Beneficial Effects of Hydrilla on Two Eutrophic Lakes in Central Florida

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Abstract: Hydrilla (*Hydrilla verticillata*) encroachment in Lake Parker and Lake Hunter was directly proportional to production of invertebrates, forage fish species and juvenile largemouth bass (*Micropterus salmoides*). Survival of young of the year largemouth bass was positively correlated with the presence of hydrilla. Improvements in the sportfish standing crop on both lakes indicated a reversal from hypereutrophic to a mesotrophic/eutrophic fishery. Water quality data revealed a possible trend of stabilization and/or improvement of nutrient levels with hydrilla encroachment.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 36:280–286

Eutrophication has become a major problem in management of aquatic systems in Central Florida. Stabilization of water levels and excess nutrient loading has rapidly caused reduced habitat diversity, invertebrate production, and sportfish populations. These problems were evident in Lakes Parker and Hunter, 2 hypereutrophic lakes in west central Florida. Various management techniques have been implemented on both lakes to improve sportfisheries, but success of these efforts were short term and limited. Hydrilla encroachment resulted in improved invertebrate, forage fish, and sportfish production. A reversal from a hypereutrophic fishery to a mesotrophic/autrophic fishery was observed. As a substitute for a naturally diverse habitat, the man-
fishery was observed. As a substitute for a naturally diverse habitat, the management potential of hydrilla in hypereutrophic systems is a documented success.

We are grateful for the assistance of Bob Betz, Harold Carpenter, Ken Denson, Homer Royals, Stanley Stooksbury, and Roger Young of the Division of Fisheries, Game and Fresh Water Fish Commission for assisting with data collections; to Bucky Wegener and Vince Williams for their review of the manuscript; and to Christy Fox and other South Region secretaries for their typing skills.

Methods

Lake Parker and Lake Hunter are urban lakes located within the city limits of Lakeland, Florida. Lake Parker, a 920 ha lake, has a 61 km^2 drainage area consisting of marshland, streams, and drainage canals. Lake Hunter, a 41 ha lake, has a 21 km^2 drainage area consisting of urban storm sewers. Water level fluctuations are practically non-existent on both lakes.

Hydrilla coverage was visually estimated each spring and fall from 1978 to 1981. Largemouth bass, selected forage species, and invertebrates were monitored to evaluate the effect of the hydrilla invasion. Species considered as forage were: bluefin killifish (*Lucania goodei*), brook silverside (*Labidesthes sicculus*), golden shiner (*Notemigonus crysoleucas*), least killifish (*Heterandria formosa*), *madtom* (*Noturus* sp.), seminole killfiish (*Fundulus seminolis*), mosquitofish (*Gambusia affinis*), sailfish molly (*Poecilia latipinna*), and tailight shiners (*Notrophis maculatus*).

Fish population sampling was conducted using the 0.4 ha blocknet rotenone technique (Wegener and Williams 1974). Annual sample numbers varied from 3 to 8 on Lake Parker and from 2 to 4 on Lake Hunter depending on year. Sites included both littoral and limnetic areas for each lake and samples were normally taken during fall months. Duplicate samples were taken during spring, 1972, 1973, 1974, and 1978.

Benthic organisms were collected biannually (fall and spring) from 1978 to 1980 with Eckman dredge or core samples (Williams et al. 1979). Three samples were taken along each of 3 transects in Lake Parker and 2 transects in Lake Hunter. The first sample was in established vegetation, the second between vegetation and midlake, the third at midlake.

Sweepnet samples were taken from hydrilla on both lakes, at a minimum of 2 fixed stations during 1979 and 1980. A 1.5-m sweep was used as a standard sample, and covered approximately 0.14 cubic meters.

Invertebrates collected from benthic and sweepnet samples were identified using taxonomic keys by Pennak (1953), Usinger (1956), Ward and Wipple (1959), Pharris (1975), and Lehnkuhl (1979). Most organisms were identified to the family level.

Water quality samples were taken quarterly from 1978 through 1980. Three fixed surface samples were taken on Lake Parker and 2 on Lake Hunter. Chemical parameters were measured in accordance with standard methods (American Public Health Association et al. 1975).

Results and Discussion

The response to hydrilla introduction within the aquatic invertebrate communities is shown in Table 1. Benthic samples show an increase in diversity in hydrilla established habitats, though this relationship was not clearly defined in overall number of organisms. Generally, the increased diversity was due to the presence of invertebrates associated with vegetation. The most noticeable increase in invertebrate number and diversity was observed in sweepnet samples. These sample sites did not contain any vegetation prior to hydrilla encroachment. Hydrilla, through increased surface area, provided the habitat needed for production of invertebrates associated with vegetation. This response of macroinvertebrates to vegetation has also been documented by Wegener et al. (1974) and Cronwell and Hudson (1967). Furthermore, the majority of these invertebrates sampled were fish food organisms. Wegener et al. (1974) found that aquatic earthworms, scuds, freshwater shrimp, and larval mayflies, damselflies, and midges were important food sources for Florida's sportfish. This same relationship was observed by Chew (1974) in studying food utilized by juvenile largemouth bass. Sweepnets from Lake Parker revealed that 91% of the phytomacroinvertebrates sampled were within these classifications; these same organisms also comprised 71% of the invertebrates sampled by sweepnet in Lake Hunter.

Increased food production and habitat provided by hydrilla is reflected by a change within the fish populations of both lakes. In Lake Parker forage fluctuated between 91 to 437 fish per hectare before 1978. After the introduction of hydrilla, the number of forage fish increased to 3947 fish per hectare in 1981 (Fig. 1). At this time, hydrilla covered approximately 81 ha, or approximately 9% of the lake.

The production of largemouth bass was also stimulated by increased habitat and food supply. Bass sampled in 1976 and 1977 were the results of supplemental stocking (Langford et al. 1977). Two year classes of bass were

Table 1. Average Number and Taxa of Macroinvertebrates Collected by Eckman Dredge, Core Sampler, and Sweepnets in and out of Hydrilla, 1978–80

		Eckman Dredge and Core Sampler (No./m^2)		Sweepnets (No./m^3)
		Out of Hydrilla	In Hydrilla	In Hydrilla
Lake Parker	Mean Density	11,035	14,510	21,479
	Mean Taxa	4	12	15
Lake Hunter	Mean Density	4,080	14,736	24,114
	Mean Taxa	6	12	15

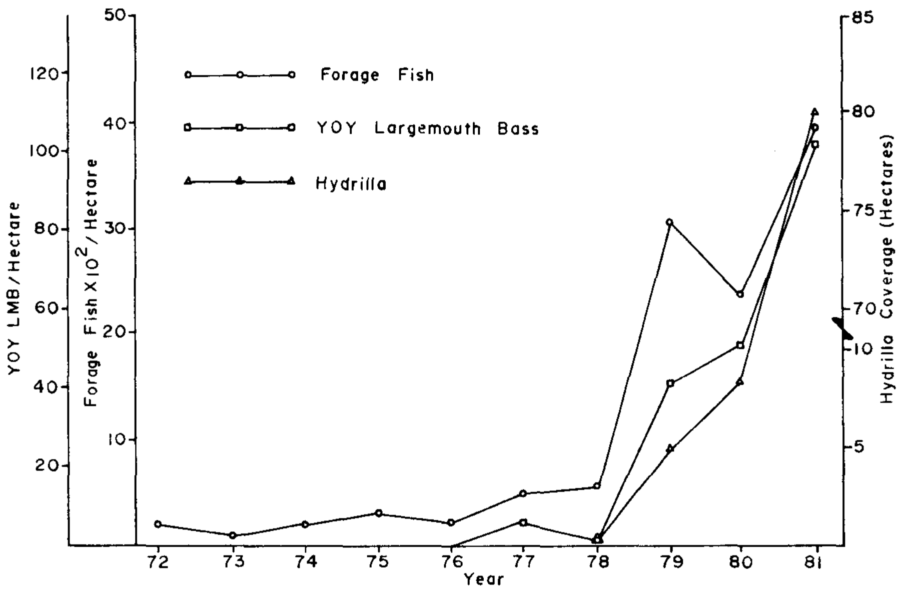

Figure 1. The relationship of selected forage fish species and young of the year largemouth bass to hydrilla expansion in Lake Parker, 1972–80.

established through this program, although no reproduction was documented before 1978. The necessary conditions required for survival of young bass were provided by hydrilla. This dependency on vegetation was also observed by Aggus and Elliot (1975), who found a significant correlation between young of the year (yoy) bass survival and the amount and seasonal duration of shoreline vegetation. Increased survival of yoy bass in Lake Parker was related with the amount of hydrilla ($R^2 = 0.79$).

Sportfish standing crop also improved with the spread of hydrilla in Lake Parker. Based on blocknet samples taken in 1977, the standing crop of sportfish averaged 7 kg/ha, of which 3 kg were harvestable. Sportfish standing crop increased to 169 kg/ha with 52 kg/ha harvestable in 1981.

The relationship between hydrilla and fish production is further illustrated in Lake Hunter (Fig. 2). Two peaks in forage production were observed between 1972 and 1981. Data analysis of the 1974 peak revealed that 90% of the forage crop consisted of 1 species, tailight shiners. Considering the eutrophic condition of Lake Hunter and the lack of significant predator populations, it is conceivable that drastic fluctuations of 1 species could occur. The 1978 peak corresponded to hydrilla expansion and represents all forage species. The decreased forage in 1979 occurred simultaneously with the increase in largemouth bass and other predators. Competition for available food sources and predation are the probable reasons for the decline of forage fish biomass in this smaller lake.

Survival of young bass in Lake Hunter as in Lake Parker, was stimulated by hydrilla expansion. Prior to 1977, only a single yoy bass was collected (1973). The 15 yoy largemouth bass sampled in 1977 are considered stocked fish (Langford et al. 1977). Although sufficient numbers of adult fish improved the opportunity for reproduction, survival of the 1978-year class was limited. As hydrilla expanded, survival increased. Linear regression between the number of yoy bass/ha and hydrilla coverage was related ($R^2 = 0.85$). Young largemouth bass dependency on vegetation was demonstrated in 1981 when hydrilla coverage on Lake Hunter was reduced to <0.4 ha by chemical treatment. The reduction in juvenile bass survival was directly proportional to hydrilla decline. Blocknet samples taken in fall 1981, show that the number of yoy bass was reduced by 78% since fall, 1980.

The change in habitat associated with hydrilla encroachment also increased the sportfish standing crop in Lake Hunter. Data collected in 1977, before hydrilla introduction, revealed that sportfish average 85 kg/ha of which 50 kg were harvestable. Samples collected after hydrilla encroachment (1981) showed total sportfish averaged 258 kg/ha and harvestable sportfish averaged 105 kg/ha. Although hydrilla coverage had been reduced when the

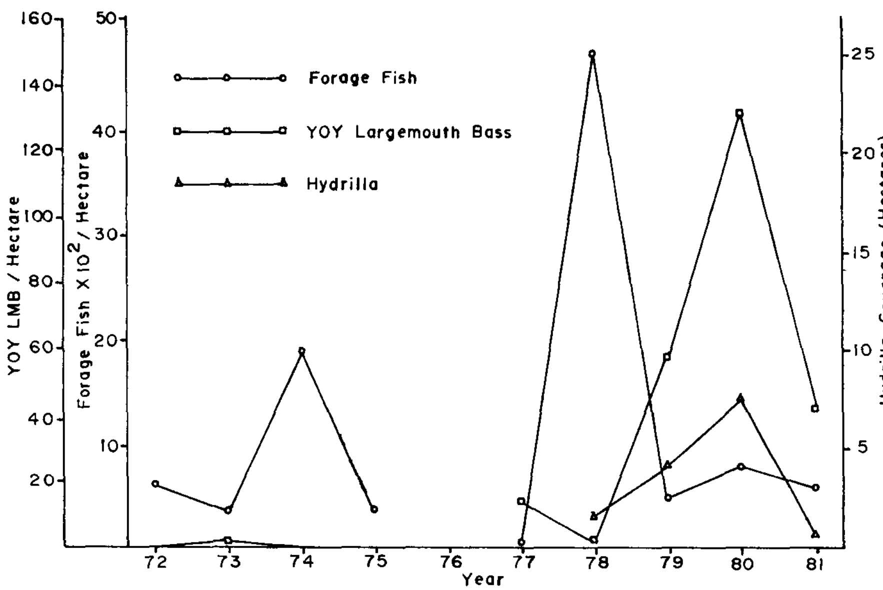

Figure 2. The relationship of selected forage fish species and young of the year largemouth bass to hydrilla expansion in Lake Hunter, 1972–80.

1981 samples were taken no significant response was observed in total or harvestable sportfish biomass. This is to be expected since hydrilla mainly effects survival of young fish, which would later be expressed as increases or decreases in standing crop. When the 1981 samples were taken, sufficient time had not elapsed to detect a change in biomass.

Chemical parameters have long been used to define eutrophication of aquatic systems (Brezonik and Shannon 1971, Holcomb and Sterling 1973, Cole 1975). Kautz (1980) used chemical parameters in conjunction with fish population data to determine effects of eutrophication on fish communities. Using Kautz's model, Lakes Parker and Hunter would both be considered hypereutrophic prior to hydrilla introduction. Chemical parameters (Chlorophyll a, total nitrogen, and total phosphate) showed a possible trend of stabilization and/or improvement as hydrilla spread (Table 2). Correspondingly, populations of forage and sportfish (especially largemouth bass) showed a reversal to a mesotrophic/eutrophic level.

Management of sportfish in highly eutrophic systems is a continuous problem for the fishery biologist. Lack of diverse vegetation, poor bottom condition, and degraded water quality all serve to limit production of a viable sportfishery. The ability of hydrilla to survive in these over-enriched systems has provided some further alternatives in terms of sportfish management. Essentially, hydrilla has simulated the habitat associated with diverse aquatic plant communities. Although hydrilla infestation can be a problem, proper management as opposed to eradication could provide positive benefits to sport fisheries in degraded lakes. The percent coverage of hydrilla, in terms of management, would greatly depend on the size and condition of the lake. Lake Parker showed the highest production of sportfish when hydrilla coverage was approximately 10%. This occurred during the last study year and may increase as hydrilla expands. The highest sportfish production on Lake Hunter occurred when hydrilla coverage was between 10 to 20%. Based on these facts hydrilla coverage between 10 to 15%, on lakes 50 ha, would probably present the least recreational problems.

Table 2. Annual Mean Chlorophyll a, Total Nitrogen and Total Phosphate on Lake Parker and Lake Hunter, 1978–80

	Lake Parker		Lake Hunter	
Parameters	1978–79	1979–80	1978–79	1979–80
Chlorophyll a (mg/m^3)	70.3	36.1	46.4	25.4
Total Nitrogen (mg/l)	2.9	3.0	1.7	1.5
Total Phosphate (mg/l)	0.43	0.50	0.52	0.40

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