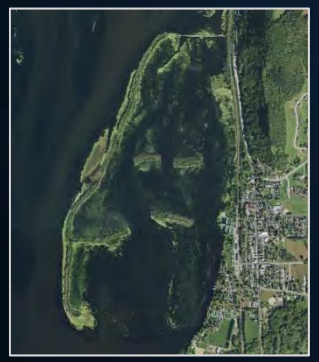
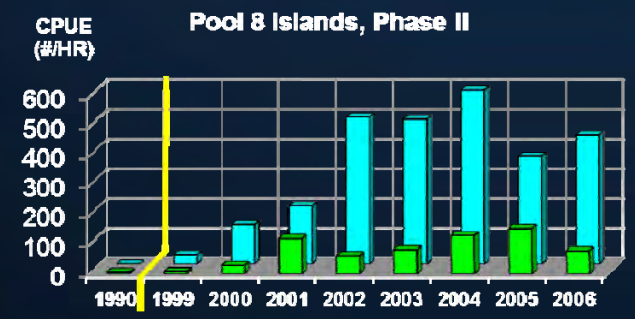
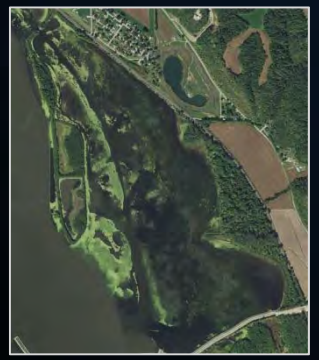
Environmental Responses are Repeatable

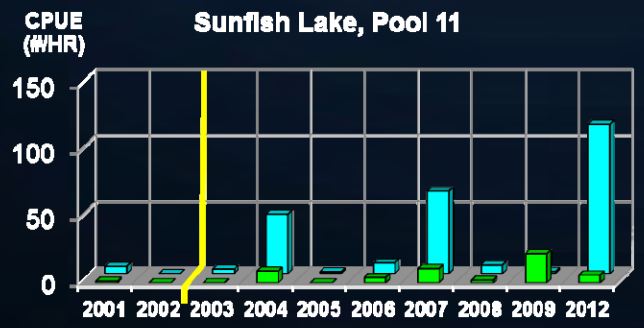


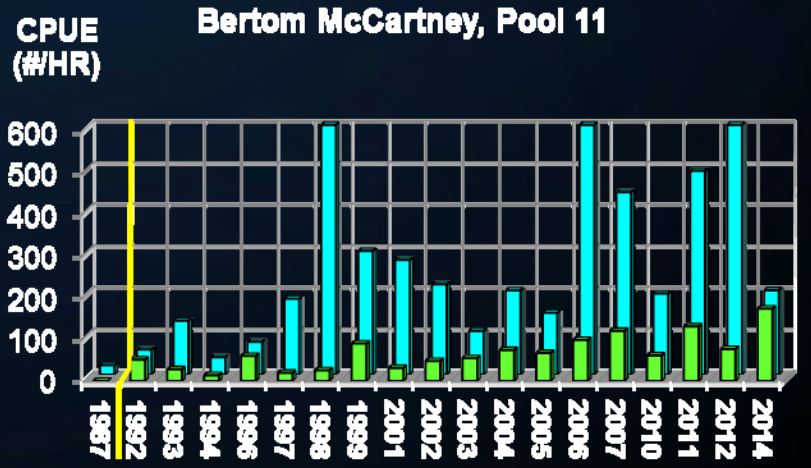






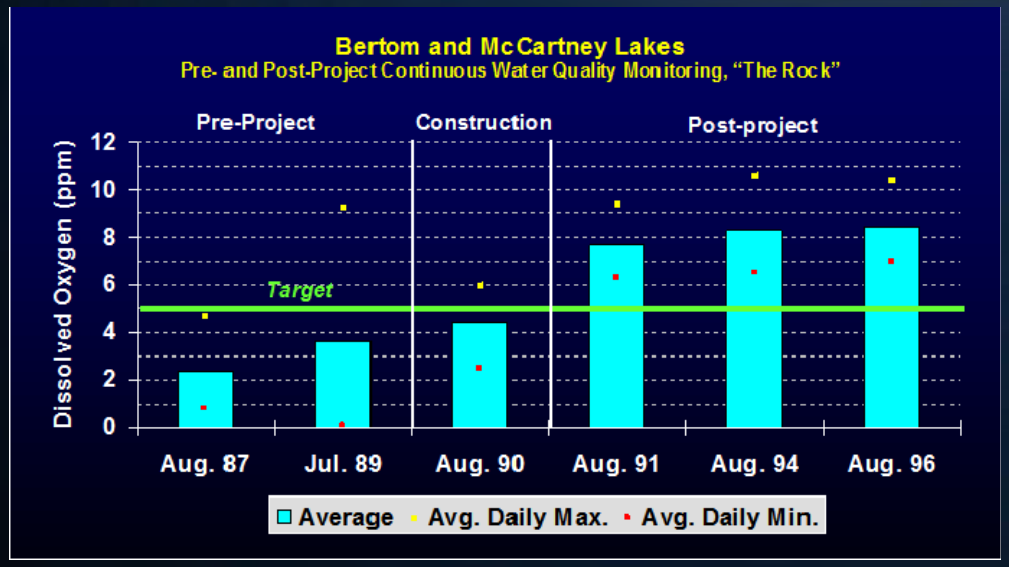


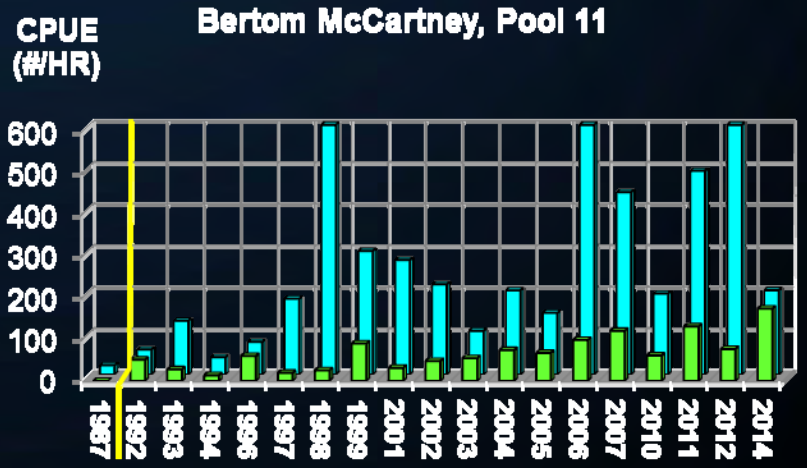




LMB > 4.9” BLG > 2.9”

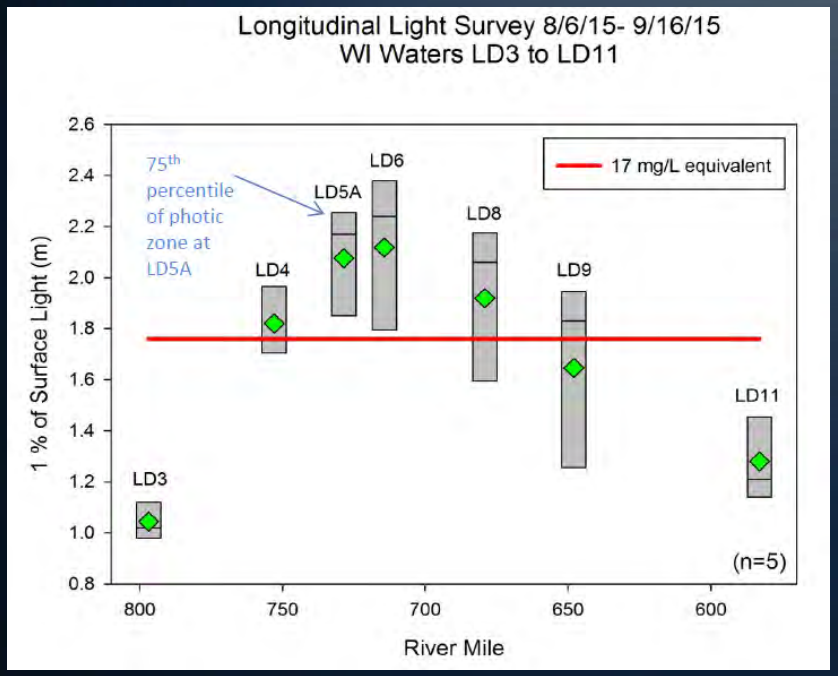
It's not all about the plants, depth is important too!





Upper Mississippi River Restoration

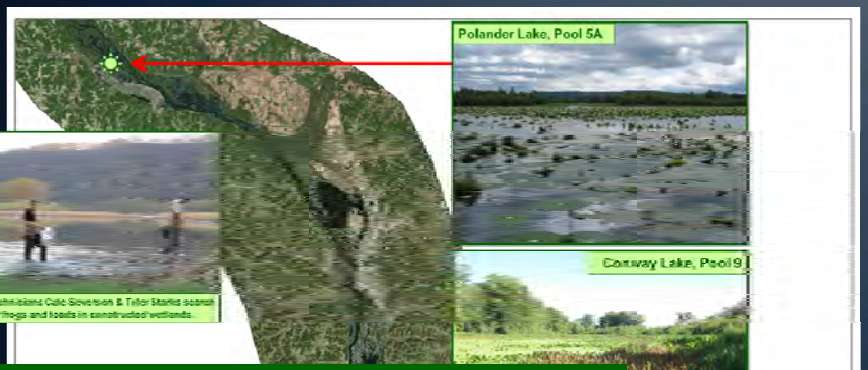
How Deep Should We Dredge?

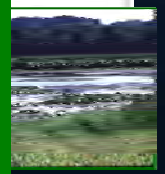


Pool	75 % photic zone (m)	75 % photic zone (ft)	Dredge to depth by Pool (75%+1 ft)
3-Upper 4	1.17	3.84	4.84
Lower 4	1.95	6.40	7.40
5	2.3	7.55	8.55
5A	2.3	7.55	8.55
6	2.4	7.87	8.87
7	2.4	7.87	8.87
8	2.2	7.22	8.22
9	1.95	6.40	7.40
10	1.95	6.40	7.40
11	1.48	4.86	5.86

Upper Mississippi River Restoration
Leading Innovating Partnering

Source: Shawn Giblin - WDNR, unpublished





Connectivity of Floodplain Wetlands

Preliminary Results of Biological Response

RESULTS - First year of data collection suggests that isolated wetlands from older aged projects result in the GREATEST species composition:

Wetlands Allowing for River Flows:

- **Polander Lake**– ONE American Toad and ONE Green Frog
- **Conway Lake**–MULTIPLE Northern Leopard Frogs
- **Island A, Capoli Slough**-- no species **Island F, Capoli Slough**– ONE Northern Leopard Frog and ONE Wood Frog, CHORUS of American Toads

Isolated Wetlands:

- **Island M, Capoli Slough**– ONE Wood Frog, ONE Northern Leopard Frog, CHORUS of American Toads
- **Bertom Island--** MULTIPLE Green Frogs & CHORUSES of Spring Peepers, Pickerel Frogs, American Toads, Gray Treefrogs ***and*** **State-endangered Blanchard's Cricket Frogs!**

Source: Brenda Kelly and Cale Severson, WDNR, unpublished

Upper Mississippi River Restoration
Leading Innovating Partnering