Analysis of an agent-based model for predicting the behavior of bighead carp (*Hypophthalmichthys nobilis*) under the influence of acoustic deterrence

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Abstract

Bighead carp (Hypophthalmichthys nobilis) are an invasive, voracious, highly fecund fish threatening the ecological integrity of the Great Lakes. This agent-based model and analysis explore bighead carp behavior in response to acoustic deterrence in an effort to discover properties that increase likelihood of deterrence system failure. Competition, reproduction/death, resource consumption/abundance, and swim behavior parameters are implemented scaled literature values. All possible combinations of parameters are evaluated in a full-factorial design of experiment. Results indicate the most significant ($p < 0.05$) influences on barrier failure 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.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 with proper maintenance of a acoustic deterrence system has potential of abating the threat of bighead carp on ecological integrity of the Great Lakes.

Keywords— Bighead Carp, Acoustic Deterrence, Agent-Based Model, Invasive Species, Great Lakes