An agent-based modeling approach for predicting the behavior of bighead carp (*Hypophthalmichthys nobilis*) under the influence of acoustic deterrence

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Bighead carp (Hypophthalmichthys nobilis) are an invasive, voracious, highly fecund fish threatening the ecological integrity of the Great Lakes. This agent-based model explores bighead carp behavior in response to acoustic deterrence, incorporating competition with native species, reproduction/death cycles, and resource availability. A simulation run continues until a reasonable amount of time passes or conditions, reported in other research, for an invasion occurs. A full factorial design of experiment is performed to include all possible combinations of parameter levels. Results indicate the most significant influences on invasion probability are the quantity of detritus and plankton behind the barrier, total number of bighead carp successfully deterred by the barrier, and number of native fishes freely moving throughout the simulation. Quantity of resources behind the barrier influence bighead carp to penetrate when populations are resource deprived. Bighead carp interact with the barrier by rotating and swimming away. Populations of native fishes are allowed to freely move throughout the simulation to maintain resource balance on both sides of the barrier. When native fish populations are low, an accumulation of phytoplankton can occur, increasing the likelihood of an algal bloom occurrence. These results expand upon previous research by validating the effectiveness of an acoustic barrier on bighead carp and identifying parameter conditions at which this deterrence is most effective. Findings of this simulation suggest successful implementation of acoustic deterrence in a real-world environment has potential of abating the threat of bighead carp on ecological integrity of the Great Lakes.