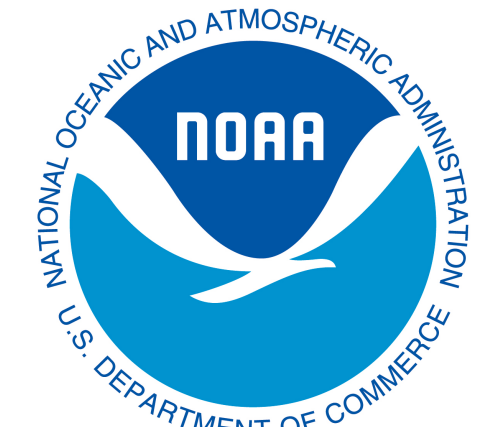


Predicted biomass and food web impacts of Bigheaded carp across Great Lakes habitats



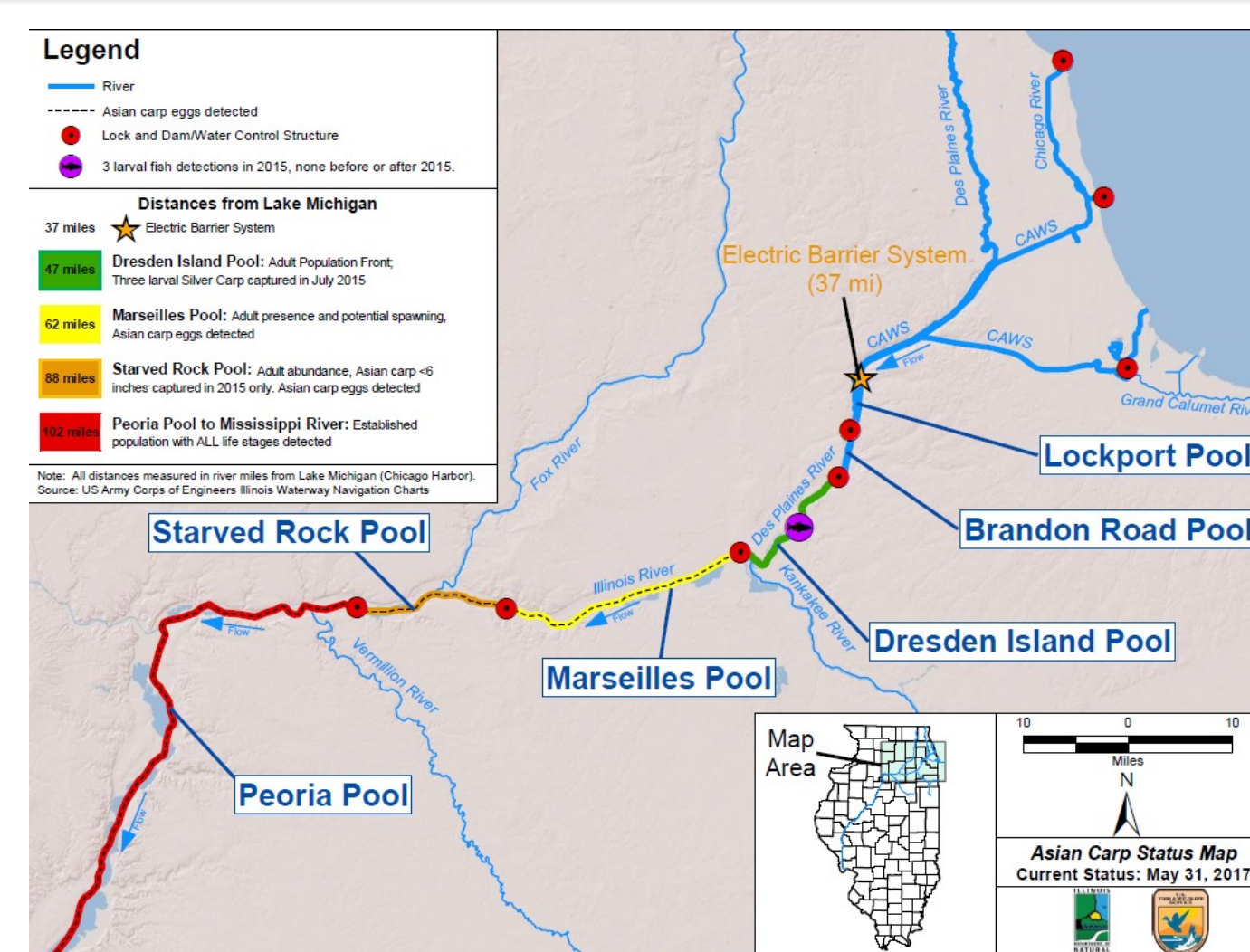
Rutherford, E.¹, Zhang, H.², Kao, Y.-C.³, Mason, D.M.², Shakoor, A.⁴, Lodge, D.⁵, Chadderton, W.⁶

¹NOAA GLERL, ²University of Michigan CIGLR, ³Michigan State University, ⁴Wayne State University, ⁵Cornell University, ⁶The Nature Conservancy

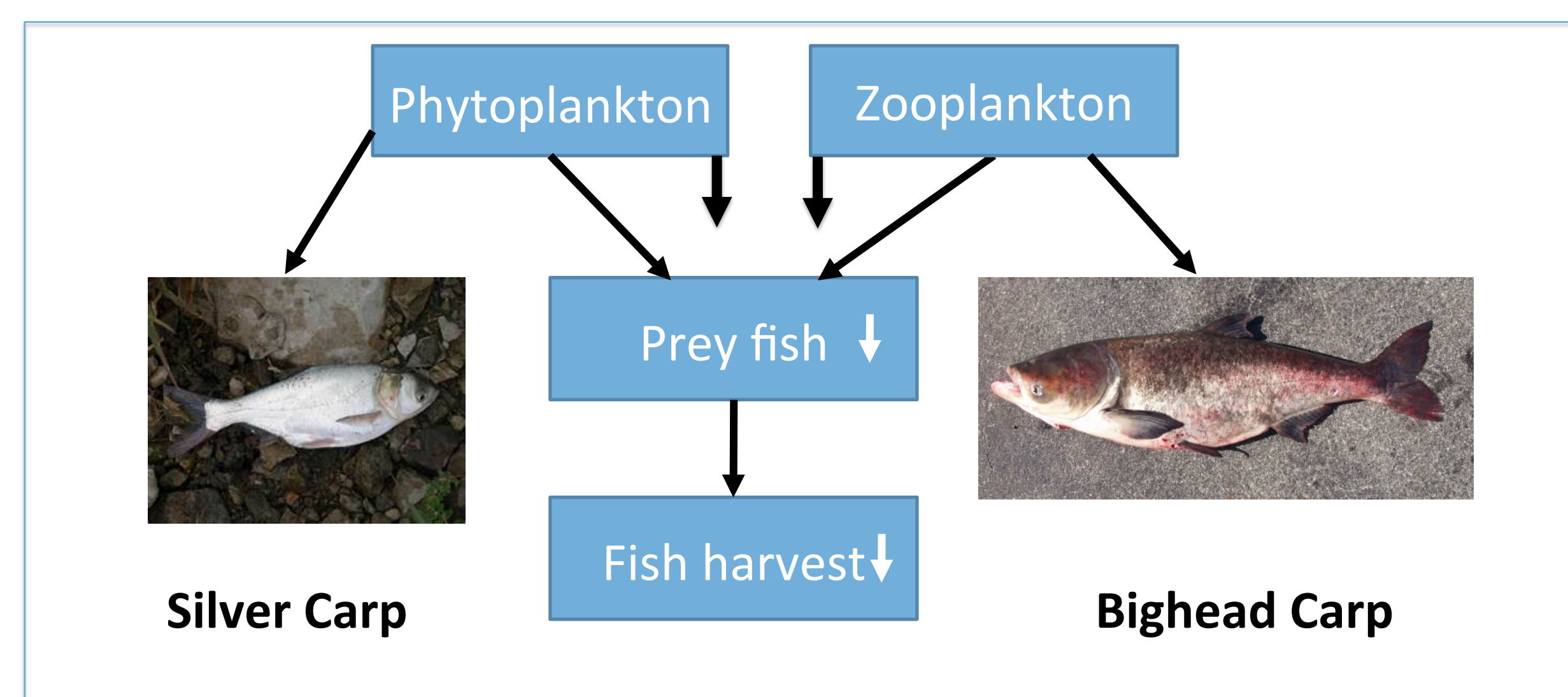


Background

Bighead and Silver Carp (collectively, bigheaded carps 'BHC') are highly invasive planktivorous fish that threaten to invade and impact Great Lakes food webs.



Current distribution map (right) of Bigheaded Carp in Illinois River, near Lake Michigan.



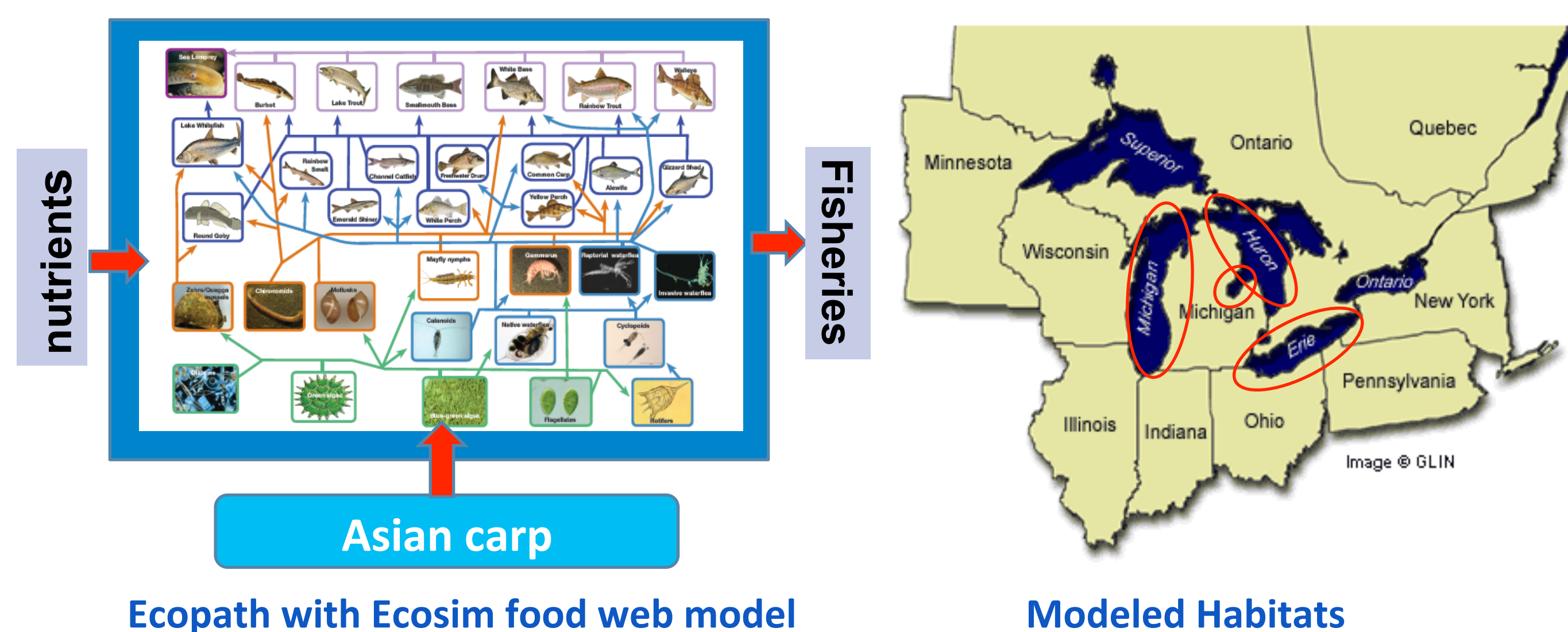
Bigheaded Carp are large filter-feeders, and may outcompete resident prey fish and fish larvae for plankton, thereby lowering their growth and harvest.

Research Objective and Hypothesis

Objective: Predict bigheaded carp population size and food web impact in Great Lakes habitats

Hypothesis: Bigheaded carp biomass and impact will vary by lake productivity and species composition.

Methods



Modeling Bigheaded Carp Growth and Food Web Impact

We used the Ecopath with Ecosim food web model (above, left) to simulate potential BHC biomass and food web impacts across Great Lakes habitats that vary in productivity, prey and predator biomass, and species composition (above, right). For each lake habitat, we standardized initial BHC biomass at 2% of the habitat's total fish biomass, and ran 120-year simulations under variable levels of prey and predator availability to BHC, and variable BHC production/biomass ratios.

Methods

Simulation Scenarios

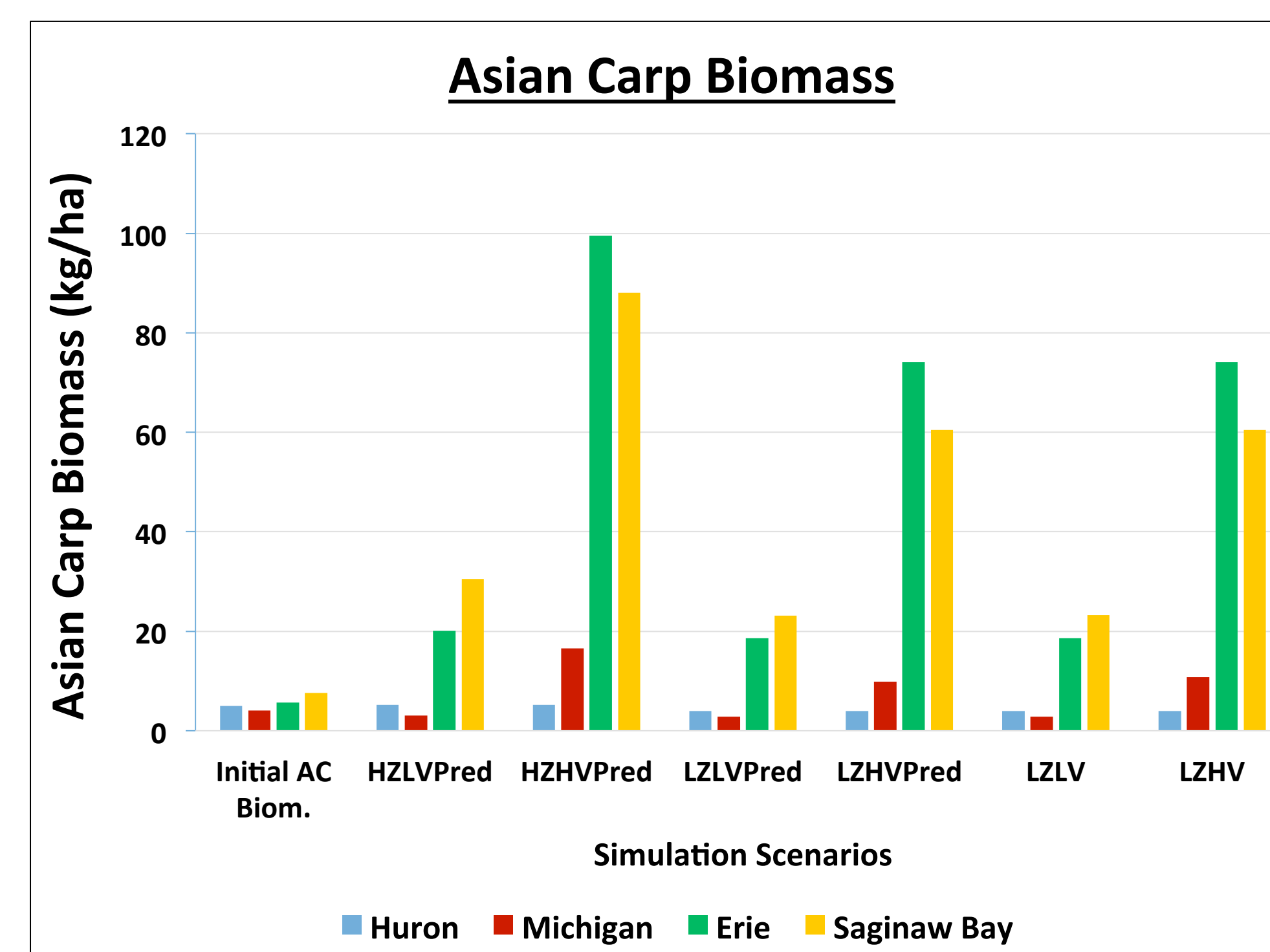
Zhang et al. (2016) showed bigheaded carp biomass and population growth were sensitive to vulnerability of their prey, adult carp production to biomass rate (i.e., mortality), and predation on young. We ran the following scenarios for each Great Lake habitat, and compared variation in prey vulnerability (LV, HV), adult mortality (LZ, HZ) and consumption by salmon and trout (Pred) to a baseline scenario of no bigheaded carp.

Scenarios	Prey vulnerability	Carp P/B	Eaten by Salmonines?
Baseline:No AC			
HZLVPred	Low	1.08	yes
HZHVPred*	High	1.08	yes
LZLVPred	Low	~0.6	yes
LZHVPred	High	~0.6	yes
LZLV	Low	~0.6	no
LZHV	High	~0.6	no

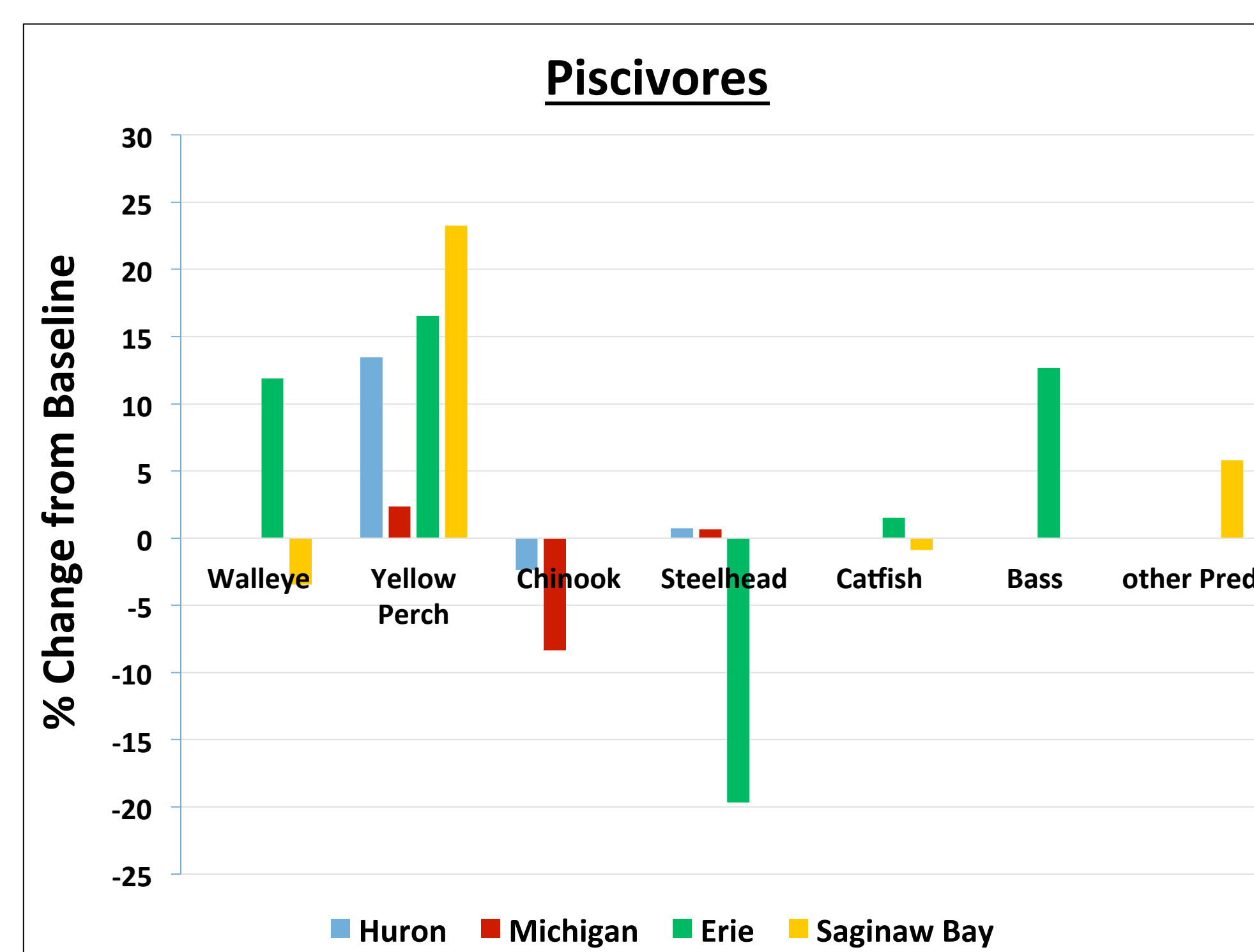
*(All results of BHC impact on food web groups below assumed scenario HZHVPred).

Results

Predicted Bigheaded Carp Biomass is highest in more productive Great Lake habitats when prey vulnerability is high

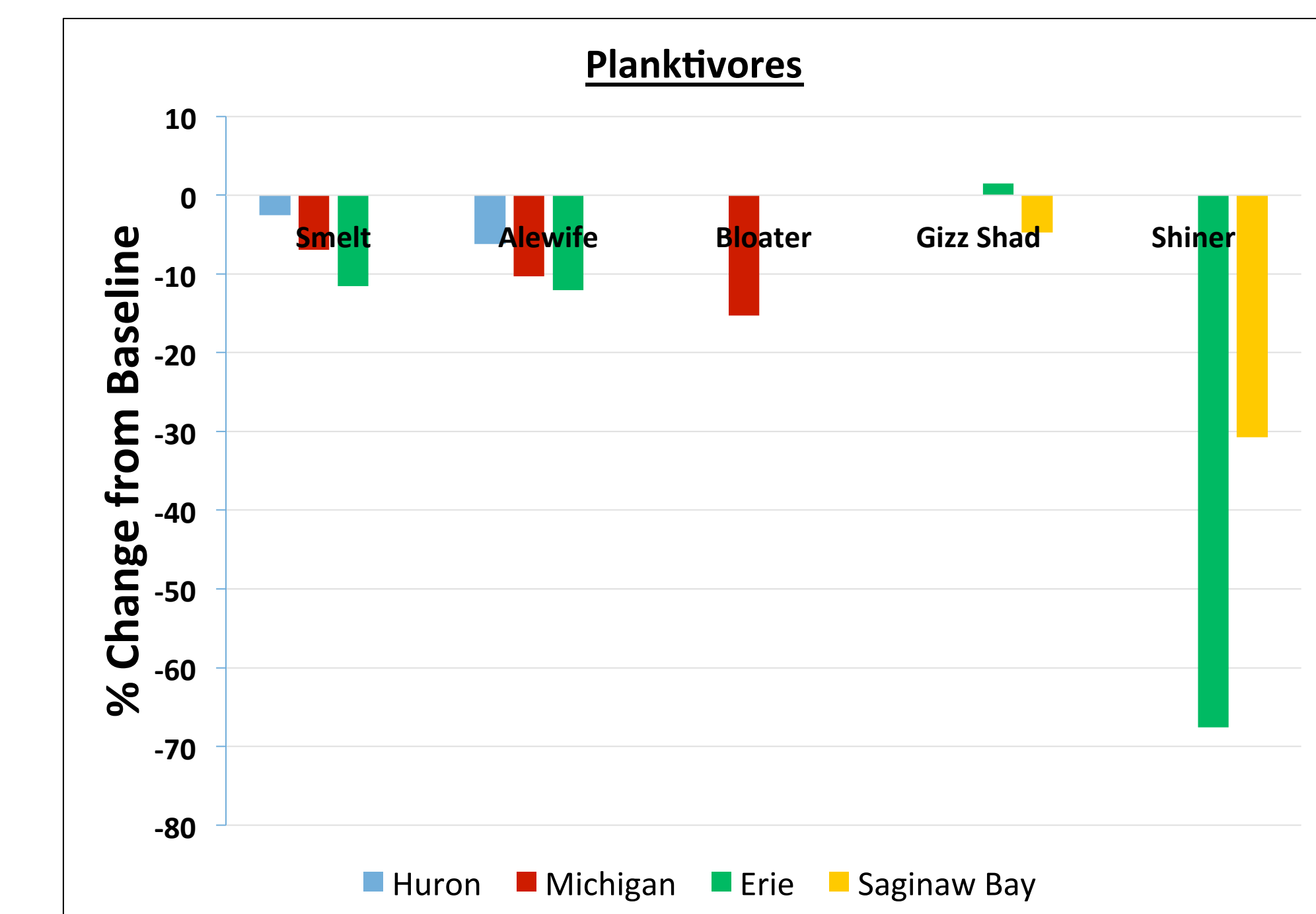


Some piscivorous fishes may benefit from Bigheaded Carp *

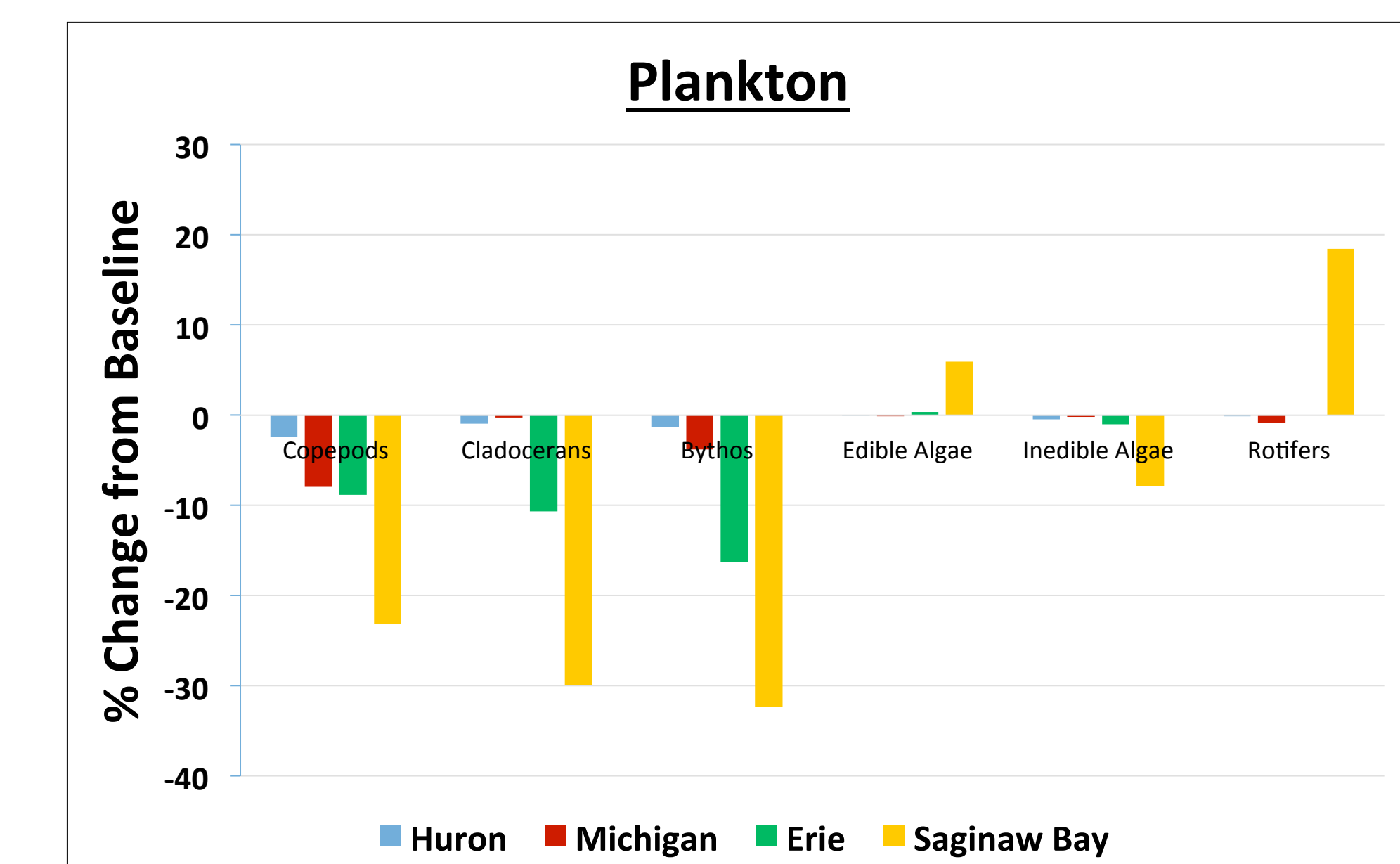


Results (cont.)

Bigheaded carp had negative effects on planktivorous fish, that were greater in more productive habitats *



Bigheaded Carp may lower zooplankton biomass through consumption, but increase phytoplankton biomass through predator release *



Summary & Future Work

- Predicted BHC biomass and food web impacts were higher in more productive habitats compared to less productive habitats. BHC impacts were mainly negative for plankton and planktivores, and positive for some piscivores.
- BHC population growth and impact were more dependent on assumptions of prey vulnerability than on assumed carp vulnerability to predators.

Future Work

- Simulate BHC population growth and impact on the Lake Ontario food web.
- Test model skill in the Illinois River food web where BHC are present and food web impacts are documented.
- Simulate food web impacts of Grass Carp and Black Carp in the Great Lakes.

Literature Cited and Acknowledgments

Zhang, H., E. S. Rutherford, D. M. Mason, J. T. Breck, M. E. Wittmann, R. M. Cooke, D. M. Lodge, J. D. Rothlisberger, X. Zhu, and T. B. Johnson. 2016. Forecasting Impacts of Silver and Bighead Carp on the Lake Erie Food Web. Transactions of the American Fisheries Society 145: 136-162.

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