An Empirical Approach to Predicting Grass Carp Stocking Rates

by
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Many factors can affect the level of aquatic plant control achieved using grass carp, including water temperature, target plant species, amount of plants present, grass carp mortality, and plant control objectives. Currently, most managers recommend only one or two grass carp stocking rates for lakes in their region based on the area coverage or biomass of vegetation and the management objectives for the site (Leslie et al. 1987; Seagrave 1988; Bonar 1990; Masser 1992). A single stocking rate may be adequate for specific geographic areas where little variation occurs in climate, target plant species, or management objectives; however, in mountainous regions where climate varies considerably or in areas where there are a wide variety of target plant species or management objectives, stocking rates must be adjusted to each site to be effective. To improve the ability to predict grass carp stocking rates for widely varying sites, we used regression analysis to examine the relationship between effective grass carp stocking rates and accumulated air temperature units for two major groups of plant species (preferred and less preferred) and for two types of management objectives (control of plants to a reduced level or eradication of all plants).

Two regression analyses were conducted based on the type of plant abundance data available. One (COVER) examined the relationship among stocking rate expressed in fish per vegetated hectare and the above-mentioned independent variables, while the other (BIOMASS) examined the relationship among stocking rate expressed in fish per metric ton of vegetation at the peak of the growing season and the same variables.

We obtained data for COVER from a questionnaire survey of grass carp managers in 28 states in the United States and 11 European countries (Bonar 1990). Data were not used from managers that had worked with grass carp for less than 3 years. For BIOMASS, we obtained stocking rates, associated data describing treatment sites and the results of the treatments from >100 grass carp field trials described in the literature.

Analysis of covariance revealed no significant differences in either area coverage-based or biomass-based stocking rates when rates were grouped by plant species preference (preferred or less preferred). Therefore, the data for both groups of plants were pooled to develop stocking rate curves based on the degree of plant removal: control and eradication.

The resulting four curves, COVER-control, COVER-eradication, BIOMASS-control, and BIOMASS-eradication, were evaluated for possible management applications. All relationships were best represented by curvilinear functions with high stocking rates necessary for cool regions declining to lower stocking rates for warmer areas. COVER-control ($R^2 = 0.66$), COVER-eradication ($R^2 = 0.33$), and BIOMASS-control ($R^2 = 0.88$) relationships were significant ($0.01<P<0.025$), while there was no discernible pattern in BIOMASS-eradication with temperature.

The curves can be used for prediction of stocking rates by selecting the curve with the appropriate management objective/plant abundance information and matching the accumulated air temperature units of the site to the

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corresponding location on the curve. The prediction obtained represents an average of successful stocking rates used by grass carp managers under similar conditions. Although curves were developed to predict stocking rates for either plant control or eradication, few sites (12 percent) examined in our study exhibited partial plant control 3 to 5 years following stocking, while the majority (88 percent) exhibited either eradication or no plant control. While the objectives of these treatments were often not stated, the low number of sites where partial control was achieved indicates that a specific level of aquatic plant control is currently difficult to obtain using grass carp.

We developed this approach based on worldwide data gathered using a variety of techniques. More precise predictions would be obtained by standardizing aquatic plant data collection, developing predictive curves for smaller geographic regions, and including other factors influencing the effectiveness of grass carp stocking rates, such as grass carp mortality, into the regression analysis.

References

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