



# **Environmental Impacts and Hydraulic Containment of Asian Carp**

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# Our Sponsors

- Aquatic Nuisance Species Research Program
- Mississippi Valley Division
- New Orleans, Vicksburg, Memphis, St. Louis, and St. Paul Districts
- State of Minnesota: Environment and Natural Resources Trust Fund

**TIME**  
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WITH **CNN**

# Asian Carp are the Number One Invasive Taxon in the World



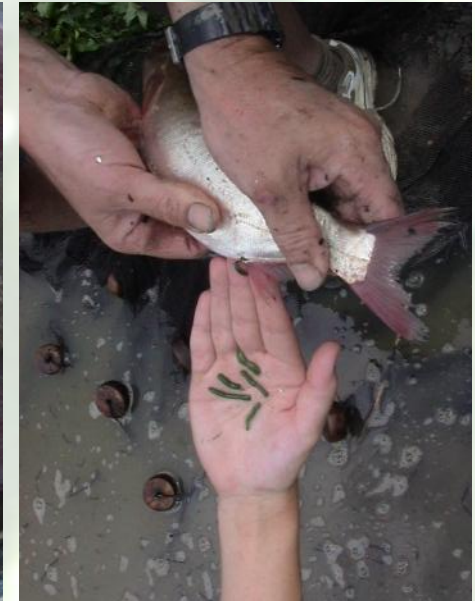
Chris Young, Springfield State Journal-Register

**02 Feb 2010**

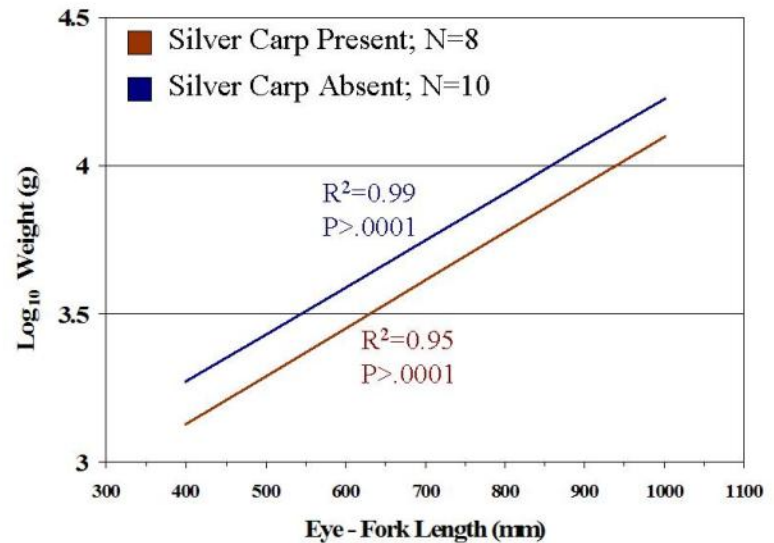


# Asian Carp Have Multi-Level Impacts on Aquatic Ecosystems:

- Enhancement of Phytoplankton
- Depletion of Zooplankton



# ...and Competition with Native Fishes like Paddlefish



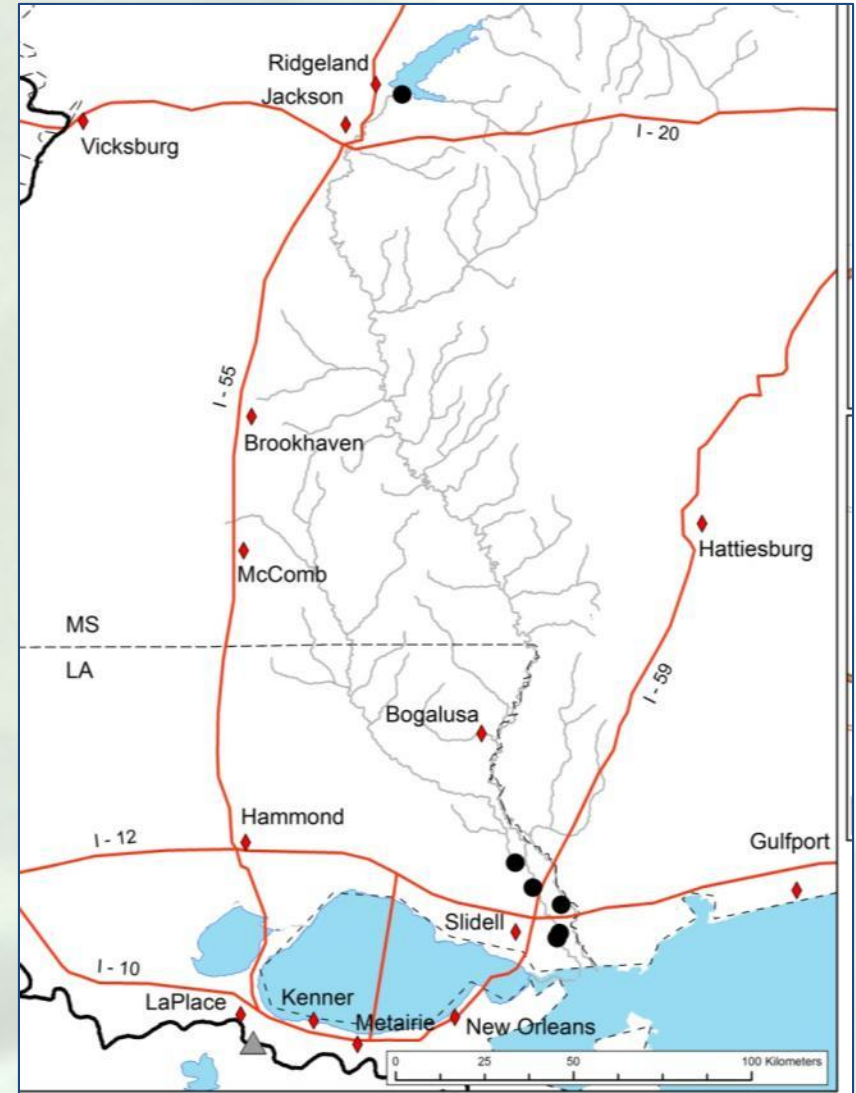


# Impacts from Asian Carp will Worsen...



...since Invasive  
Characteristics of  
Asian Carp  
Populations Have  
Been  
Underestimated.

# Asian Carp are Expanding their Geographic Range in the US

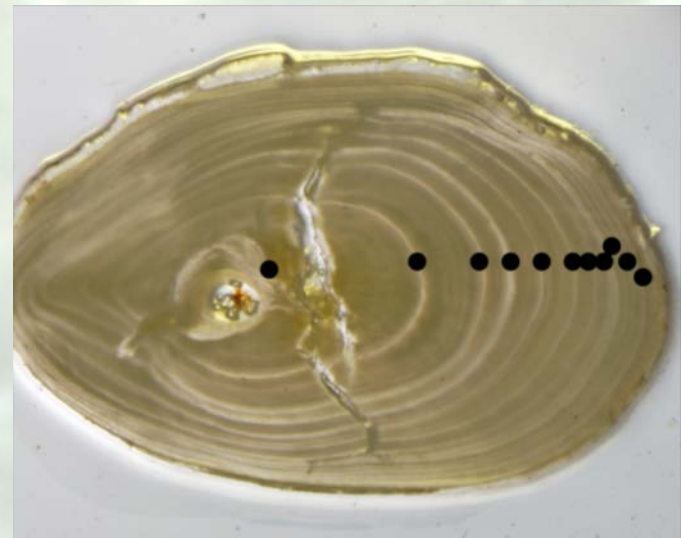


Slack et al., In review.



# Annual Survival of Asian Carp is Higher Than Documented Previously

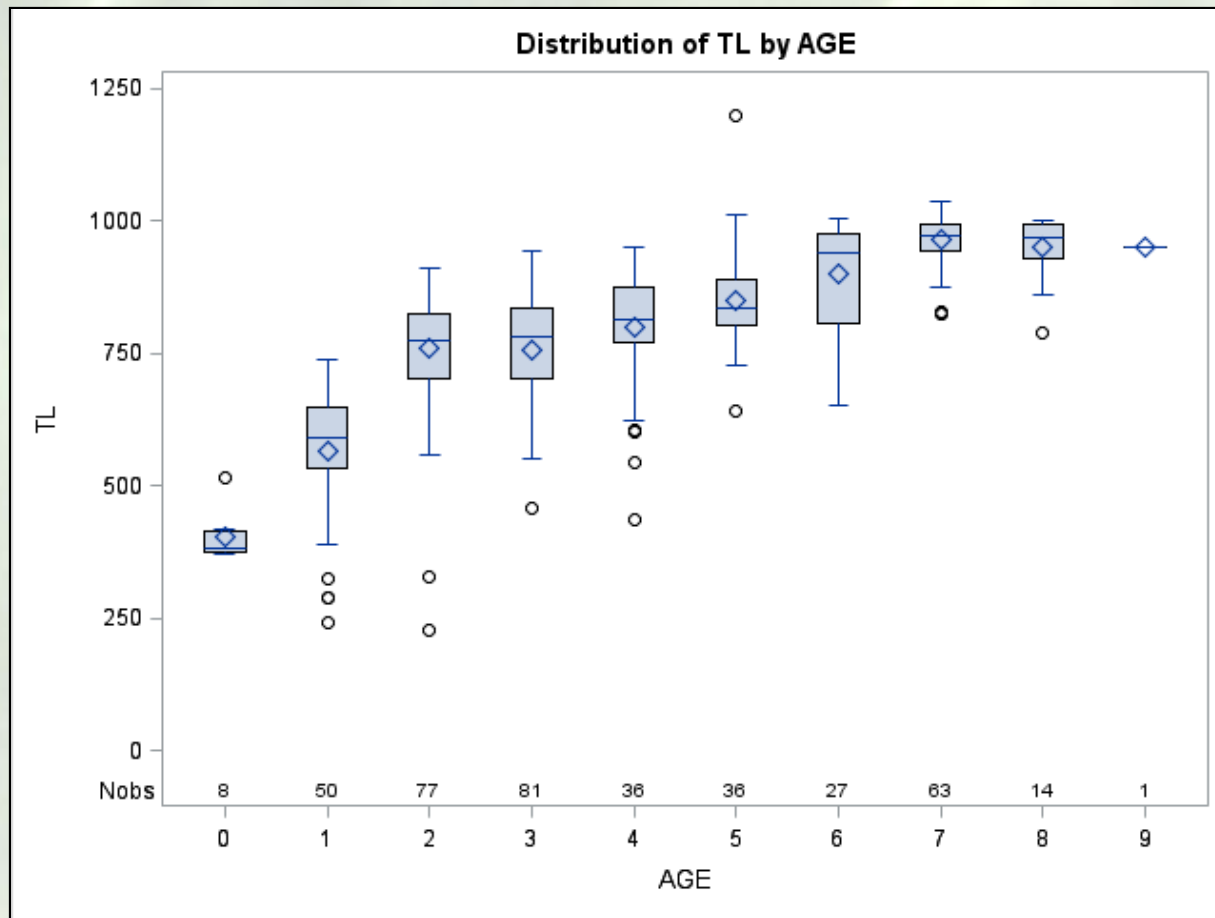
- Prior studies indicate lifespans  $< 7$  years
- Studies in Lower Mississippi River indicate lifespans of  $> 10$  years for Bighead Carp and  $> 7$  years for Silver Carp



Hoover et al., 2015



# Annual Growth of Asian Carp is Higher than Documented Previously and...



ERDC, unpublished data

# Egg Production of Asian Carp is Higher than Prior Estimates



1.9 – 2.7 million eggs, at two stages of maturity, in one female Bighead Carp (Hoover et al., 2015)



# Existing Population Models Assessed Risk of Establishment and Benefits of Harvest

- Establishment unlikely in most open waters of the Great Lakes (Cooke and Hill, 2010)
- Establishment in the Great Lakes within 10-35 years of colonization (Cuddington et al., 2014)
- Effective suppression in the Mississippi River Basin with 50-70% harvest (Tsehaye et al., 2013)

Because these models were based on conservative (low) estimates of survival, growth & fecundity, they underestimate risk.

# Swim Studies Indicate that Containment of Populations is Possible

- Electrical Barriers – Great Lakes
- Hydraulic Barriers – Upper Mississippi River
- Vertical Barriers – Multiple Locations

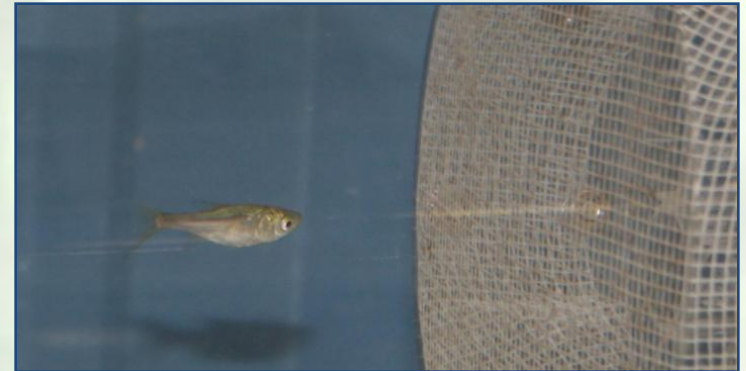
Asian Carp Adults are NOT Powerful Swimmers but ....



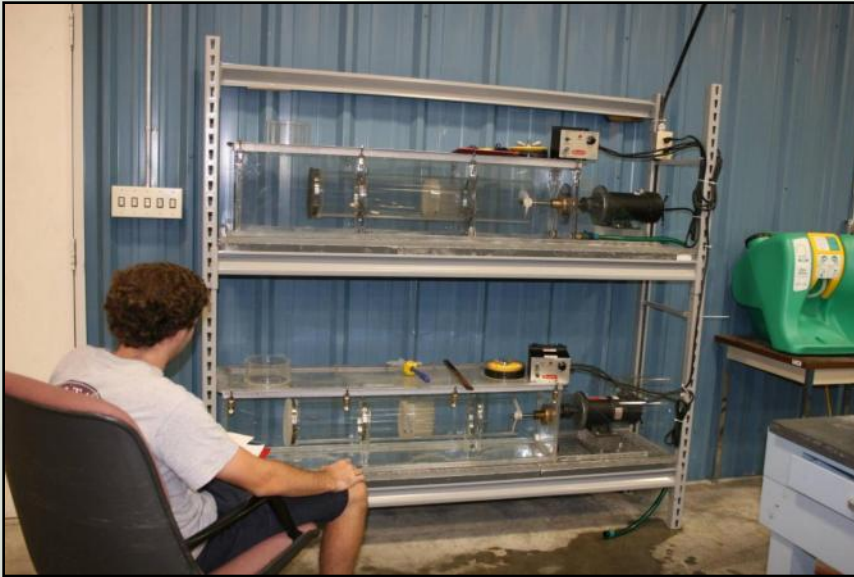
# Laboratory Studies Indicated Significant Differences in Swimming Performance....



- Between Bighead and Silver Carp
- Among Juvenile and Sub-Adult Carp



# ...In Blazka and Brett Swim Tunnels



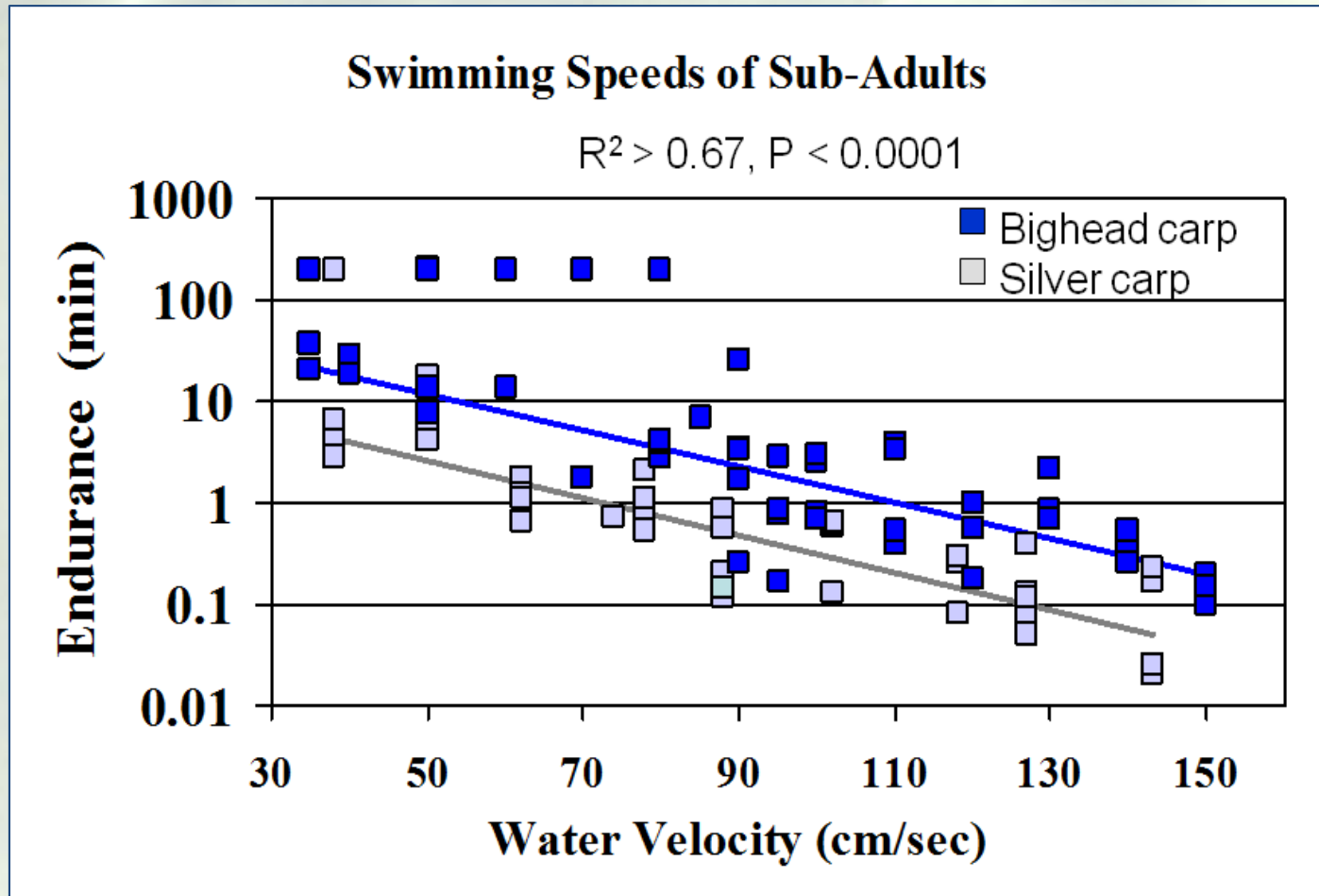
100 L Tank  
7 L Working Section



1200 L Tunnel  
490 L Working Section



# Bighead Carp were Better Swimmers Than Silver Carp





# Field Studies were Conducted with Adult Carp



Hoover, Zielinski, and Sorensen, In Review



...in a Specially Designed Mobile Swim  
Tunnel in Spring 2015



# Water Temperature Varied but Water Quality was Benign & Consistent

Water Quality	Range
Temperature ( C )	13.1 - 25.9
Conductivity ( $\mu$ S )	506 - 660
pH	7.3 – 8.7
Dissolved Oxygen (mg/L)	7.0 – 11.7
Turbidity (NTU)	0.8 – 5.2



# Carp Represented a Wide Range of Adult Size

	Bighead Carp	Silver Carp
Number	17	43
Total Length (mm)	760 - 1040	535 - 931
Weight (kg)	5.2 - 12.3	1.5 – 9.1
Condition ( $K_F$ )	0.98 - 1.60	0.85 – 1.30

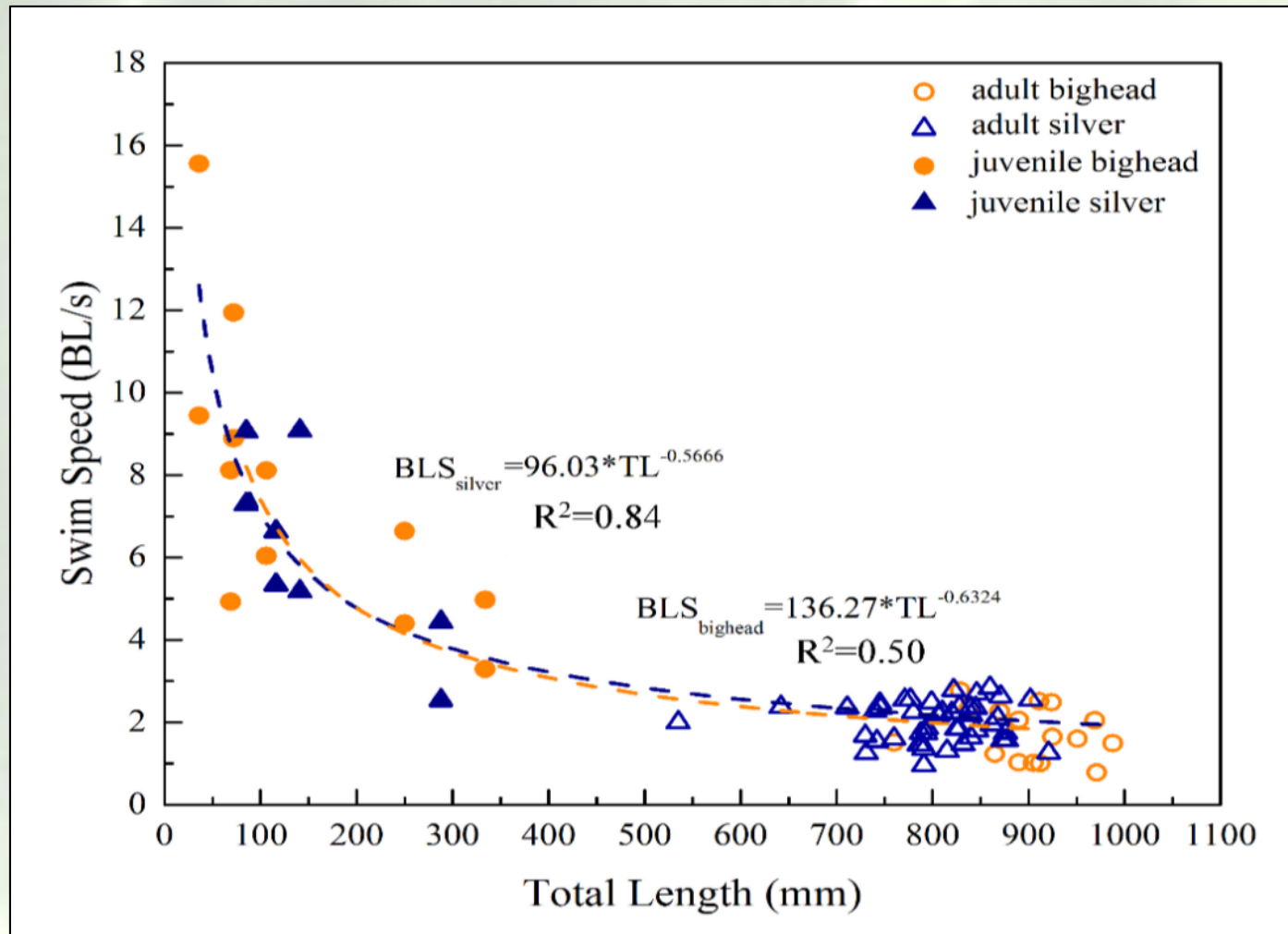
Temperature Effects were Negligible.



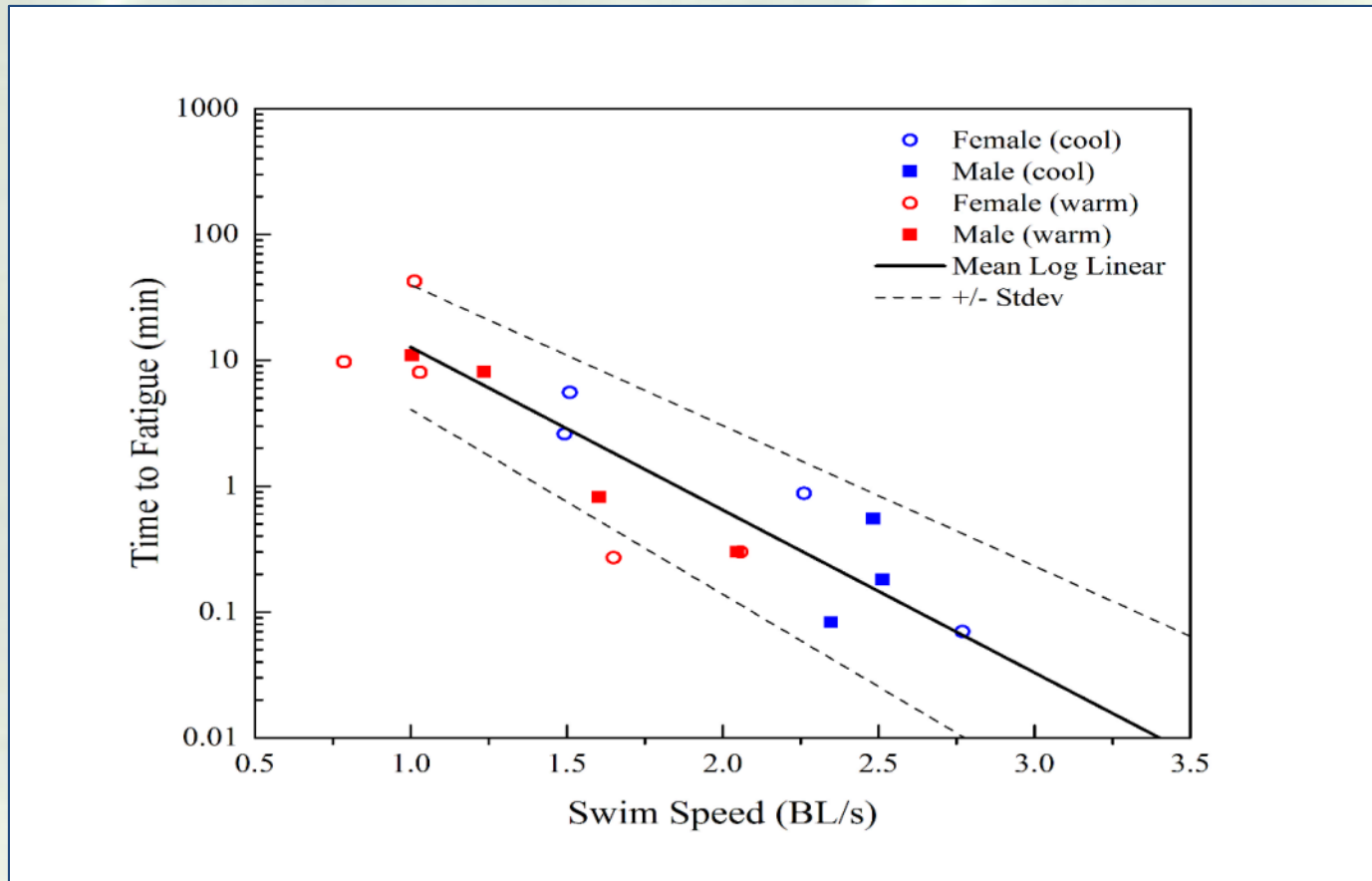
Bighead Carp Swam Differently than Silver Carp but Both Species were Relatively Slow.



# Relative Swim Speed Declines with Increased Size of Juvenile Carp but not Adult Carp



# Bighead Carp Endurance Declined Sharply with Swim Speed but Point Scatter was Low ( $R^2 = 0.78$ )





Equal-Sized Upper & Lower Caudal Lobe



No Ventral Keel





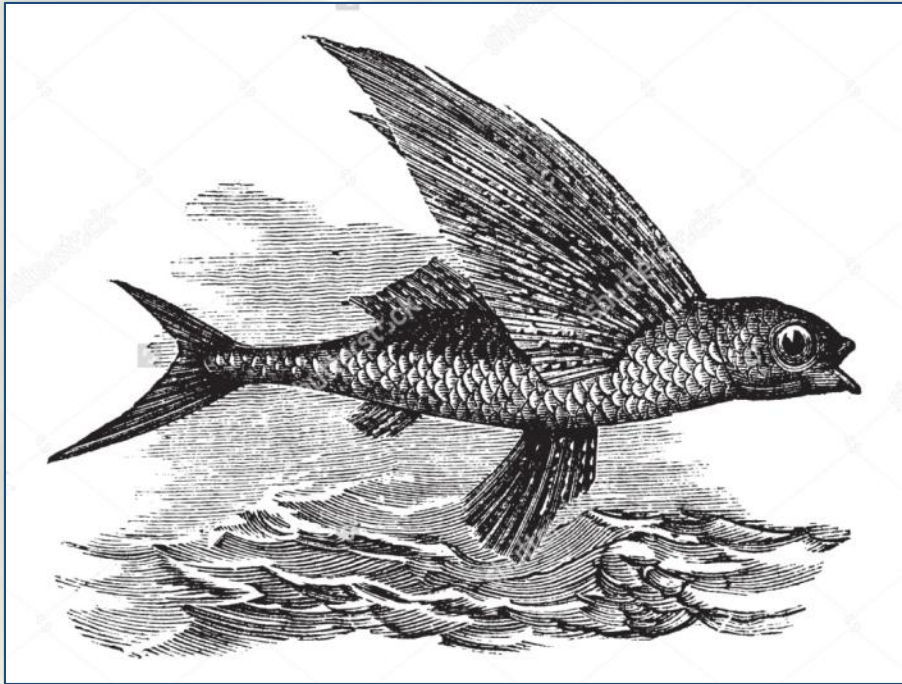


Large Lower Caudal Lobe

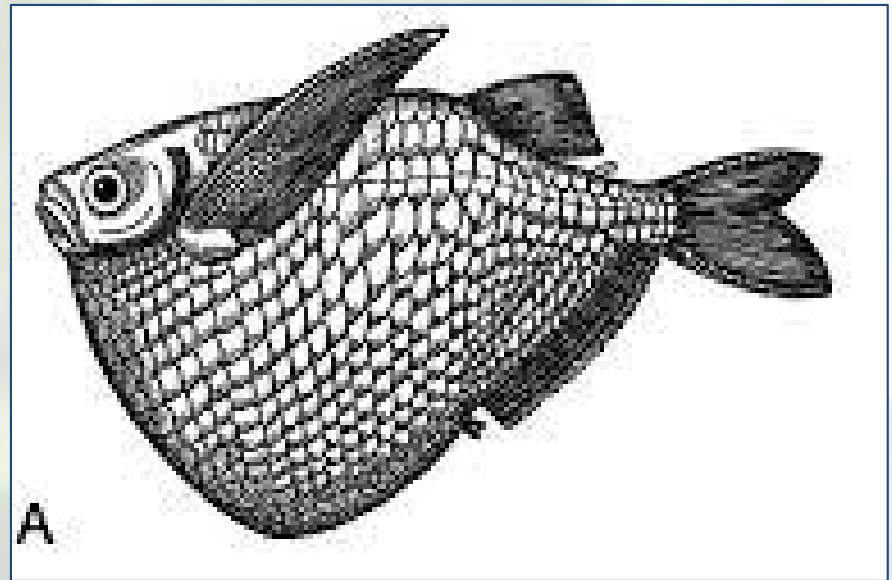


Extensive Ventral Keel

# Fishes With Large Lower Caudal Lobes and Prominent Ventral Keels Are Capable of Flight



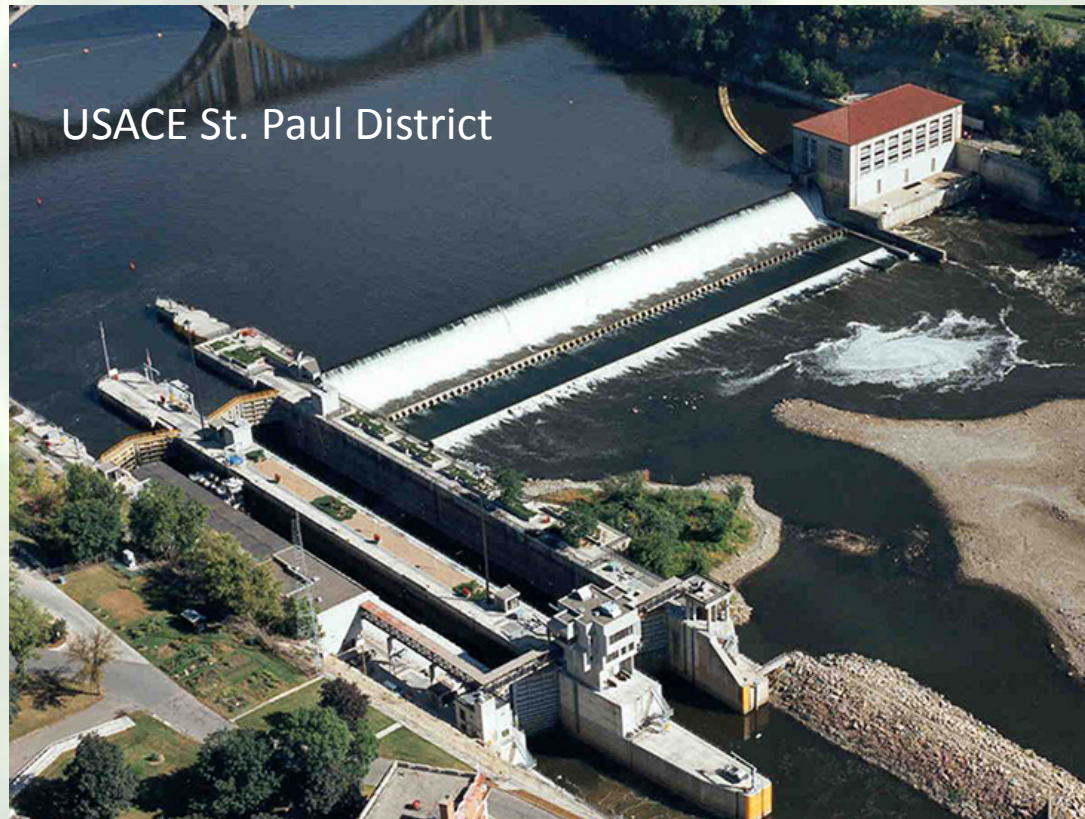
Marine Flying Fish (Exocoetidae)



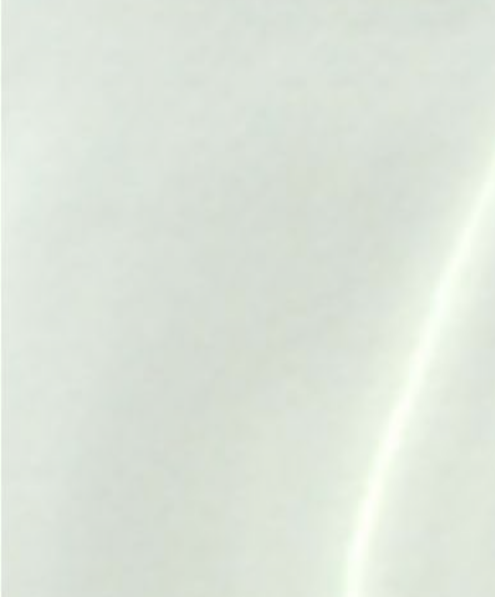
Freshwater Flying Fish (Gasteropelecidae)



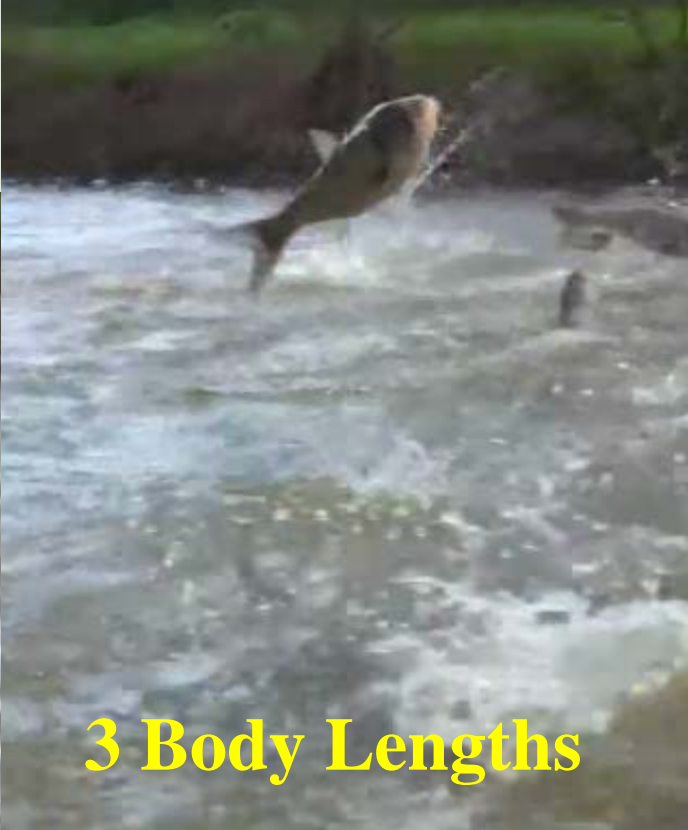
Flow Fields of Sufficient Distance with Velocities  $> 10$  Body Lengths/sec ( $> 3$  m/s) Can Contain Asian Carp & Can be Generated at Lock-and-Dams on the Upper Mississippi River...



...but Silver Carp are also Capable of Leaping.



**2 Body Lengths**



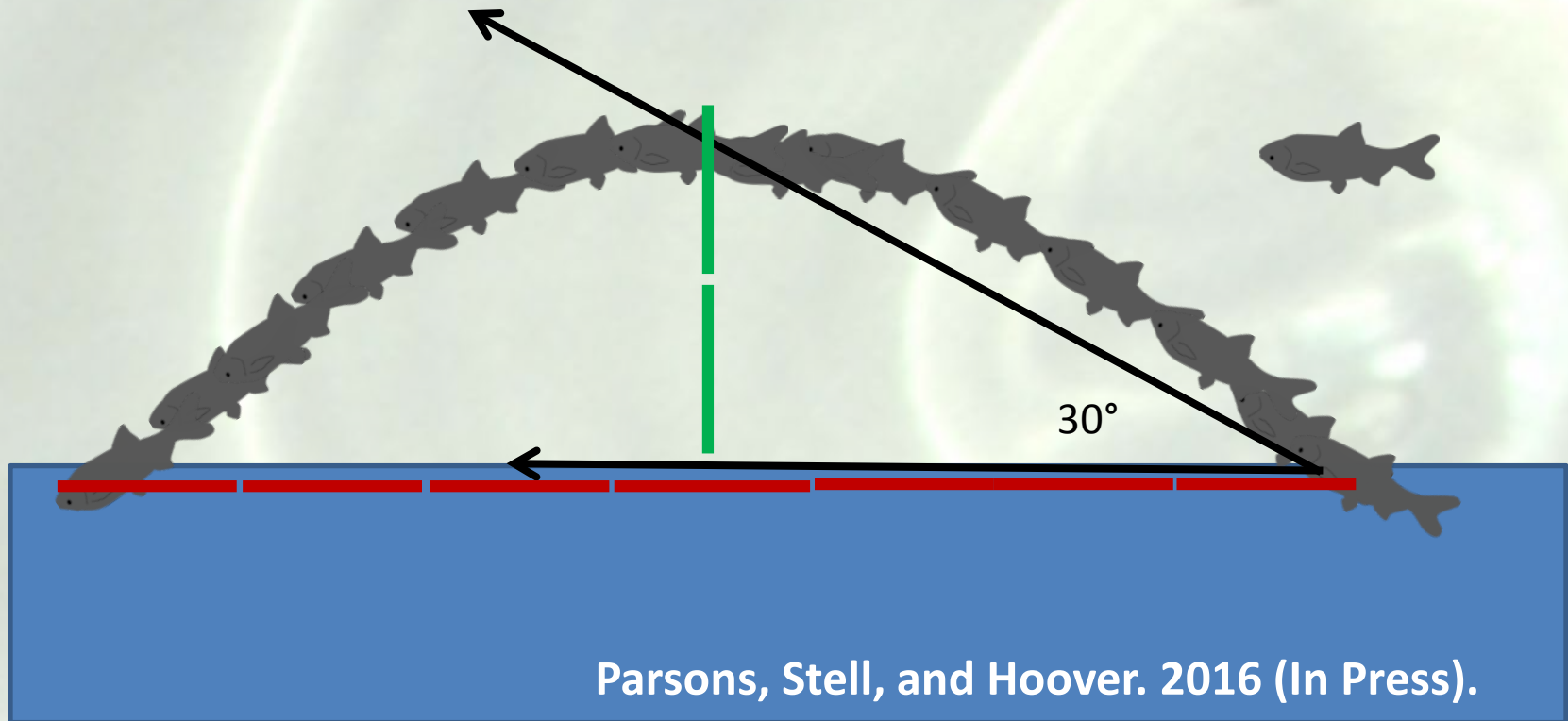
**3 Body Lengths**



**1 Body Length**



# Angle, Distance, & Height of Jump are Measurable from Videos



Based on video analyses to date – maximum burst speeds range from 8.2-11.3 BLS (most < 10 BLS), and jump heights range from 1.9-2.2 m.



# Summary

- Asian Carp impacts are substantial and will increase over time
- Greater predictive capabilities are possible but require data on basic life history: demography, salt tolerance, maximum swim speed and jump characteristics – especially of large, hard-to-sample fish.
- Asian Carp can be contained by hydraulic barriers and vertical barriers

Questions ?

