Mississippi River Dams: How can we block invasive fish yet help natives?

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INTRODUCTION

Protection of the freshwater ecosystems of Minnesota could be greatly enhanced by stopping the invasion of big-headed carps (origin: Asia) and promoting native fish passage through Mississippi River lock-and-dams (LD). Altering operating procedures of spillway gate openings along a series of existing LDs offers promise for accomplishing this paradoxical goal. While both species of carp have reached Minnesota waters, their "established front" (the upstream-most area of reproduction and recruitment to the adult life stage) currently is in southern Iowa between Pool 14 and Pool 16 (Larson, *et al.*, 2017, Kokotovich *et al.*, 2017). Further, results from a recently developed CFD-AB model (Zielinski *et al*. 2018) suggest that upstream movements of bigheaded carps at LD 8 (the southern-most LD in Minnesota) can be cut in half with small gate adjustments. Application of the model at LDs 4 and 5 showed similar results. A modified version of the model (Gilmanov *et al.*, 2019, Water) currently is being tested to provide gate Adjustments that could improve passage of native fishes at LDs upstream of LD 2. The idea of improvement of CFD-AB model by using "attraction" zone ("rest area") was adopted from the field data of fish tracking studies at LD 2 (Finger, Riesgraf, and Sorensen, 2019, River Res Applic).

To accomplish our goal, we propose that LDs 15, 14, and 8 could be used in sequence to reduce the movements of bigheaded carps into Minnesota by ≥ 94%. We further propose that LDs further upstream—most likely LD 5, 4, and 2—could be adjusted to enhance movement of native fishes in this reach of the river. If an established front for either carp species reached Minnesota, LDs 5 and 4 could be converted quickly for blockage.

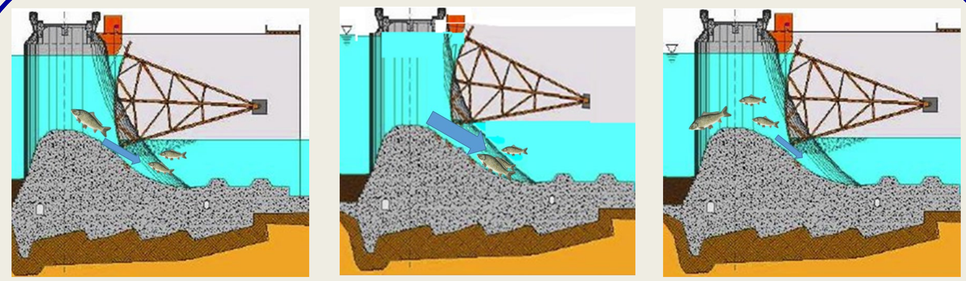
METHODS

We used the CFD-AB model of (Zielinski et al. 2018) and its modification (Gilmanov *et al.*, 2019) to implement a broad range of numerical simulations of upstream movement of Walleye under two different river discharge conditions at LD 2. We calculated a fish passage index (FPI) for each set of simulations under gate adjusted proposed by USACE. We did the same for a series of other gate adjustments that preserved USCAE criteria for downstream scour and safe navigation.

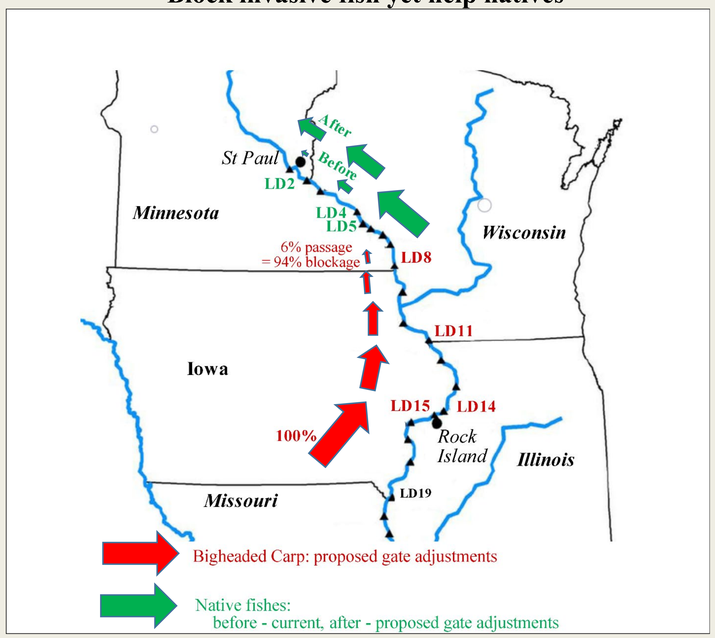
RESULTS

In order to show capabilities of helping native fish to pass through LDs, simulations of Walleye passing through LD2 have been executed. It was found that for gate adjustments proposed by USACE, there was no passage of Walleye (FPI<1%). But by changing gate adjustments we have observed that FPI is increased (see Figure below).

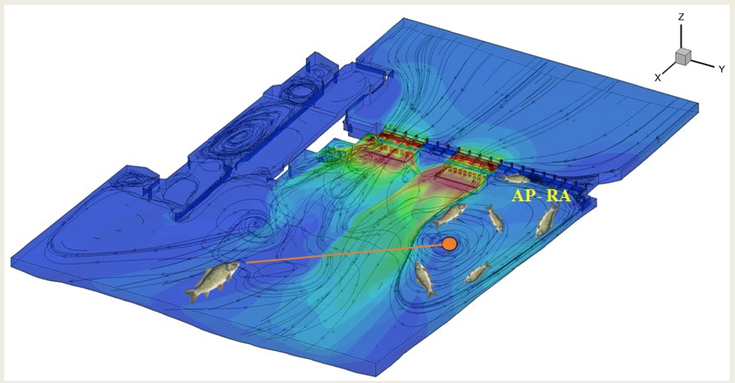
How gate adjustments work.



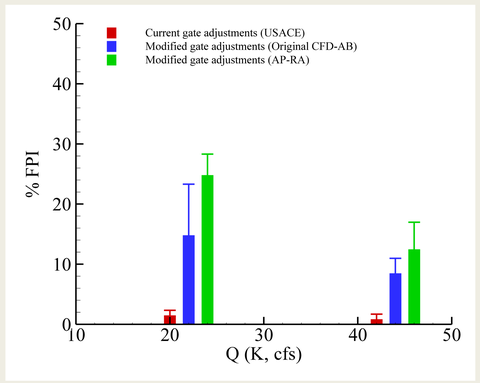
Block invasive fish yet help natives



Attraction Points (AP) to model fish swimming: AP-Rest Area (AP-RA)



Simulations of Walleye passing through LD2



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