Investigating fish passage through lock and dam structures: Validation of a computer model
Finger J.S., Riesgraf, A., Gilmanov A., Zielinski D. P., Sorensen P.

INTRODUCTION

Lock and dams are thought to deter fish movement, to what extent is poorly understood. While potentially problematic for native species, the extent to which this is true is unclear and whether it might be decreased by altering spillway gate operations is not yet known. Conversely, it could also be used to prevent invasion (e.g. bigheaded carp). A detailed understanding of fish passage through these structures will allow us to facilitate native fish passage and block invasive species. Accordingly, a computer model (i.e. CFD agent-based model; see Gilmanov et al., poster) was built to simulate fish upstream passage through the spillway gates of lock and dams. In this project we tested assumptions and predictions of this model by monitoring actual fish challenging Lock and Dam #2. Findings will allow us to validate and improve this model.

MODEL ASSUMPTIONS AND PREDICTIONS

a. Fish approach the dam uniformly, 100 m downstream.
   b. They only move upstream until total exhaustion.
   c. Approach and passage depend on fish swimming performance.
   d. Low rate of passages through Lock and Dam #2 dam’s gates (between 0.1 to 18 percent rate of passages).

WHY USING A COMPUTER MODEL

Obtaining data on fish passage (as we are doing here) is extremely difficult and expensive because of high flows and is also dam-specific. Using this model will allow us to:
- Try numerous flow and gate operations scenarios.
- Investigate numerous lock and dam structures.
- Test different fish species (upon availability of swimming performance data).
- Modify gate operations to block or facilitate fish passages.

EXPERIMENTAL DESIGN

We captured 112 fish (Common Carp, Channel Catfish, Walleye, Bigmouth Buffalo and Smallmouth Buffalo) above Lock and Dam #2, displaced them below Lock and Dam #2, radio/acoustically-tagged them, and then released them there.

We then tracked the movement of these fish from a boat to get detailed information on movement patterns relative to flow.

Fish passage through both individual spillway gates and the lock was also automatically monitored using archival listening stations.

RESULTS

0 out of 112 fish went through the spillway dam’s gates (see Riesgraf et al., poster).

Fish preferred slower flowing areas and were mainly found near shore (i.e. they did not approach the dam in a random fashion).

Common carp were highly mobile near the high flow areas and seemed to enter these flows close to the gates (i.e. not downstream as assumed by the model).

DISCUSSION

Less fish than predicted by the model went through the spillway gates: the model appears to overestimate likelihood of passage. Potentially because fish are found to prefer slower flow than assumed by the model.

Conservative estimations of fish passage are good when trying to prevent upstream movements of invasive carp. However, estimation accuracy needs to be improved when trying to facilitate native fish movements.

As indicated by fish movements the model’s assumptions could be improved taking into account these behaviors:
- Fish do not approach the dam uniformly
- Fish resting close to spill way gates (start challenging flow from anywhere)
- Fish highly mobile in the flow area (not exhausted)

ACKNOWLEDGEMENTS

We thank the DNR and U.S. Fish and Wildlife for their funding and help.

We thank the Sorensen lab team for their advises and help on this project, the U.S. Coast guard for letting us use their channel buoys, the U.S. Army corps for their continuous help and MAISCR for invaluable administrative assistance.