Fish Migration in the US

Are Navigation Locks Important?

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U.S. Army Corps of Engineers
PIANC WG 127, Fish Passages

Rock Island, Illinois, USA

Schiffsschleusen und Fischwanderung
Fachveranstaltung im BMVBS

Bonn
4 December 2009

Fish Lockage through Navigation Locks

Allegheny River – Locks 5-9
(1980-present)

walleye

Sander vitreus

sauger

Sander canadensis

Cape Fear River - Lock 1
(1962-present)

American shad

Alosa sapidissima

blueback herring

Alosa aestivalis

Alabama River – Jim Woodruff Lock
(2005-present)

American shad

Alosa sapidissima

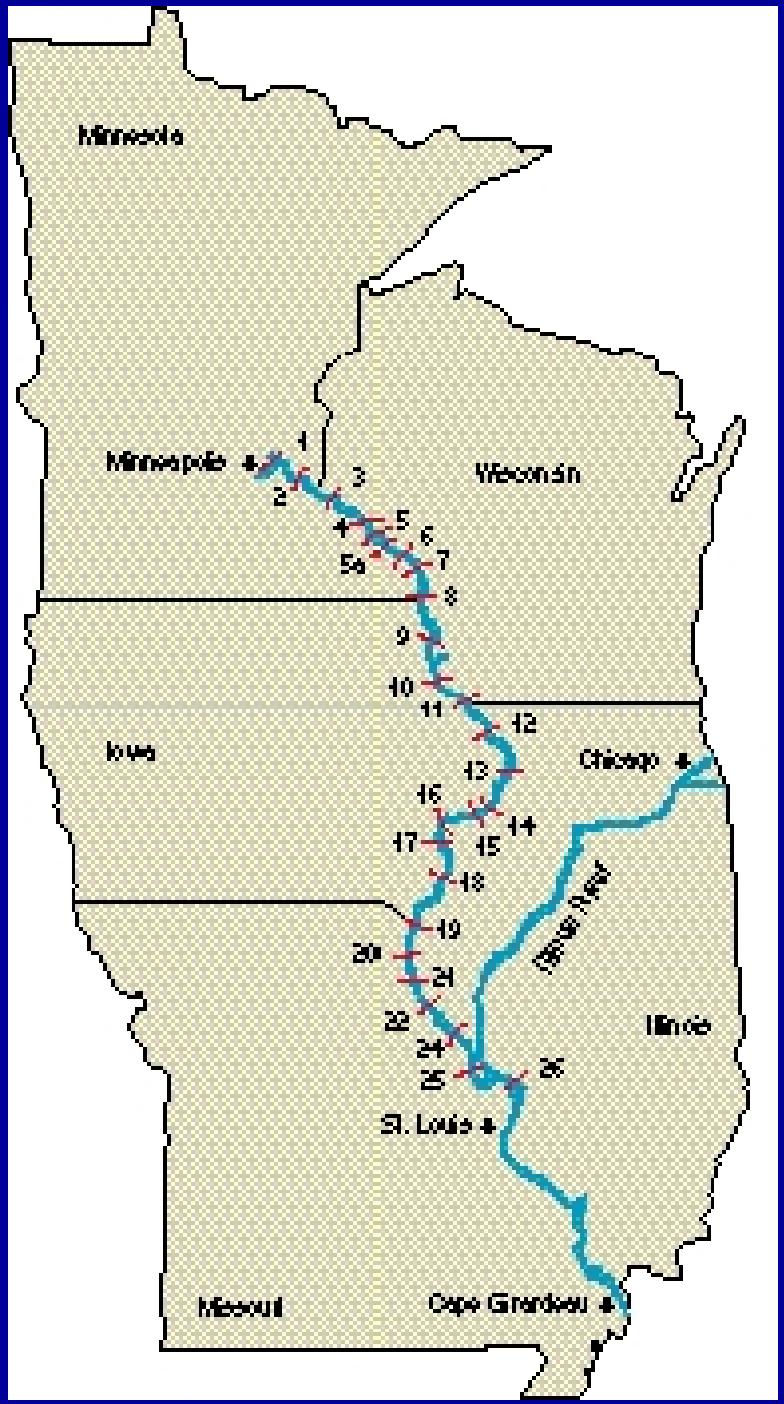
Gulf striped bass

Morone saxatilis

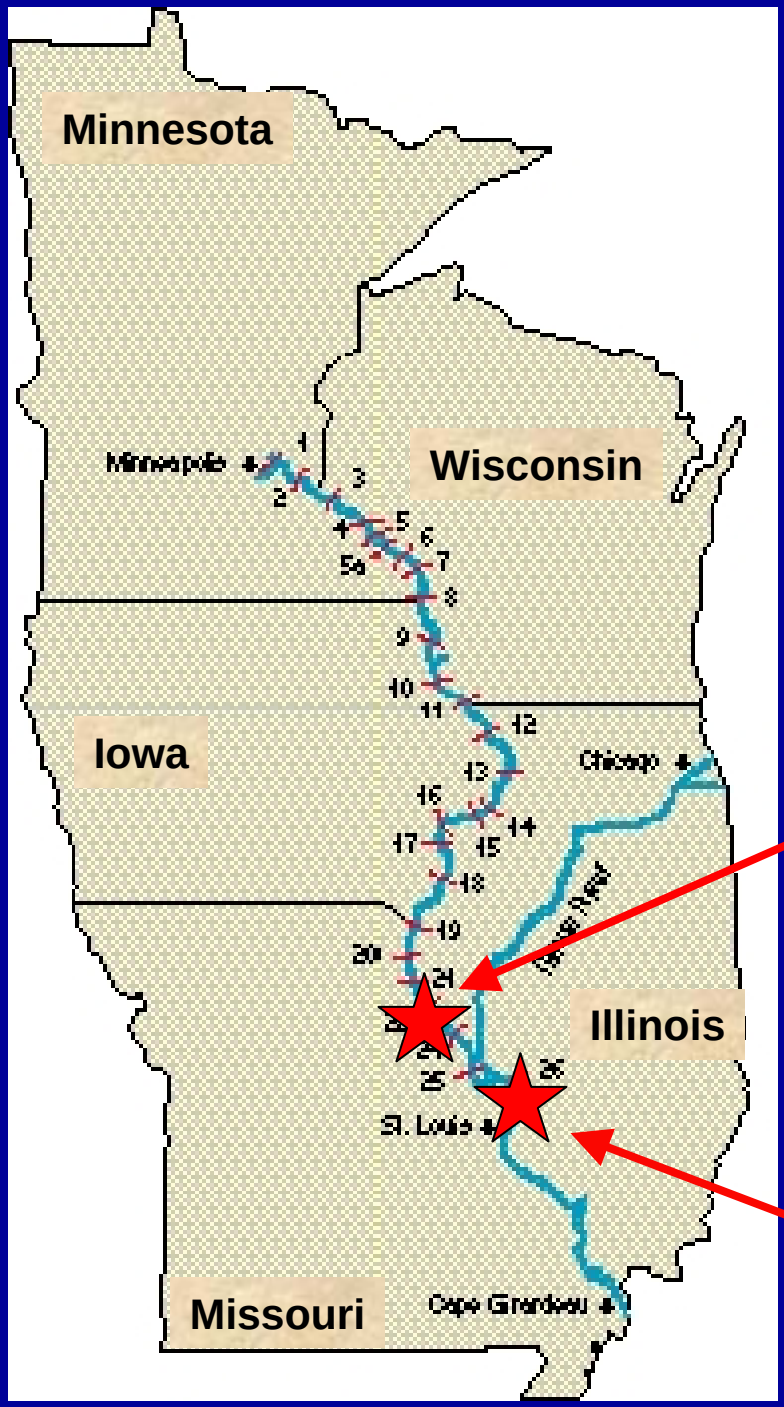
Maximum Passage Efficiency

Allegheny River	unknown
Cape Fear River	>50%
Alabama River	65%

Mississippi River



Study Area



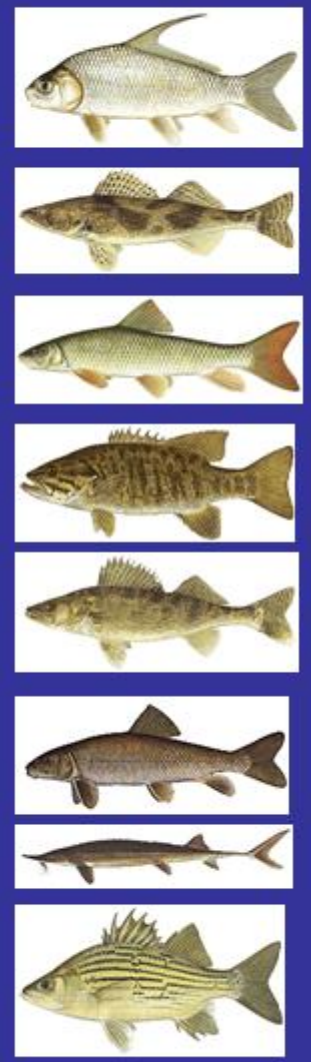
Lock and Dam 22

Melvin Price Locks and Dam

Migratory Fish Species of the UMR

American eel
spotted sucker
silver lamprey
shorthead redhorse
lake sturgeon
black redhorse
pallid sturgeon[A]
golden redhorse
longnose gar
silver redhorse
shovelnose sturgeon
northern hog sucker
goldeye
white sucker
mooneye
channel catfish
paddlefish[B]
blue catfish

Alabama shad
flathead catfish
skipjack herring
white bass
gizzard shad
yellow bass
threadfin shad
northern pike
blue sucker[B]
smallmouth bass
smallmouth buffalo
largemouth bass
bigmouth buffalo
sauger
quillback
walleye
highfin carpsucker
freshwater drum



[A] federally listed endangered species

[B] candidate for federal listing

Monitoring Plan

- Mobile hydroacoustics
- Fixed hydroacoustics
- Telemetry
- Ecohydraulic Modeling

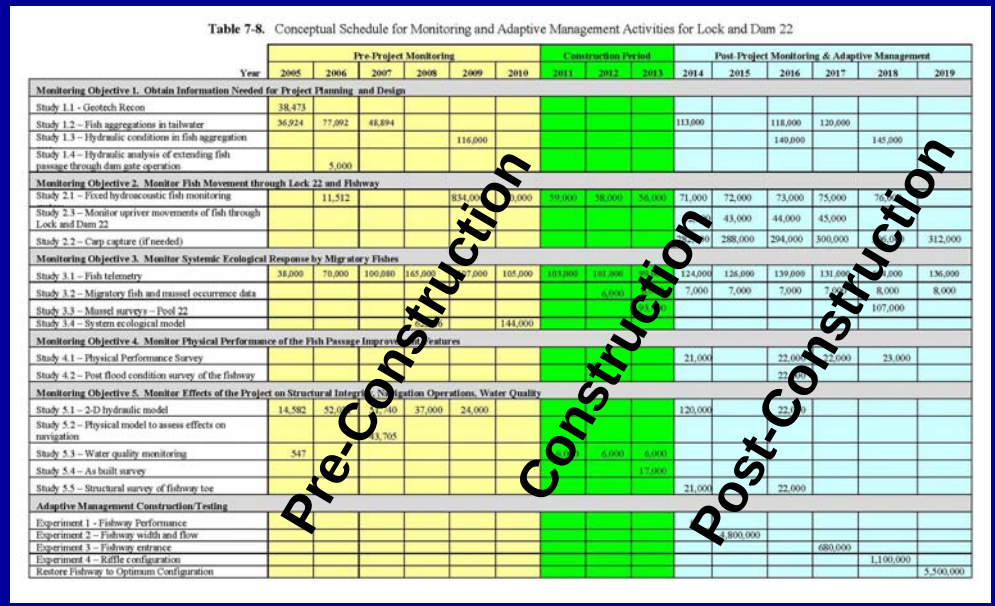


Table 7-8. Conceptual Schedule for Monitoring and Adaptive Management Activities for Lock and Dam 22

	Pre-Project Monitoring						Construction Period			Post-Project Monitoring & Adaptive Management					
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Monitoring Objective 1. Obtain Information Needed for Project Planning and Design															
Study 1.1 - Geotech Recon	38,473														
Study 1.2 – Fish aggregations in tailwater	36,924	77,092	48,894							113,000		118,000	120,000		
Study 1.3 – Hydraulic conditions in fish aggregation					116,000							140,000		145,000	
Study 1.4 – Hydraulic analysis of extending fish passage through dam gate operation		5,000													
Monitoring Objective 2. Monitor Fish Movement through Lock 22 and Fishway															
Study 2.1 – Fixed hydroacoustic fish monitoring		11,512			834,0	,000	59,000	58,000	56,000	71,000	72,000	73,000	75,000	76	
Study 2.3 – Monitor upriver movements of fish through Lock and Dam 22											43,000	44,000	45,000		
Study 2.2 – Carp capture (if needed)											288,000	294,000	300,000		312,000
Monitoring Objective 3. Monitor Systemic Ecological Response by Migratory Fishes															
Study 3.1 – Fish telemetry	38,000	70,000	100,080	165,00	,000	105,000	103,000	101,000		124,000	126,000	139,000	131,00	,000	136,000
Study 3.2 – Migratory fish and mussel occurrence data								6,000		7,000	7,000	7,000	7	8,000	8,000
Study 3.3 – Mussel surveys – Pool 22														107,000	
Study 3.4 – System ecological model						144,000									
Monitoring Objective 4. Monitor Physical Performance of the Fish Passage Improv tures															
Study 4.1 – Physical Performance Survey										21,000		22,0	,000	23,000	
Study 4.2 – Post flood condition survey of the fishway												22			
Monitoring Objective 5. Monitor Effects of the Project on Structural Integr igation Operations, Water Quality															
Study 5.1 – 2-D hydraulic model	14,582	52,0	,040	37,000	24,000					120,000		22,0			
Study 5.2 – Physical model to assess effects on navigation			3,705												
Study 5.3 – Water quality monitoring	547							6,000	6,000						
Study 5.4 – As built survey									17,000						
Study 5.5 – Structural survey of fishway toe										21,000		22,000			
Adaptive Management Construction/Testing															
Experiment 1 - Fishway Performance															
Experiment 2 – Fishway width and flow												,800,000			
Experiment 3 – Fishway entrance													680,000		
Experiment 4 – Riffle configuration														1,100,000	
Restore Fishway to Optimum Configuration															5,500,000

Pre-Construction

Construction

Post-Construction

Methods

Mobile Hydroacoustic Sampling

DIDSON
(Dual-Frequency Identification Sonar)

RDI Workhorse
Acoustic Doppler Current Profiler

BioSonics model DT 5000

RESON SeaBat 8101 multibeam

Methods

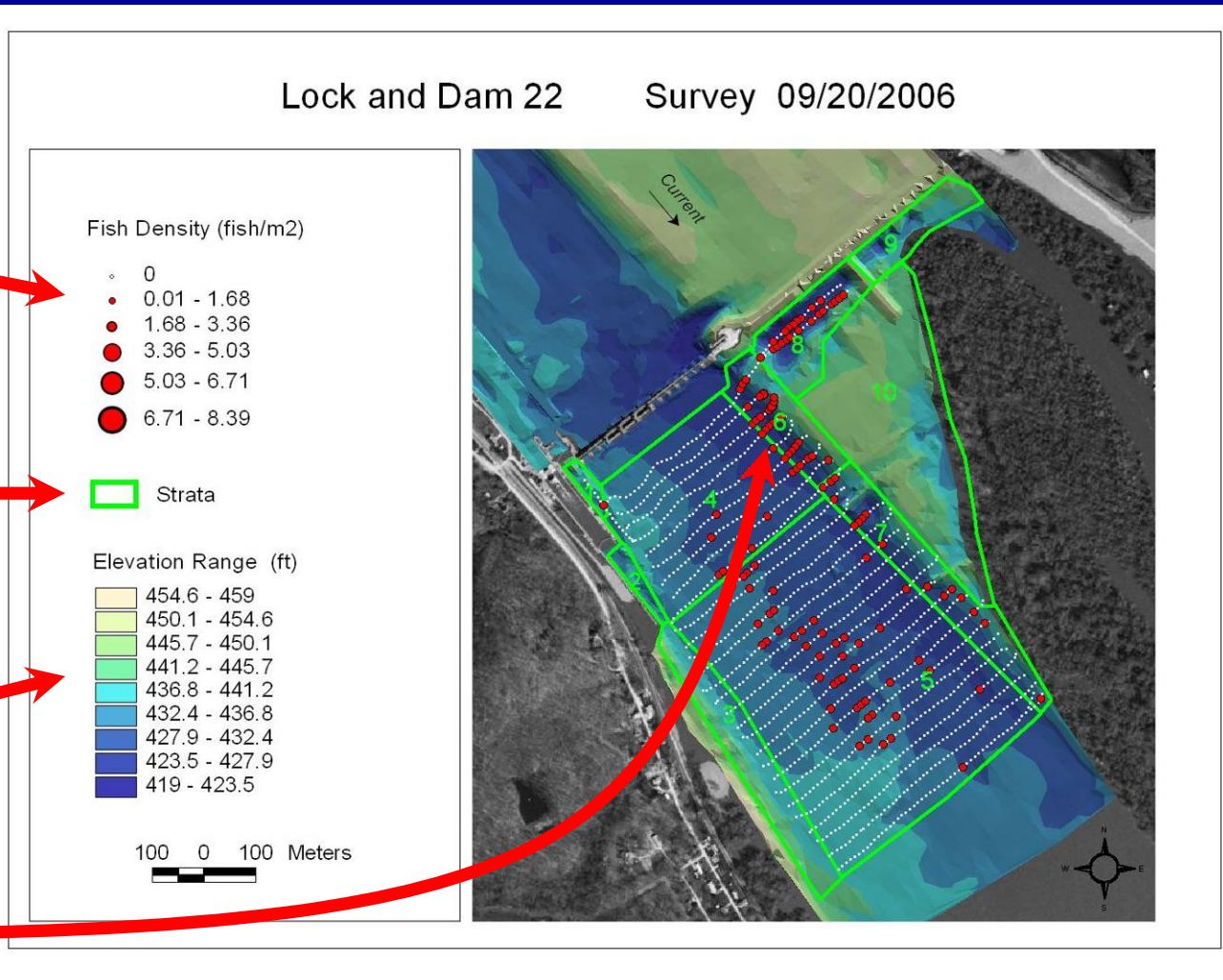
Hydroacoustic Transects

Fish Density (fish/m^2)

Population Estimate

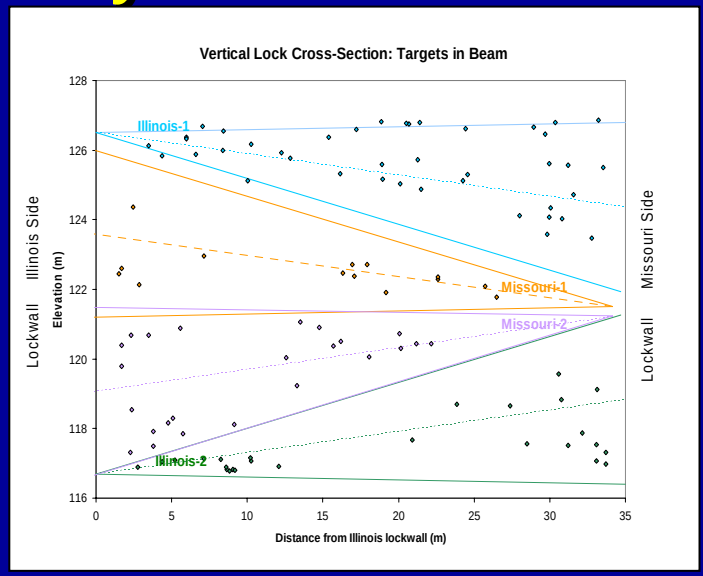
Bathymetry/ Habitat Utilization

Fish Aggregations



Methods

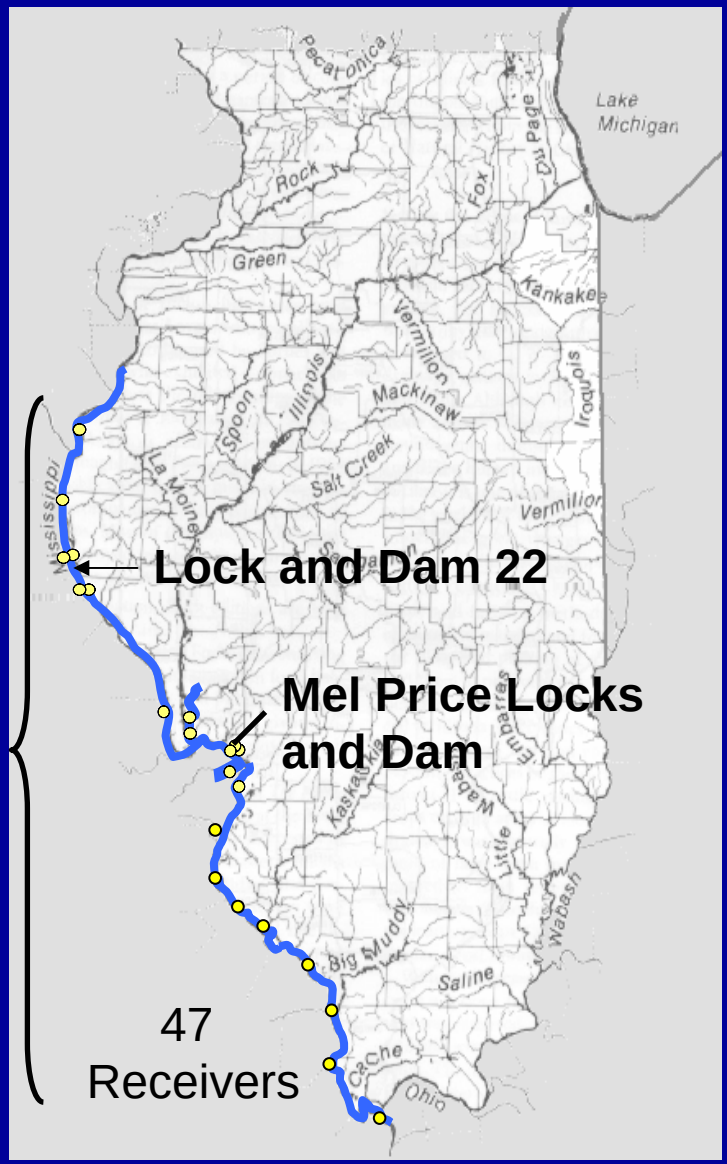
Fixed Hydroacoustics




MISSOURI
St. Charles Co.
ILLINOIS
Madison Co.
201
530' x 100'
3860' x 100'
360' x 100'
1200' x 100'
200 m lock chamber
Fish Passage Alternatives
Bypass Channel
Fish Lockage
Rock Ramp
River Miles
UMR Lock & Dam No. 26
Fish Passage Structures
0 250 500 750 1,000 Feet
US Army Corps of Engineers
Rock Island District
1998 USGS DOQQs
Map produced by PM-M GIS Team
4 March 2005.

Methods

Ultrasonic Telemetry



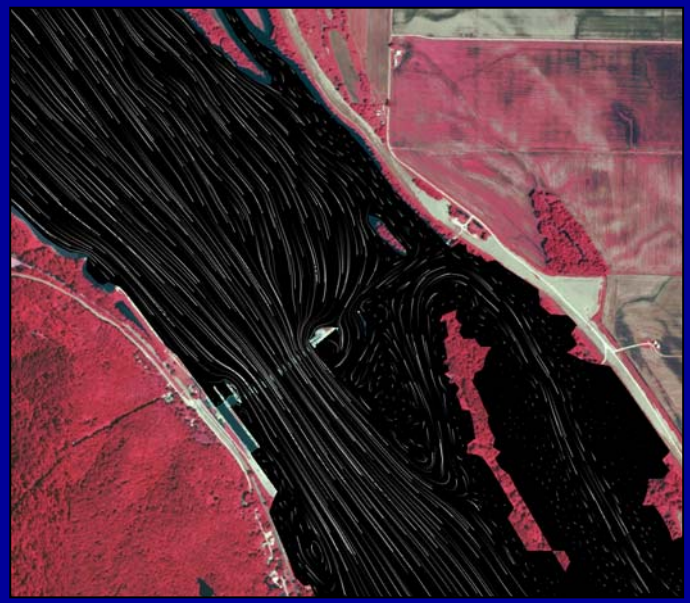
Receiver (hydrophone)

Transmitter

- Sept 2007-Sept 2009
- 817 fish tagged
- Representing 6 guilds
- 75% released below the dam

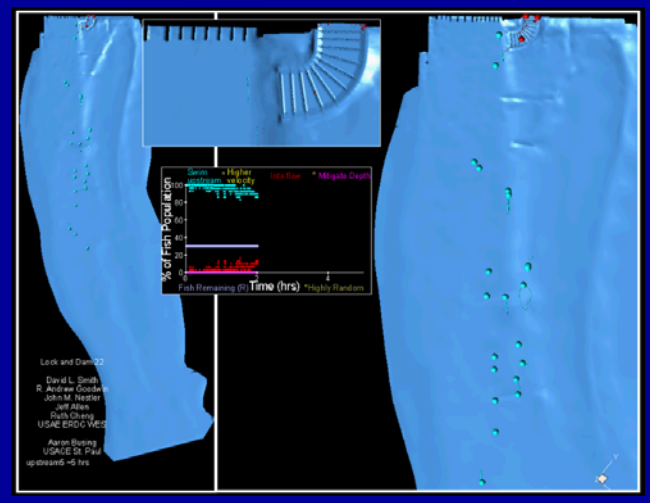
Methods

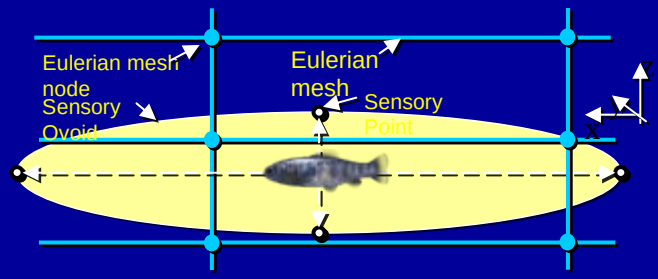
Ecohydraulic Modeling



ADH Model
(Adaptive Hydraulics Model)

Flow Patterns and Intensity





ELAM Model
(Eulerian Lagrangian Agent Method)

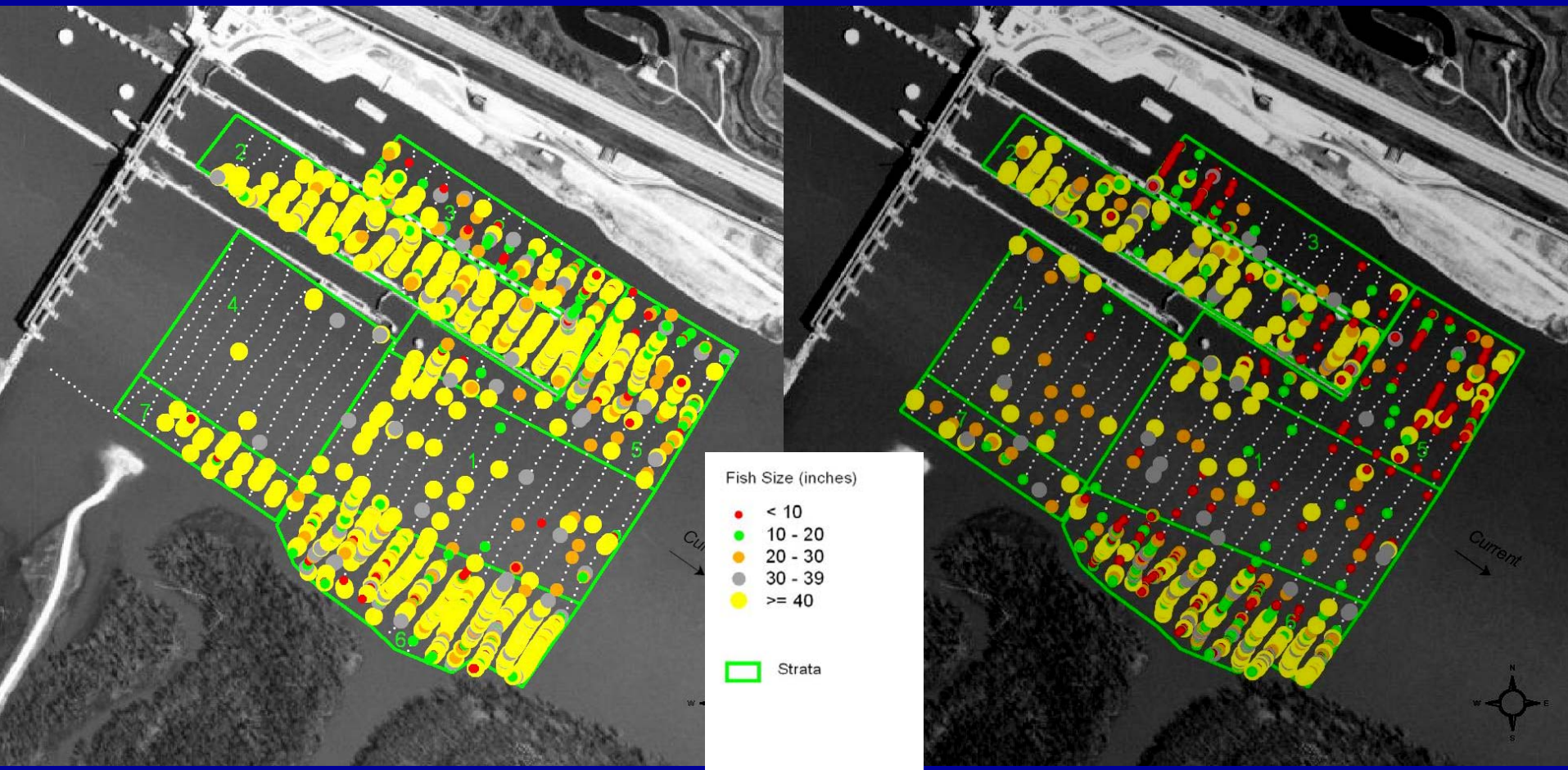
Fish Behavior

Results

Mobile Hydroacoustic Data

8 April 2006

6 June 2006

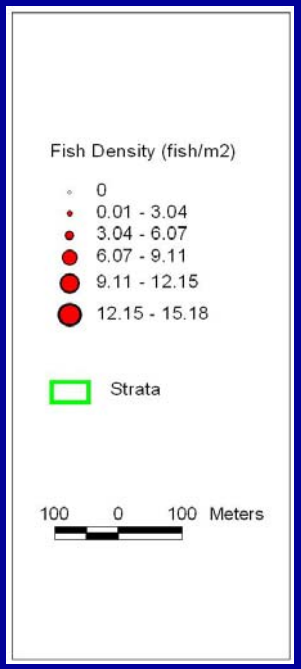


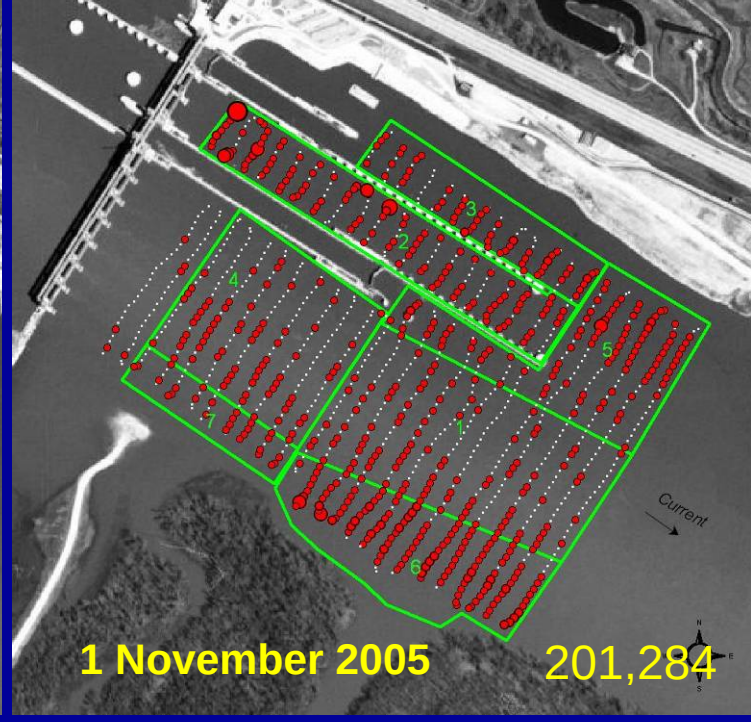
Population Estimate = 96,404

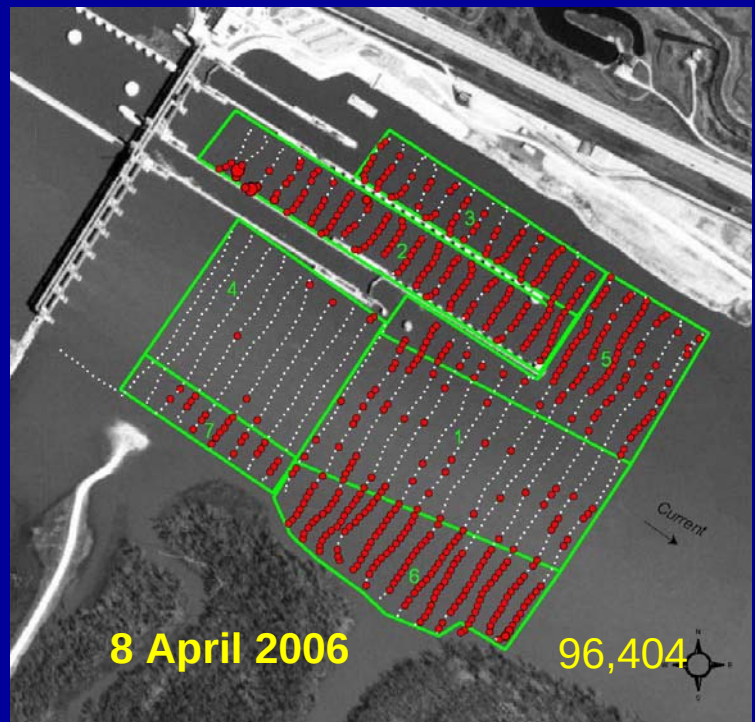
Population Estimate = 172,878

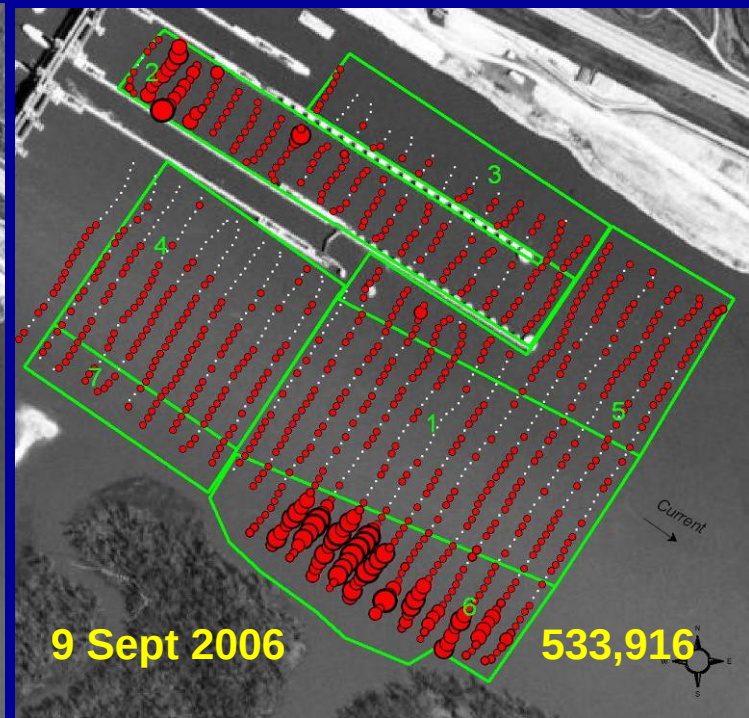
Results

Fish Density



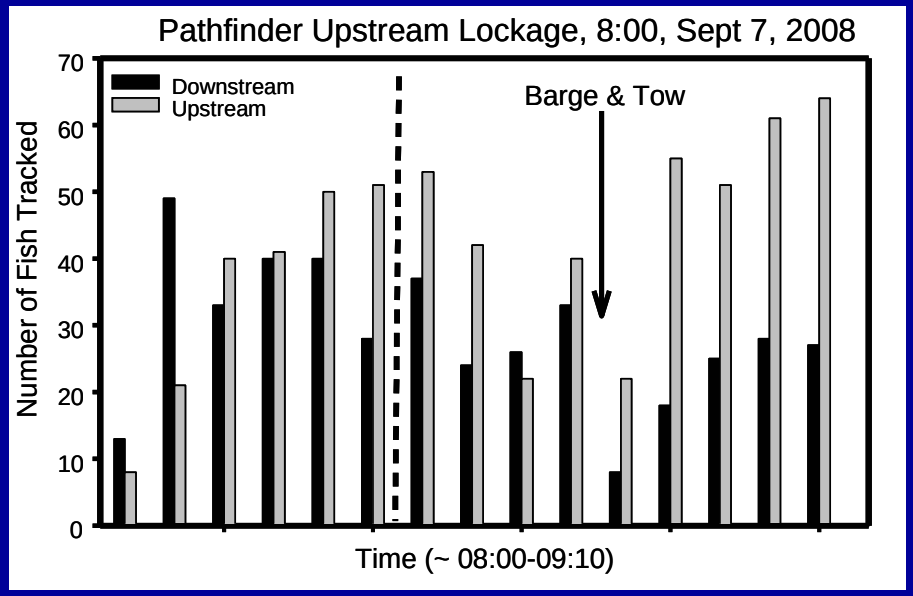


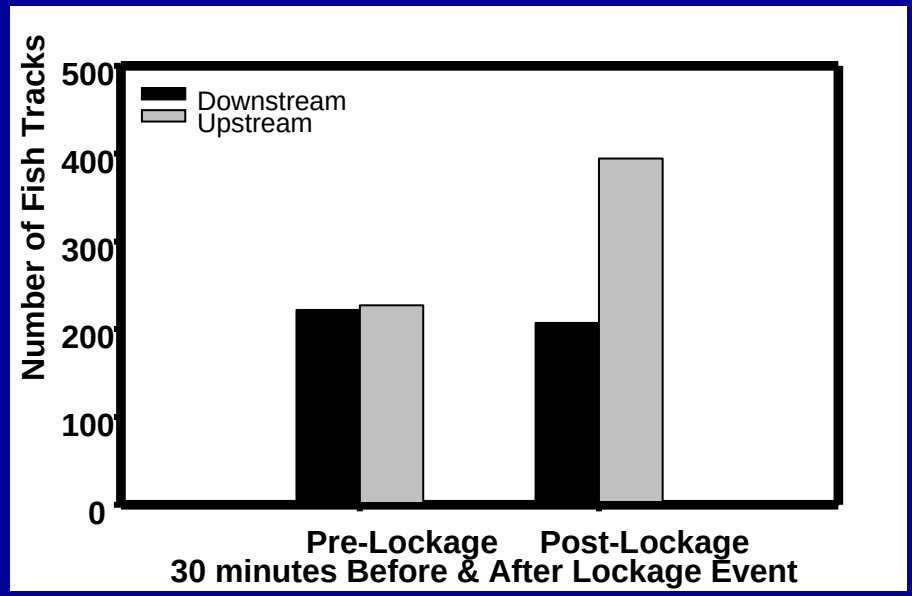




Results

Fixed Hydroacoustics





Total Fish Tracked =	1050
- Upstream	621
- Downstream	429

Pre-Lockage Total =	449
- Upstream	227
- Downstream	222

Post-Lockage Total =	601
- Upstream	394
- Downstream	207

Passage Effectiveness >0.1 %/day

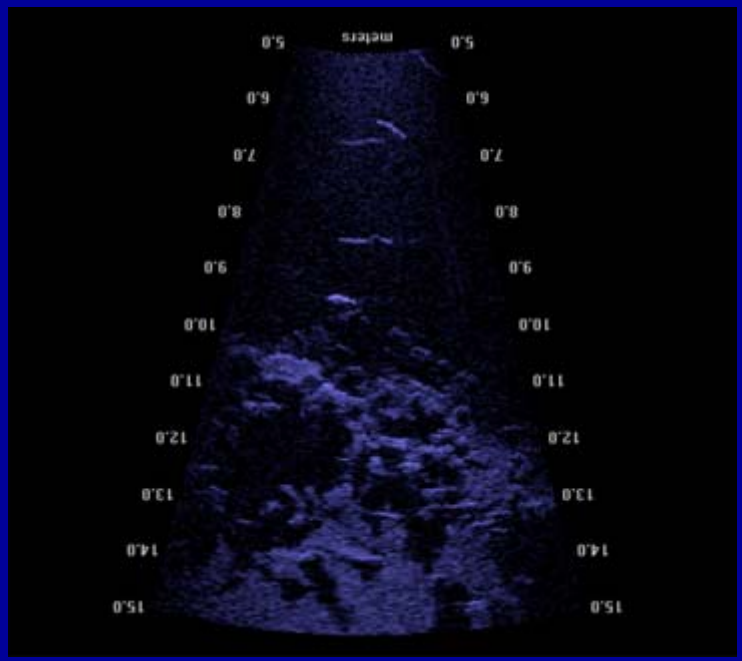
Results

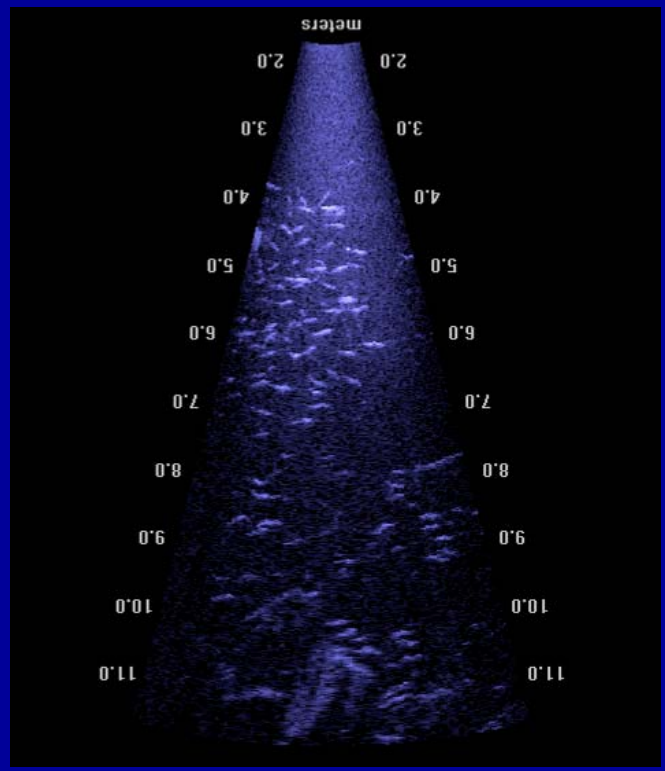
Ultrasonic Telemetry

- 342 fish detected
- 282 were silver carp (an invasive species)
- 23 fish used the lock for passage
- 17 upriver (15 were silver carp)
- 6 downriver
- 5 of 6 fish species used the lock

Results

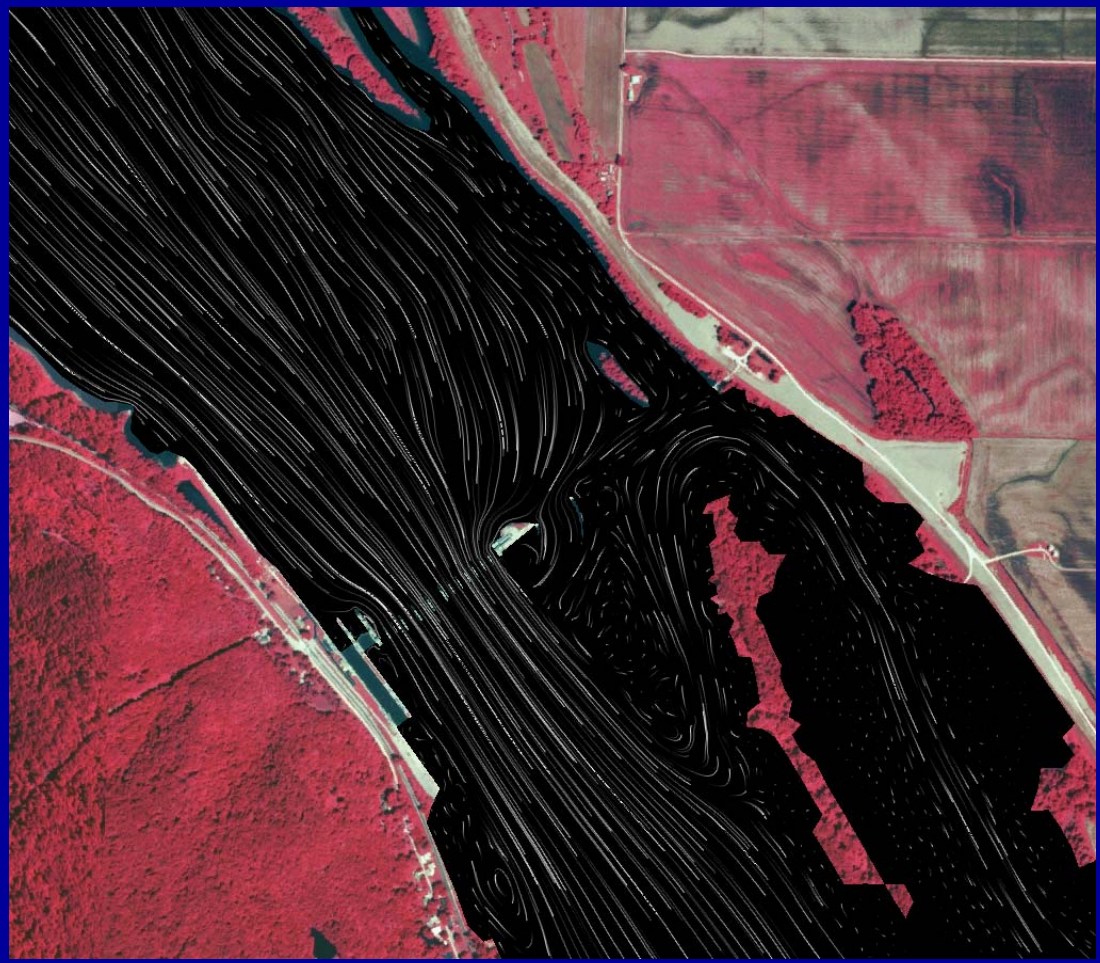
DIDSON **(Dual-Frequency Identification Sonar)**





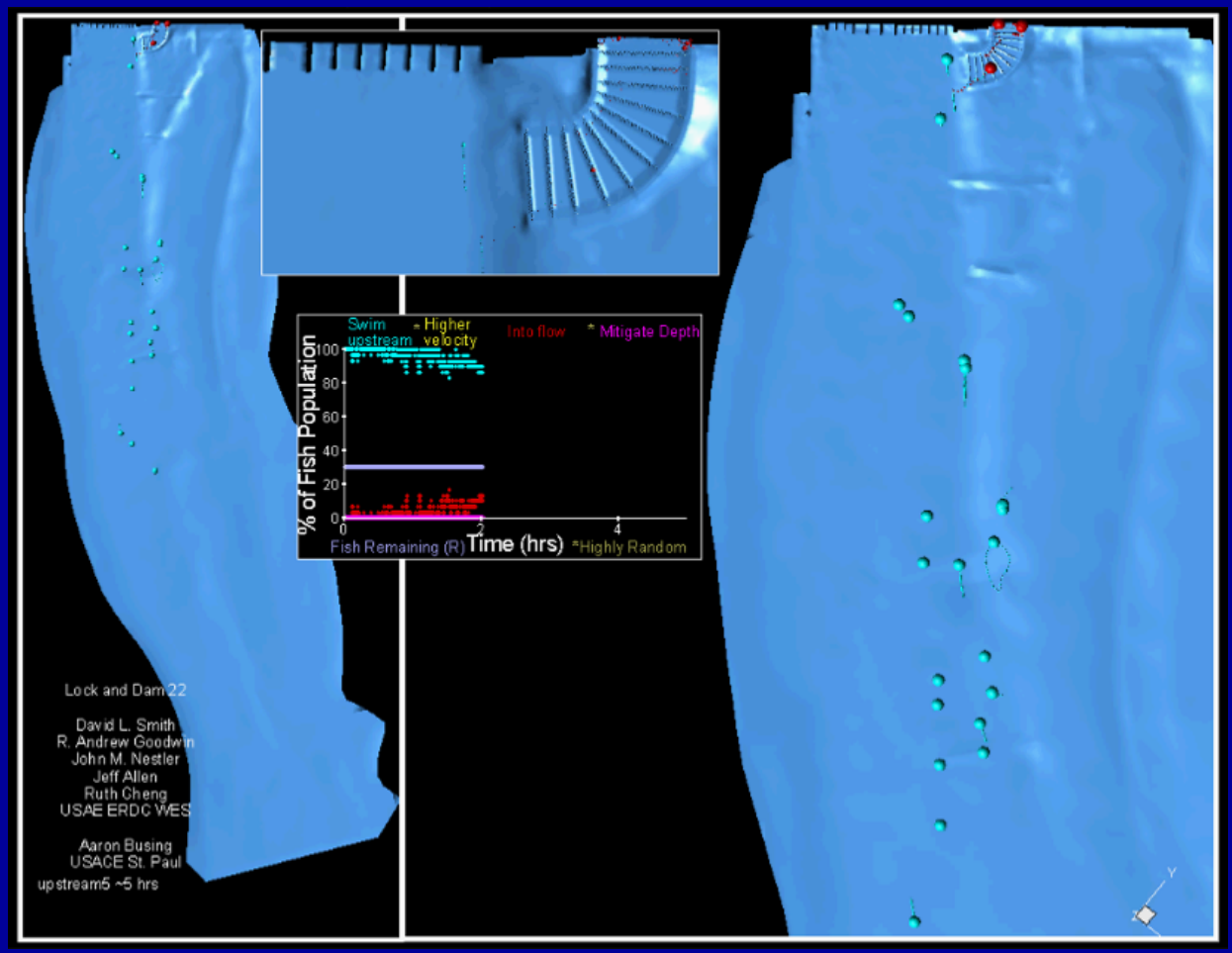
Results

ADH Model



Results

Ecohydraulic Modeling



Conclusion

Mobile Hydroacoustics

- Fish aggregate at hydraulic breaks and near habitat.
- It may be possible to manipulate the flows around lock chambers to increase the likelihood that a fish will move upstream.

Fixed hydroacoustics

- Low numbers of fish move both upstream and downstream through the lock.

Telemetry

- Upstream fish movement through the lock is rare in the Mississippi River

Ecohydraulic Modeling

- Rheophilic fish behavior can be predicted using flow use shear stress and flow to guide directional movement and migration. Rheophilic fish are generally not attracted to the flow conditions in the lock.

Conclusion

Navigation locks are generally not suited for fish passage because:

- Flow patterns with the lock differ from those found in other parts of the river.
- Locks pass only a fraction of the population.
- Locks do not pass all species of migratory fish.

Decisions regarding the adequacy of locks for restoring fish migration should be based upon a thorough scientific study of fish behavior at each dam.

Acknowledgements

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