

Development of a Warmwater Fish Community Model

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Abstract.-An individual-based model, LakeMod, was developed to synthesize information and to help answer questions raised in the management of freshwater fish communities, particularly ponds and lakes containing bluegills and largemouth bass or walleyes. The daily model accounts for size-specific interactions between predators and prey, selection among multiple prey types, energetics of growth, changes in body composition, and seasonal water temperature. Sources of fish mortality include predation, starvation, and other causes. Because of the importance of energy density to fish growth and survival, a new model has been developed for dynamic changes in energy density, body composition, and relative weight. This model explains the common observation that both percent lipid and energy density show a linear relationship with percent water, and also explains the difference in vulnerability to starvation among fish of different sizes. Because of the abundance of forage fish compared to their predators, each “individual” bluegill in the model represents many identical fish in a lake or pond, whereas each largemouth bass in the model may represent one or more fish in a pond. The model has been used to explain patterns in the density-dependent growth of bluegills and largemouth bass, and to examine predator-prey interactions. Simulations of pond experiments involving different densities of largemouth bass show that the numbers and mean lengths of surviving bluegills reflect size-dependent and density-dependent processes that are readily represented in an individual-based model. Simulations show the strong interactions between growth of forage fish and growth and survival of piscivores. Understanding these complex response patterns should improve the ability of fisheries managers to determine appropriate sizes and densities of predators and prey in warmwater fish communities.

Bluegills *Lepomis macrochirus* are of special interest to fisheries scientists because they are the ecologically dominant fish species in many Michigan warmwater lakes, often exceeding 50% of the total fish biomass (Schneider 1973a, 1981). They are of interest to fisheries managers because bluegills are among the most popular panfish for anglers.

Slow-growing bluegill populations are a common problem in southern Michigan lakes. Various management actions have been tried in an attempt to provide long-term improvements in growth and size structure of slow-growing populations. Such actions have included chemical treatment to remove juveniles, manual removal to thin the population, harvesting macrophytes to increase predation on juveniles,