M.L. 2013 Minnesota Aquatic Invasive Species Research Center Subproject Abstract
For the Period Ending June 30, 2019

SUBPROJECT TITLE: MAISRC Subproject 26: Updating an invasive and native fish passage model for locks and dams

SUBPROJECT MANAGER: Anvar Gilmanov
AFFILIATION: University of Minnesota
MAILING ADDRESS: 135 Skok Hall, 2003 Upper Buford Circle
CITY/STATE/ZIP: St Paul, MN 55108
PHONE: (612) 626-2110
E-MAIL: agilmano@umn.edu
WEBSITE: www.maisrc.umn.edu/team-gilmanov
FUNDING SOURCE: Environment and Natural Resources Trust Fund (ENRTF)
LEGAL CITATION: M.L. 2013, Chp. 52, Sec. 2, Subd. 06a

SUBPROJECT BUDGET AMOUNT: $90,827
AMOUNT SPENT: $88,296
AMOUNT REMAINING: $2,531

Sound bite of Subproject Outcomes and Results
This project updated the Computational Fluid Dynamics Agent-Based fish passage model using the field and experimental data through Lock and Dam 2. This new model will better stop invasive Asian carp moving up the Mississippi River in case of blocking or help native fish to swim upstream through navigation dam.

Overall Subproject Outcome and Results
The main purpose of the project was to develop an updated version of the Computational Fluid Dynamics Agent-Based (CFD-AB) fish passage model (Zielinski, et al., 2018) using the field/experimental data of fish passage through Lock and Dam #2. This updated CFD-AB model can better help stop invasive carps while allowing native fish to pass through Mississippi River locks and dams.

The subproject has been fulfilled for all the goals that were declared:

1. The computational code CFD-AB directed to enhance the simulation of swimming fish trying to pass through the navigation dams was updated/developed. The analysis of different fish passage index (FPI) showed that the values of FPI for the modified algorithm for a model channel (Gilmanov, et al., 2019, Water, under review) were greater than the FPI of the original algorithm at about 16%. At this moment, no essential differences in fish passage index FPI for the original and modified model at LD2 and LD8 have been found. This effect can be explained by the special gate adjustments, which generate a rather high fluid flow prevented fish to pass through the dams. In other words, in case of blocking invasive species, the modified algorithm does not change the final results of FPI at LD2 and LD8. But the modified algorithm could play a positive role to help native fish to pass through the navigation dams in the case of changing gate adjustments leading to decrease flow velocity.
2. The modified algorithms now account for more realistic fish behavior, including placement of “attraction points”, such as resting zones characterized by low recirculating fluid flow. These parameters have been informed by the literature and unpublished field data collected on other projects.
3. Based on investigations of (Larson, et al., 2017, Kokotovich et al, 2017) it was reported that the “Invasive Front" is currently positioned in southern Iowa between Pool 14 and Pool 16. Therefore, the strategy of blocking bigheaded carp at Lock and Dams of Minnesota should be reconsidered. It is well documented that the navigational dams have significantly altered the movement, spawning, feeding and other

activities of native fish (Wilcox et al. 2004). Hence, managers should consider alternative strategies whereby navigation dams are adjusted to *help* native fish pass, instead of *blocking* invasive fish. This strategy could help with ecosystem restoration efforts and potentially improve natural resistance to invasion by bigheaded carps. To evaluate this strategy, simulations of walleye passing through LD2 have been executed. It has been shown that by changing gate adjustments, FPI=4% is for the original algorithm and FPI=12% for the modified algorithm. We have to note, that for current gate adjustments from USACE the FPI=0% for original and modified CFD-AB models. By utilizing active monitoring data of bigheaded carp managers could *instantly* change gate adjustments at LD2-LD8 by using our CFD-AB approach if the invasion front threatens Minnesota.

Subproject Results Use and Dissemination

The results of the "MAISRC Subproject 26: Updating an invasive and native fish passage model for locks and dams" were/will be presented at the following events:

- MAISRC Research & Management Showcase (2018) with a poster presentation "A computational model provides a way to stop invasive carp at two key Minnesota Lock and Dams." Discussions and conversation with different groups of people were very informative and helpful.
- 2018 Upper Midwest Invasive Species Conference that was held with a joint conference of North American Invasive Species Management Association on October 15-18, 2018 - Mayo Civic Center - Rochester, MN and made an oral presentation "Computational model of fish swimming through Mississippi River locks and dams demonstrates ways to stop carp."
- The paper (Gilmanov, et al., 2019, under review) with the description of development/modification of CFD-AB model was submitted to the "Water" (an Open Access Journal from MDPI).
- MAISRC Research & Management Showcase (2019) with a poster "Mississippi River Dams: blocking invasive fish, helping natives".
- Additional paper "Spillway gate settings in Mississippi River navigation lock and dams can be used to help native fish upstream passage" is in process and will be submitted for review in October-November 2019.
- The computer code of fish swimming through the navigation dam LD2 will be prepared and put in the publicly accessible Data Repository and the University of Minnesota (DRUM) system.