

# Potential Control Of Florida Elodea By Nutrient-Control Agents

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## INTRODUCTION

It has become evident and urgent that we must solve the problem of excessive aquatic vegetation in Florida and other parts of the world to maintain and improve the navigation and recreation status of streams and canals. The dense growth in Florida streams of Florida elodea (*Hydrilla verticillata* and *Egria densa*) is typical and particularly troublesome<sup>1,2</sup>. Most problems caused by Florida elodea can be related to its characteristics.

Elodea seems to be remarkably equipped for survival and spreading<sup>1</sup>. This is a perennial, submerged aquatic plant that is generally rooted by means of long, white, adventitious roots that anchor the plant firmly to the bottom. The plant reproduces primarily by vegetative processes and occasionally by seeding. It can survive as a pleustophyte, or free floating plant, when up-rooted or detached from the bottom; this ability increases the survival possibility and contributes to the rapid spreading and reinfestation of the plant. Also, elodea can deposit vegetative propogules on the bottom from which regrowth occurs even after the parent plant has been destroyed or removed.

Three general methods have been used in past efforts to control Florida elodea—chemical, mechanical, and biological. Chemical treatments have included acrolein<sup>3</sup>, concentrated sulfuric acid<sup>4</sup>, and several herbicides, including Diaquat and copper sulfate<sup>1</sup>. Mechanical methods have involved cutting by a barge-situated mower with a limited depth of cutting. This is obviously a maintenance operation. Several biocontrol methods have been proposed, though

none as yet seem to have proven effective in field work. Organisms that have been considered include the Florida manatee (*Trichecus manatus*), a fresh-water snail (*Marisa cornuarietis*), and grass carp or white amur (*Ctenopharyngodon idella*)<sup>2,5</sup>.

Each of the methods has advantages and limitations. With chemicals, the chief advantage is ease of application; the disadvantages include program costs, personnel requirements, possible physiological and ecological damage, and nutrient release from destroyed plants. Mowing removes the plant physically with little nutrient regeneration, but disposal problems remain and reinfestation occurs. Biocontrol can have four advantages: low program costs, ease of application, minimal personnel requirements, and the possibility of outstanding success (as in the control of alligatorweed by flea beetles). Proliferation or lack of it seems to be critical problems with *Marisa* and the Florida manatee, respectively; *Marisa*, and perhaps species of elodea eating fish, may have indiscriminate feeding habits and may eat desirable plants. Also, many biocontrol organisms of tropical origin are sensitive to colder weather, even in semitropical areas.

Inasmuch as all three approaches have obvious and serious limitations, it seems appropriate to consider alternative methods of control. One method would be control by deprivation which would consist in depriving Florida elodea and other aquatic weeds of critical nutrients through the use of chemical control agents<sup>7</sup>. The approach involves the assumption that typical micronutrients (nitrate and phosphate) are present in sufficient quantities in Florida

lakes and streams as to be non-growth limiting. Enhanced supplies of trace metal elements during recent years in Florida's natural waters can be associated with human activities, including fertilization, municipal wastes, industrial activities, and agricultural operations. The present paper summarizes results of a preliminary study of the potential use of nutrient control agents to limit elodea growth.

### EXPERIMENTAL

**Analytical Methods.** All metals were determined by flame photometry or atomic absorption spectroscopy<sup>8</sup>, phosphate was determined by a single reagent method<sup>9</sup>, nitrate-nitrite nitrogen was determined by cadmium reduction<sup>10</sup>, dissolved oxygen was determined using the Winkler method (azide modification). The analyses were used for field studies (Table 1) and laboratory studies (Table 2).

**Elodea and water sources.** Elodea samples, obtained from the Hillsborough River, were washed and dried by placing them on paper towels and allowing them to dry for 10 minutes at room temperature before weighing. USF science center deep well water was used without additional enrichment.

**Qualitative experiments** were run in 3-liter Fernbach stoppered flasks filled with well water and containing 10 g. of elodea, and were illuminated with one cool white 40w fluorescent lamp for 13 hrs. daily.

**Quantitative experiments.** The apparatus, Fig. 1, (test and control illuminated as in the other studies) was closed to

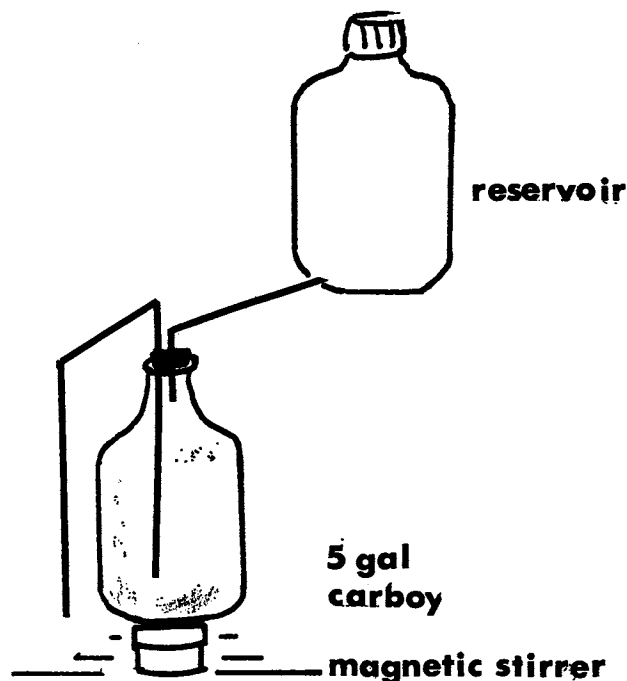


Figure 1. Schematic representation of apparatus used to study elodea.

TABLE 1. ANNUAL MEAN WATER QUALITY DATA FOR LAKE CARROLL AND WHITE TROUT LAKE, TAMPA

Parameter	Lake Carroll	White Trout Lake
Temperature, °C	23.2	22.7
Dissolved Oxygen, ppm	10.24	7.98
pH	6.93	6.57
Orthophosphate, ppm PO <sub>4</sub> -P	0.025	0.020
Nitrate-Nitrite, ppm NO <sub>3</sub> ,NO <sub>2</sub> -N	0.61	0.88
Chloride, ppm	16.5	15.7
Calcium, ppm	21.8	14.7
Magnesium, ppm	2.8	2.9
Sodium, ppm	10.6	9.8
Potassium, ppm	3.6	2.8

TABLE 2. QUALITATIVE STUDIES OF EFFECTS OF RESINS ON ELODEA

Resin	MDA,*g	
Cation-Exchange Resin (H <sup>+</sup> form, Amberlite IR-120 H C.P.)	3	Death in 5 days
Anion-Exchange Resin (Cl <sup>-</sup> form, Amberlite IR-45)	5	-----
Chelating Resin (Dowex A-1)	5	-----
Non-functional Group Resin (Amberlite XAD-2)	5	-----
Molecular Sieve (Type 4A)	5	-----
Anion-Cation Exchange Resin Mixture	2.5 + 2.5	-----

\*MDA., Maximum dose applied to a 3-liter sample with 10 g. of plant present.

atmospheric oxygen, and as water was withdrawn periodically for a sample by releasing a clip, it was replaced by an equal volume of water from a common reservoir. Water samples were subjected to various analyses, and the dissolved oxygen levels were used as an indicator of plant health.

**Resin and plant composition studies** (Table 3). The quantitative study was conducted using 70 g of elodea and 30 g of Amberlite IR 120 H C.P. resin (test); resin was omitted in the control system. After the demise of the plant (approximately 5 days), plants were collected by filtration from both carboys. The plants and resin were dried 24 hrs. at 105°C and treated separately. Plant materials were ground and samples were digested in conc. nitric acid for 4 hrs. at 50°C and 2 hrs. at 80°C. The cooled solutions were neutralized with sodium hydroxide. Blank solutions were run in parallel. Resin samples were digested in the same way. Analyses were performed on the neutralized solutions.

TABLE 3. WEIGHT PERCENTAGE COMPOSITION BEFORE AND AFTER TREATMENT WITH CATION-EXCHANGE RESIN

Sample	C	H	N	Cu	Mn	Fe	Zn	Mg
Live plant (Control)	36.60	4.83	2.72	0.001	0.024	0.044	0.015	0.12
Dead plant (test)	40.87	5.25	2.78	0.023	0.005	0.035	0.011	0.022
Unused resin, ppm	-----	-----	-----	0.004	0.00	0.10	0.009	0.0045
Used resin, ppm	-----	-----	-----	0.003	0.034	0.037	0.040	0.020
Initial water, ppm	-----	-----	-----	0.03	0.05	0.50	0.10	0.22
Final water, ppm	-----	-----	-----	0.00	0.00	.05	.05	0.00

## DISCUSSION

We have found what we consider to be an ideal elodea study system in Hillsborough County (Fig. 2). The system consists of Lake Carroll (infested with elodea) and adjoining White Trout Lake (not infested).

The simple observation of an absence of elodea in White Trout Lake leads to an "analysis tree" (Fig. 3). The absence of elodea arises from one of two causes: the observation is fortuitous or it is real. It might be fortuitous because we have failed to recognize any significant growth of elodea, or because White Trout does not contain a public boat ramp (elodea trapped on boat propellers probably contributes to the spread of this weed), or because of some other similar reason.

The difference might be real because something is different in the water or sediments of White Trout Lake. We have been able to grow elodea in water from both lakes, so we are inclined to discount the possibility that water composition is a critical difference. We are also unable to detect significant differences in water composition (Table 1).

On the other hand, the sediment of White Trout Lake may be different because this was a site of a sawmill operation and a significant area of the lake bottom was covered with cypress sawdust. We have added this and other sawdust to the flasks of elodea and found that plants slowly die, though control plants live. These results suggest that the sawdust is effective because it removes or adds some chemical. It could remove directly by absorption or indirectly by action of heterotrophic bacteria associated with this high-carbon source. Cypress sawdust would probably add tannic acid, although the leaching process should have terminated in White Trout Lake years ago. In any case, tannic acid was not effective in causing the *in vitro* demise of elodea, even at a tannic acid concentration of 360 ppm. This concentration produced an intense yellow coloration not noted in any of the sawdust experiments.

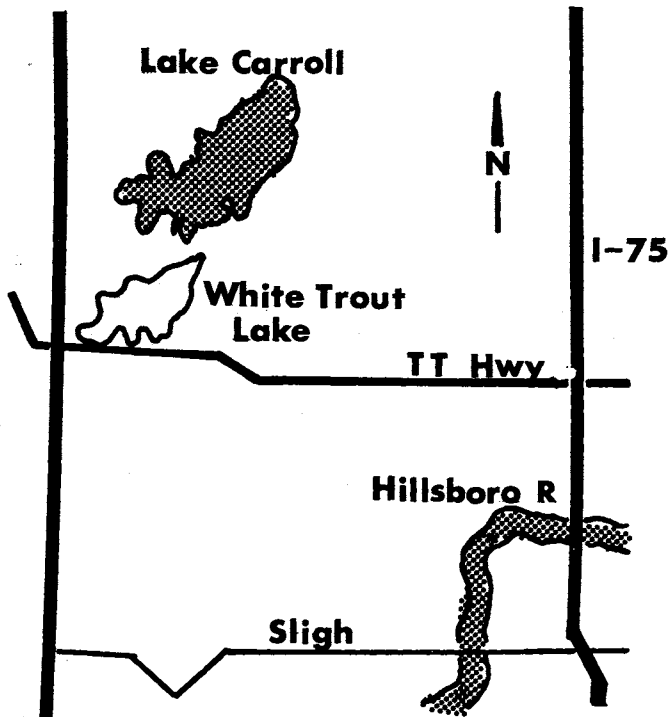


Figure 2. Model study area.

## WHITE TROUT LAKE VS LAKE CARROLL

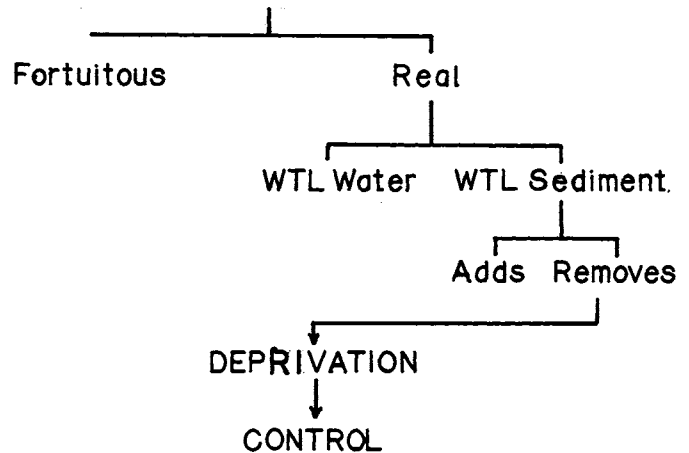


Figure 3. "Analysis tree" showing implications of evident differences in White Trout Lake and Lake Carroll.

The possibility remains that sawdust directly or indirectly controls the concentration of a critical constituent. We have attempted to determine the nature of the constituent(s) through the use of various synthetic chemical-control agents. Screening experiments were run under standard conditions (Table 2).

These results suggest, under the conditions used, the critical species is cationic because the cation-exchange resin was the only chemical control agent effective in causing the demise of elodea. Similar weights of anion-exchange resin, molecular sieve, chelating-exchange resin and non-functional group resin had no evident effect on elodea samples. Thus, an anion (phosphate, nitrate, nitrite) or an organic molecule evidently is not critically involved because these should have been removed by the anion exchange, by the non-functional group resin or by the molecular sieve.

The quantitative effect of cation-exchange resin on the plant and water composition was studied in two ways: the plant composition was determined before and after treatment with the resin and analyses of water composition was made at various times.

Plant composition data (Table 3) are similar for carbon, hydrogen, nitrogen, iron and zinc. Manganese and magnesium show significant decreases that may be ascribed to removal of chlorophyll. Corresponding increases in magnesium and manganese content of cation-exchange resin were observed. These observations, while not conclusive, do indicate the effectiveness of the resin as a removal agent and that certain metals (iron and zinc) are tenaciously held by the plant.

The variation of concentrations of representative constituents (phosphate, magnesium, calcium, and sodium) was measured at various times using the standard system. Sodium concentration seems to show little variation with time. Magnesium and calcium have a common pattern (Fig. 4): an initial increase in concentration of the metal in solution is observed for the control carboy (probably by removal from the plant surface), and a decrease is observed in carboy that contains the resin. On the other hand, phosphate concentration in the control slowly decreased (Fig. 5). The enhanced concentration of phosphate in the test carboy is ascribed to plant decomposition.

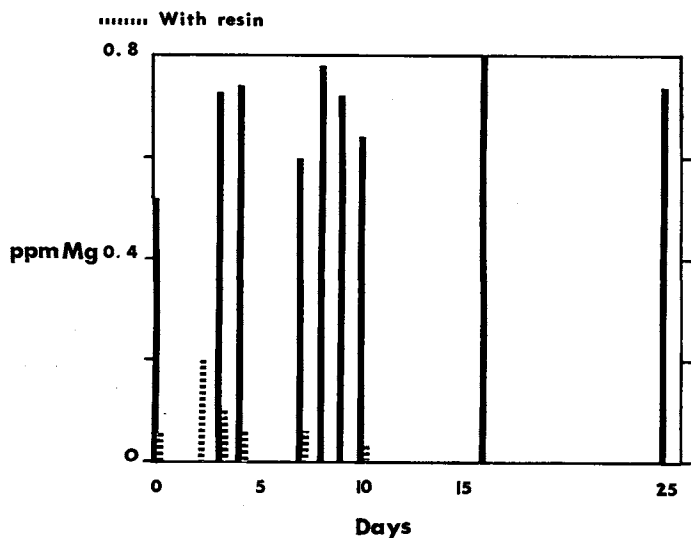


Figure 4. Variation of magnesium concentration with time in control (solid) and test (dashed bar) carboys indicating the ineffectiveness of magnesium removal by cation-exchange resin.

We have considered the possibility that the resin could be causing demise by lowering pH to a lethal value. The possibility is a reasonable one because as metals such as magnesium are removed hydrogen ion is released. This was investigated in a separate study during which water was first equilibrated with resin and the pH values of test and control were made the same (pH 5.6). Though this value was lower than natural waters, elodea did survive in test water with much lower pH (3.14) for over three weeks. We conclude that the death of elodea in our experiments was not caused by lowered pH values.

In our opinion, chemical control agents are potentially useful for the control of Florida's elodea and other aquatic weeds for which effective biocontrol procedures are not available. It is apparent that more research will be needed to develop the potential usefulness.

#### ACKNOWLEDGMENTS

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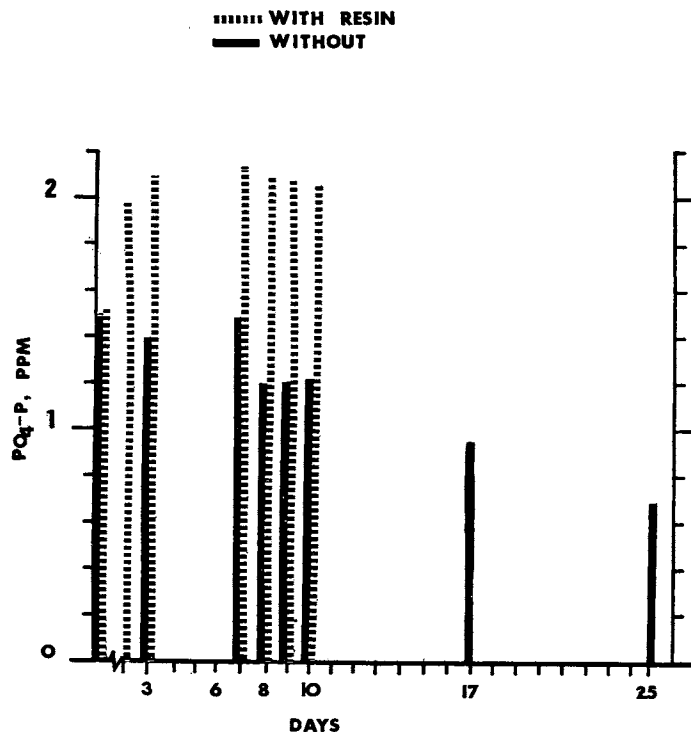


Figure 5. Variation of orthophosphate concentration with time in control (solid bar) and test (dashed bar) carboys.

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