A computational model provides a way to stop invasive carp at Minnesota Lock and Dams

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INTRODUCTION

It is crucial to protect the freshwater ecosystems of Minnesota by stopping the invasion of bigheaded carp from Asia while promoting native fish passage through Mississippi River locks and dams. We have the opportunity to do this by altering operating procedures for spillway gate openings at existing locks and dams structures through which all migratory fish must pass (see Map). In this study we use the CFD-AB model developed by (Zielinski et al. 2018) to test a broad range of numerical simulations of invasive carp trying to pass through Lock and Dam #4 key structure. This numerical model is explained to the right. The findings predict that fish passage of invasive bighead carp reduces more than half.

RESULTS

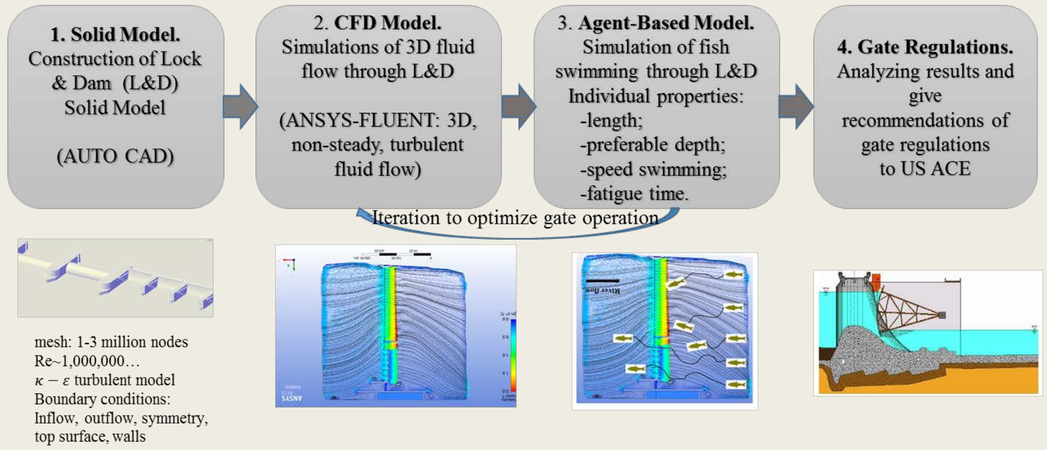
The model was run for five flow conditions at Lock and Dam #4. Under current operating conditions a fish passage index for bighead carp was between about 12% and 6% depending on flow discharge. This passage index dropped by about 50% on average after modifications of dam's gates operation. In the example below (flow rate of 40,000 cfs), fish passage index was reduced by an average of 50% for adult bighead carp after small adjustments in gates. Targeted spillway gate manipulation based on our numerical simulations with presenting to the US Army Corps of Engineering, which they could use that will protect Minnesota's freshwater. These changes should not effect at navigation as well as erosion of dams.

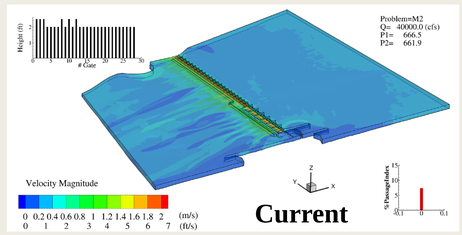
FUTURE DEVELOPMENT: NEW PROJECT

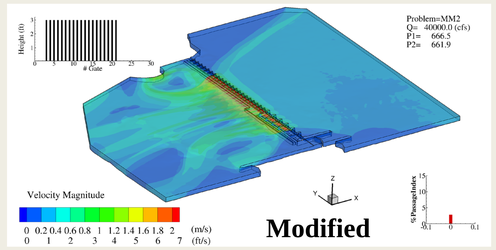
New field data on fish movement around LD2 (Jean Finger and Andy Riesgraf, Sorensen Lab) suggest that the current CFD-AB model could be improved and we plan to update this model according experimental field data of active invasive (common carp) and native (catfish) fish tracking around LD2.

Algorithm of CFD-AB Model

The Concept of Computational Fluid Dynamic + Agent-Based (CFD-AB) Model: universal and can be used for any L&D.







LD4: *Contours of velocity flow in the region around LD4 for* ***current (left)*** *and tentative* ***modified (right)*** *gate configurations at* $Q = 40K\ cfs$. ***Top-Left (gray bars)****: Gate regulations - height of roller and tainter gates;* ***Right-Bottom (red bars):*** *%Fish Passage Index*

River Discharge (cfs)	Bighead Carp Passage		
	Current	Modified	K
20K	10%	4.1%	2.4
40K	6.8%	1.6%	4.2
60K	2.6%	1.1%	2.4
80K	0.8%	0.25%	3.2
90K	5.8%	5.8%	1.0

LD4: *Fish passage index for bighead carp under current and modified gate operations*

Acknowledgements

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