Effects of Grass Carp on the Aquatic Vegetation in Lake Conway, Florida

by

Andrew J. Leslie, Larry E. Nall,
Gregory P. Jubinsky and Jeffrey D. Schardt

Florida Department of Environmental Protection
3915 Commonwealth Boulevard, MS 710
Tallahassee, Florida 32399

March 1994

The Lake Conway project was initiated in 1976 as a US Army Corps of Engineers Large Scale Operations Management Test (LSOMT) of the feasibility of managing hydrilla (*Hydrilla verticillata*) with grass carp (*Ctenopharyngodon idella*), and to delineate possible collateral effects on aquatic ecology (see Addor and Theriot 1977). The Florida Department of Environmental Protection (FDEP), formerly the Department of Natural Resources, was contracted to evaluate the effects of grass carp on hydrilla and non-target aquatic vegetation.

Lake Conway is a 737 ha lake located in Orlando, Florida (Nall and Schardt 1977). The lake is composed of five interconnected pools consisting of Lake Gatlin, Little Lake Conway (east and west pools) and Lake Conway (middle and south pools). Lake Conway is an urban representative of the Central Ridge waters of Florida. Canfield (1981) reported the following water quality values: pH 7.4-7.7; total alkalinity 27-31 mg/L $CaCO_3$; total nitrogen 350-517 ug/L; total phosphorus 3.7-24.2 ug/L; chlorophyll *a* 1.7-6.7 ug/L; color 0-5 mg/L as Pt; Secchi transparency 3.4-4.0 m. The typical shoreline plant species of cattail (*Typha latifolia*), maidencane (*Panicum hemitomon*) and torpedograss (*P. repens*) had been removed around much of the lake by homeowners by the inception of this study (Nall and Schardt 1977). Illinois pondweed (*Potamogeton illinoensis*), nitella (*Nitella megacarpa*) and tapegrass (*Vallisneria americana*) were the dominant submersed species; however, by 1976, hydrilla was rapidly expanding.

METHODS

The Lake Conway system was stocked in September 1977 with an average of 10.4 monosex (all female, Stanley 1976) grass carp per hectare (Table 1). This stocking rate represents approximately 20 fish per hectare of submersed vegetation and 1.6 fish per metric ton of vegetation present in the lake at

Table 1. Stocking rates of monosex diploid grass carp placed into Lake Conway, Florida, on September 9, 1977. Also included are data on stocking of triploid grass carp in 1986 and 1988.

September 9, 1977	South	Middle	East	West	Overall
Total grass carp	1629	3408	919	1066	7022
Grass carp/ha	12.3	12.3	7.4	7.4	10.4
Grass carp/ha veg	17.8	24.2	16.0	16.8	19.9
Grass carp/tonne veg	2.1	1.7	1.2	1.2	1.6
1986			**East-West**		
Total grass carp	---	---	1600		1600
Grass carp/ha	---	---	6.0		2.4
Grass carp/ha veg	---	---	9.9		3.7
Grass carp/tonne veg	---	---	1.7		0.8
1988			**East-West**		
Total grass carp	---	---	1000		1000
Grass carp/ha	---	---	3.7		1.5
Grass carp/ha veg	---	---	4.3		2
Grass carp/tonne veg	---	---	0.4		0.2

the time of stocking (Table 1). Stocking rate figures for each pool were determined by an experimental stocking rate model which considers vegetation biomass, grass carp feeding rates and other parameters in its computations (Nall and Schardt 1977). Because they are interconnected, grass carp can move freely among pools. Such movement is much more restricted between middle pool and both south and east pools than between east and west pools which share a 4-m deep, 50-m wide connection (Nall et al. 1979).

Random Plant Biomass Sampling--Samples were collected using a 7.7-m length pontoon barge, with an hydraulic sampling device, that was specifically designed for this project. A map of the four major pools (Lake Gatlin was excluded for logistical reasons) was overlain with a numbered grid. Sixty random samples were chosen for each pool by selecting numbered squares designated by random number tables. The 0.25 m^2 sampling device was lowered and retrieved hydraulically. Each sample was separated by species and washed to remove mud and detritus. Excess water was removed by vigorous shaking. Fresh weight was determined to the nearest gram.

SCUBA Plots--Fifteen permanently marked 0.1 ha plots were located in selected areas of the four major pools of Lake Conway. A SCUBA diver swam in a random underwater pattern in each plot while making 30 visual observations. Percent frequency of occurrence for each species was calculated from these data.

RESULTS AND DISCUSSION

Baseline sampling showed that submersed plants were rarely encountered at depths below 6 m. Approximately 35% of south, west and middle pools, and 17% of east pool are deeper than 6 m (Nall and Schardt 1977).

A summary of average percent frequency of occurrence of hydrilla versus all other aquatic plant species from SCUBA plots monitored from July 1976 to August 1980, then bimonthly to August 1981, is presented in Figure 1. Also included in Figure 1 is the

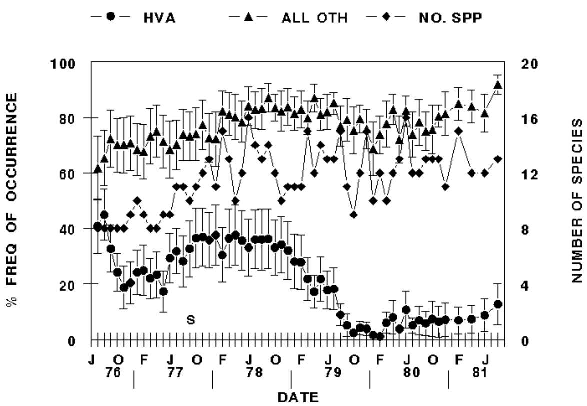

Figure 1. Average percent frequency of occurrence of hydrilla (HVA) and all-other-submersed aquatic plants in fifteen 0.1 ha SCUBA plots located throughout the Lake Conway chain (east, west, middle and south pools), Florida. NO. SPP=total number of species observed each sampling date. Error bars represent one standard error of the mean.

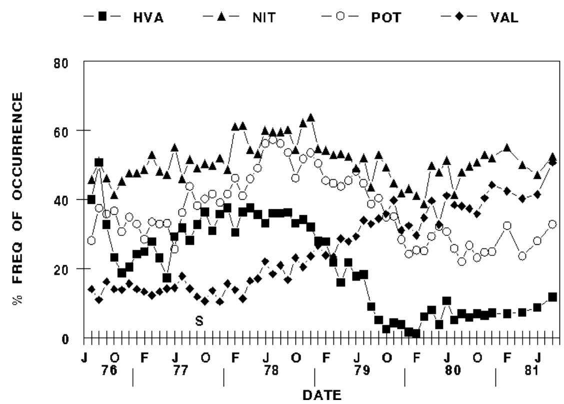

Figure 2. Average percent frequency of occurrence of the four predominant submersed aquatic plants in fifteen 0.1 ha SCUBA plots located throughout the Lake Conway chain (east, west, middle and south pools), Florida. HVA=hydrilla, NIT=nitella, POT=Illinois pondweed, VAL=tapegrass.

total number of species encountered. These data show that the impact of the grass carp was relatively slow in this study--no overt changes were noted until the second summer after stocking. Two years after stocking 10.4 grass carp/ha, hydrilla was greatly reduced with no discernable effect on frequency of occurrence of other species. Total number of species was slightly higher during the post-stocking period.

Hydrilla, Illinois pondweed, and nitella are highly preferred foods for grass carp, but tapegrass is non-preferred (Nall and Schardt 1977; Leslie et al. 1987). Data from SCUBA plots showed that tapegrass increased dramatically as the pressure of herbivory reduced the competitiveness of the other species (Figure 2). The expansion of tapegrass was considered desirable because it is considered to be an ecologically valuable native plant (Duke and Chabreck 1976). If instead this had been an unpalatable, canopy-forming, non-native species, such as Eurasian watermilfoil (*Myriophyllum spicatum*), such expansion would be highly undesirable, altering the fishery and the traditional uses of this waterbody (Van Dyke et al. 1984; Colle et al. 1987; Leslie et al. 1987). During this time period, nitella remained relatively stable. Illinois pondweed increased initially until hydrilla became scarce, then the grass carp began to feed on Illinois pondweed and reduced its abundance.

SCUBA monitoring resumed in 1984 with FDEP funds upon completion of the USACE contract period. SCUBA plots have since been monitored annually in late summer. An additional 2.4 and 1.5 triploid grass carp/ha were stocked in 1986 and 1988, respectively, in response to the increased frequency of occurrence of hydrilla (Figure 3). These stockings reduced hydrilla by 1989 and hydrilla frequency of occurrence has remained low to date. There has been little discernable effect on frequency of occurrence of other submersed species; but a drop in the number of species was detected.

The dynamics of the four major species, on SCUBA plots, over the last 17 years are

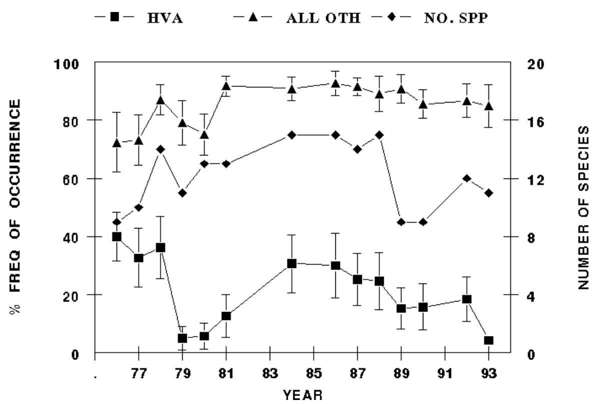

Figure 3. Average percent frequency of occurrence of hydrilla (HVA) and all-other-submersed plants in fifteen 0.1 ha SCUBA plots located throughout the Lake Conway chain (east, west, middle and south pools), Florida. NO. SPP=total number of species encountered per sampling date. Error bars represent one standard error of the mean.

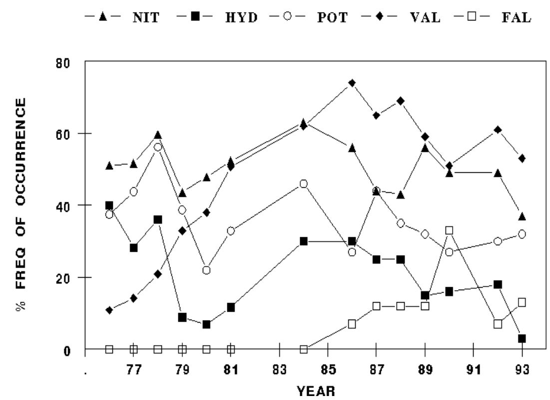

Figure 4. Average percent frequency of occurrence of five submersed aquatic plants in fifteen 0.1 ha SCUBA plots located throughout the Lake Conway chain (east, west, middle and south pools), Florida. NIT=nitella, HYD=hydrilla, POT=Illinois pondweed, VAL=tapegrass, FAL=filamentous algae.

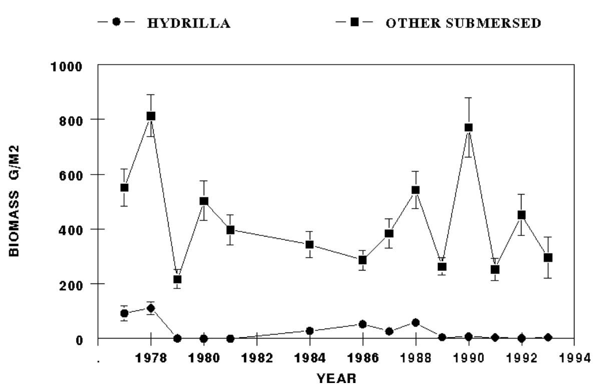

Figure 5. Fresh weight biomass (g/m2) of hydrilla and all-other-submersed aquatic plants collected in random biomass samples in the Lake Conway chain (east, west, middle and south pools), Florida. Error bars represent one standard error of the mean.

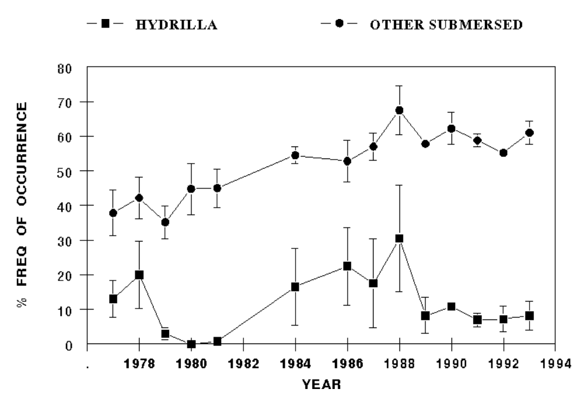

Figure 6. Percent frequency of occurrence of hydrilla and all-other-submersed aquatic plants collected in random biomass samples in the Lake Conway chain (east, west, middle and south pools), Florida. Error bars represent one standard error of the mean.

shown in Figure 4. The percent frequency of occurrence of tapegrass increased from about 10% in 1979 to an average of more than 50% over the last ten years. Illinois pondweed and nitella, both highly palatable species, have remained fairly abundant throughout the study. Filamentous algae are increasing in the Lake Conway system, and are indicative of increased urbanization in the watershed.

Figure 5 depicts the results of random plant biomass sampling conducted in late summer each year. Note that in Lake Conway, hydrilla was not a dominant component of the aquatic plant community at any time during the study. As seen with the SCUBA data,

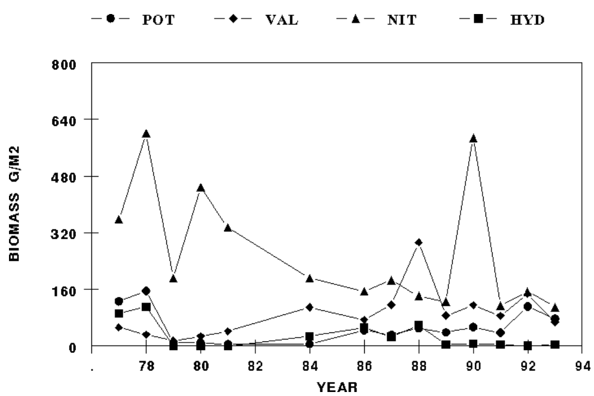

Figure 7. Fresh weight biomass (g/m2) of the four predominant submersed aquatic plants collected in the Lake Conway chain (east, west, middle and south pools), Florida. POT=Illinois pondweed, VAL=tapegrass, NIT=nitella, HYD=hydrilla.

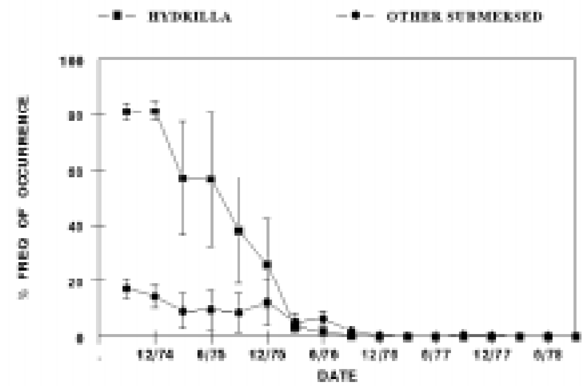

Figure 8. Average percent frequency of occurrence of hydrilla and all-other-submersed aquatic plant species on transects monitored quarterly in three central Florida lakes. Lakes Bell, Clear and Holden were stocked with 50 diploid grass carp/ha in October 1974. Error bars represent one standard error of the mean.

hydrilla biomass was reduced by more than 99% in two years without reducing the overall biomass of other species. By 1984, hydrilla biomass began to rebound but was again reduced by the stocking of additional triploid grass carp in 1986 and 1988. These stockings resulted in no apparent reduction in overall biomass of other submersed species. Percent frequency of occurrence of plants other than hydrilla in the biomass samples (Figure 6) shows an increasing trend not seen in the SCUBA data (Figure 1).

An examination of the biomass data for the four major plant species in Lake Conway over time, reveals that tapegrass has increased, nitella has declined slightly, and that Illinois pondweed (a preferred food species for grass carp) showed initial declines but has increased over the latter years of the study (Figure 7). Grass carp have been able to maintain hydrilla at low biomass for over 15 years with minimal impact on other submersed species.

In many instances, plant management with grass carp has resulted in total (or near-total) elimination of vegetation or has had little impact at all. This all-or-none response has not been the case in Lake Conway. But we have not been able to duplicate these results in other lakes over the long term. Reasons are elusive but some factors to consider include: (1) although perhaps locally abundant, hydrilla was a relatively minor component of the submersed plant community in Lake Conway at the onset of this LSOMT; (2) the lake, which was treated with endothall herbicide one year prior to the onset of this project, historically had an abundant and diverse submersed native plant community; (3) there were at least three abundant highly palatable plant species present, including hydrilla; (4) there were less palatable native species, like tapegrass, poised to fill vacant space; and (5) the lake is relatively large, clear, and deep.

Figure 8 depicts three central Florida lakes that, while submersed plant dominated, were so because of a dense, near monoculture of hydrilla (Van Dyke et al. 1984). Under these conditions, perhaps any stocking rate that affected hydrilla or even use of integrated methods with low stocking rates would result in lakes devoid of submersed vegetation. In Lake Conway, however, grass carp have maintained hydrilla at low levels while an abundant and diverse native submerged flora has continued to flourish.

LITERATURE CITED

Addor, E. E. and R. F. Theriot. 1977. Test plan for the large-scale operations management test of the use of the white amur to control aquatic plants. US Army Corps of Engineers Waterways Experiment Station Instruction Report A-77-1, Vicksburg, MS.

Canfield, D. E. 1981. Chemical and trophic state characteristics of Florida lakes in relation to regional geology. University of Florida Center for Aquatic Weeds, Gainesville.

Colle, D. E., J. V. Shireman, W. T. Haller, J. C. Joyce, and D. E. Canfield. 1987. Influence of hydrilla on harvestable sport-fish populations, angler use, and angler expenditures at Orange Lake, Florida. North Amer. J. Fish. Manage. 7:410-417.

Duke, R. W., and R. H. Chabreck. 1976. Waterfowl habitat in lakes of the Atchafalaya Basin, Louisiana. Proc. SE Assoc. Game and Fish Comm. 29:501-512.

Leslie, A. J., J. M. Van Dyke, R. S. Hestand, and B. Z. Thompson. 1987. Management of aquatic plants in multi-use lakes with grass carp (*Ctenopharyngodon idella*). Lake and Reservoir Management 3:266-276.

Nall, L. E. and J. D. Schardt. 1977. The effect of the white amur on the aquatic vegetation of Lake Conway, Florida. Baseline Data. Florida Department of Natural Resources, Tallahassee.

Nall, L. E., J. D. Schardt, B. D. Billets, and S. L. Collins. 1979. Radio telemetry tracking of the white amur in Lake Conway. Report Florida Department of Natural Resources, Tallahassee.

Stanley, J. G. 1976. A review of methods for obtaining monosex fish and progress report on production of monosex white amur. J. Aquat. Plant Manage. 14:68-70.

Van Dyke, J. M., A. J. Leslie, L. E. Nall. 1984. The effects of grass carp on aquatic macrophytes of four Florida lakes. J. Aquat. Plant Manage. 22:87-95.