FACTORS AFFECTING THE MAXIMUM DEPTH OF COLONIZATION BY SUBMERSED MACROPHYTES IN FLORIDA LAKES

By

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In 32 Florida lakes, Secchi disk (SD) transparency, light attenuation coefficient values, plant and sediment type, and slope were examined with respect to the maximum depth of plant colonization (MDC). In the 32-lake study, MDC was shown to be significantly related to light through measurements taken by a SD ($R^2 = 0.46$; $p < 0.0001$) and a light meter ($R^2 = 0.41$; $p < 0.0001$). There was no significant difference in the mean percent of light penetration at MDC stations between hydrilla (*Hydrilla verticillata* Royle) and non-hydrilla species ($p = 0.2$), and furthermore, between angiosperms and charophytes ($p = 0.4$). Similarly, organic, sandy, and mixed sediment types were not shown to exert a significant influence ($p = 0.07$) on the depth of aquatic plant colonization. Lake bottom slope was not shown to be significantly related ($R^2 = 0.03$; $p = 0.35$) to the maximum depth of plant growth.

To increase the sample size, SD transparency, color, chlorophyll, and water column nutrients (total phosphorus and total nitrogen) were examined with respect to the

maximum depth of macrophyte growth for 279-lake-years of information. An upper limit line relating MDC to SD in meters was calculated and was found to be equal to: log (max MDC) = 0.52 log (SD) + 0.59. The maximum MDC line describes light limitation when the MDC response fall on or near the response curve and when MDC values fall below the line, there is some other limiting environmental factor. For the 279-lake-year study, the maximum depth of aquatic plant growth was significantly related to Secchi disk transparency ($R^2 = 0.67$; $p < 0.0001$), color ($R^2 = 0.41$; $p < 0.0001$), chlorophyll ($R^2 = 0.30$; $p < 0.0001$), total phosphorus ($R^2 = 0.42$; $p < 0.0001$), and total nitrogen ($R^2 = 0.33$; $p < 0.0001$).

CHAPTER 1
INTRODUCTION

The distribution and abundance of aquatic macrophytes in lakes are affected by many forces including but not limited to pressure (Hutchinson 1975), substrate characteristics (Bachmann et al. 2001) and lake morphology (Duarte and Kalff 1986), water column nutrient concentrations (Jupp and Spence 1977), waterfowl grazing (Weisner et al. 1997), and light availability (Chambers and Kalff 1985; Canfield et al. 1985). Given the high attenuation of irradiance through the water column, and because plants require light to photosynthesize, it is not surprising that light availability is often considered one of the most important factors that regulate abundance and distribution of aquatic macrophytes (Zimmerman et al. 1994).

The maximum depth at which autotrophic aquatic plants grow has been shown to be linearly related to transparency of the water in numerous studies (Maristo 1941; Canfield et al.1985; Hudon et al. 2000). Chambers & Kalff (1985) found the maximum depth of colonization (MDC) for charophytes on average to occur at 11% of the surface incident irradiance. For angiosperms and bryophytes, they found MDC to be 21% of the surface irradiance. However, aquatic plants have been recorded in areas receiving less than 1 and 2% of the surface irradiance (Hutchinson 1975).

Canfield et al. (1985) demonstrated a relationship between water transparency as measured by a Secchi disc (SD) and the maximum depth of macrophyte colonization in 26 Florida lakes. They also developed an empirical model for the relationship and suggested the model could provide lake managers with a first approximation of how changes in SD values caused by either natural or anthropogenic activities might affect the extent of macrophyte colonization in lakes. However, they cautioned lake mangers that, in using the model, other environmental factors (e.g., types of plants present, basin morphometry, sediment types) besides SD values need to be considered to enhance the predictive ability of the model.

In the 1990s, the Florida Legislature directed the state's water management districts to establish minimum water levels for lakes (Section 373.042, Florida Statutes). The Southwest Florida Water Management District (SWFWMD) developed methods for establishing minimum lake levels (Chapter 40D-8. Florida Administrative Code), which included use of the model developed by Canfield et al. (1985) to assess potential changes in the coverage of submersed vegetation with changes in water transparency. The Southwest Florida Water Management District, however, recognized the need to try to develop a more robust model from a larger number of lakes.

This study was designed based on the earlier work of Canfield et al. (1985) in an attempt to develop more robust model/models for use by SWFWMD. The first part of the study involved the sampling of 32 Florida lakes. At each lake, environmental factors such as water chemistry, photosynthetically active radiation (PAR), and bottom slopes were measured to determine if the maximum depth of macrophyte colonization could be better predicted than relying solely on SD transparency. The second phase of this study used information collected by Florida LAKEWATCH on a large number of Florida lakes to develop a series of models to predict the maximum depth of colonization of macrophytes and establish a model where the maximum depth of macrophyte colonization in Florida lakes should be limited by light.

CHAPTER 2
MATERIALS AND METHODS

Two data sets were used for model development. The first part of the study involved field sampling of 32 Florida lakes using the basic approach of Canfield et al. (1985). Study lakes selected were located in eight counties, with the majority located in peninsular Florida (Figure 2-1). Lakes located in the SWFWMD comprised 38% of the sampled lakes. Each lake was sampled once between May and December of 2004.

At each study lake, four straight transects were established to provide an assessment of macrophyte coverage. A Raytheon DE-719 fathometer was used to detect the MDC for the macrophyte community along each transect. Buoys were placed at locations of measured macrophyte MDC. After all transects were completed, the three to four deepest buoy stations were checked with a toothed hook (18 cm by 18 cm) for the presence of submersed aquatic macrophytes.

At stations where the MDC was identified, measurements were made for SD transparency, light attenuation (E), true color, sediment type, and bottom slope, and the plant species were identified. In some lakes with sparse plant growth, fewer than three stations were found harboring submersed aquatic macrophytes. At these lakes, open water stations were sampled for SD transparency, light attenuation (E), true color, and sediment type. The variables that had quantitative values (i.e., SD transparency, E, color, and slope) were averaged by lake for the day sampled, and because lakes were visited only once during the study, each lake is considered the experimental unit for the quantitative variables. On the other hand, the experimental unit for qualitative variables, such as plant type [i.e., the inclusion or exclusion of the plants being a hydrilla (*Hydrilla verticillata* Royle) versus non-hydrilla species and being an angiosperm versus a charophyte] or sediment type (i.e., organic, sandy, mixed) was considered to be the lake stations.

At each of the 32 study lakes, water transparency was measured where the MDC occurred by the use of a Secchi disc on the shady side of the boat. If the Secchi disc was visible on the bottom for all three stations, an additional Secchi reading was taken in a deeper location to use for analysis. Surface and corresponding underwater light irradiance were measured (in quanta units) on the sunny side of the boat using a photometer (LI-COR model LI-1400 data logger) with a quantum sensor that was placed both above (LiCor 193) and below (LiCor 192) the water. Light meter readings were taken at two to three depths. If possible, light measurements at each station were made at depths of one, two, and three meters to better represent light attenuation for the entire water column. An additional open-water light reading was taken in deeper water at some lakes where all three stations were shallow (less than 3 meters) or when sun coverage was fading and no stations had yet been sampled for light. Light readings were averaged over ten seconds to mitigate instantaneous fluctuations with light intensity. The downward attenuation coefficient values for each station were calculated as the slope of the graph of the natural logarithm of the irradiance values, corrected for changes in incident irradiance on the y-axis, against depth on the x-axis (Lind 1974). The percent of surface irradiance penetrating at MDC was calculated using the relationship: $I_Z / I_o = 100e^{-Ez}$, where I_Z / I_o = percent of subsurface irradiance, E = light attenuation coefficient and z = the maximum depth of plant colonization (Scheffer 1998).

Color samples were collected at the surface (0.5 m) with 250-mL, acid cleaned, triple-rinsed, Nalgene bottles and immediately placed on ice until they could be put in a freezer to await analysis. True color values were determined following filtration through a Gelman type A/E glass fiber filter, centrifugation of the filtrate, and using the platinum-cobalt standard technique determined by spectroscopy (Bowling et al. 1986).

A ponar dredge with a 15 cm opening was used to obtain soil samples. Sediment type was classified as one of three types: sandy, organic, or mixed. Soil samples that were dark colored and slippery to the touch were classified as organic while white, granular soil samples were classified as sandy, and a blend of organic and sandy soil was categorized as a mixed soil.

Bottom slope was calculated around MDC stations and not the entire littoral area. Slope was calculated from the Raytheon DE-719 fathometer chart by dividing the rise (the change in water depth) by the horizontal distance across the station.

For the 32-lake study, regression equations and coefficient of determination values (R^2) were calculated using SD and E readings as the independent variables in order to predict the maximum depth of submersed macrophyte colonization. Multiple regression analysis was used to relate SD, E, and MDC to color and chlorophyll. Chlorophyll concentrations were obtained from the Florida LAKEWATCH database. Best fit linear regressions were calculated between SD and E and vise versa. A t-test was used to test whether there was a significant difference in the average percent of incident light at the maximum depth of colonization between stations with hydrilla versus non-hydrilla and between stations harboring angiosperms versus charophytes. To investigate soil influence on MDC, an ANOVA was used to test for differences in the mean depth of plant growth for the three soil types. Also, the coefficient of determination was calculated for the relationship between slope and MDC (McClave and Sincich 2000). The statistical software package JMP version 4.0 was used for statistical analysis and Kaleidagraph version 3.6 was used to generate linear regression figures.

The second part of this study involved obtaining information on 187 lakes which had their macrophyte communities sampled by Florida LAKEWATCH. The lakes were sampled between 1991 and 2004. The water chemisty data were represented as yearly averages and although most lakes were sampled only once, some lakes were sampled multiple times providing 279-lake-years of information. Florida LAKEWATCH is a volunteer citizens' lake monitoring program in which volunteers take measurements at three mid-lake locations, usually on a monthly basis, for total phosphorus (TP), total nitrogen (TN), chlorophyll, and SD transparency. The 187 lakes were located in 24 counties (Figure 2-1) and 35% of the lakes were in the SWFWMD.

For the 279-lake-year study, Florida LAKEWATCH provided 250 Raytheon DE-719 fathometer chart papers that were later examined for the maximum point of plant colonization. The 32-lake study provided an additional 29 Raytheon DE-719 fathometer chart papers.

Secchi disk readings and true color samples were obtained using the same procedures as the 32-lake study. Surface (0.5 m) water samples for measuring chlorophyll were collected in 4-L, tap-water rinsed, plastic milk jugs and placed in coolers until the samples could be filtered. A measured volume of water was filtered through a Gelman Type A-E glass fiber filter. Filters where folded and placed inside a larger paper filter and then stored inside a silica gel desiccant bottle in a freezer.

Chlorophyll was extracted from the filters in hot ethanol (Sartory and Grobbelarr 1984). The trichromatic equation for chlorophyll *a* was used to calculate the concentrations of chlorophyll with the hot ethanol method (Method 10200H; APHA 1992).

Water samples for TP and TN were collected at the surface (0.5 m) with 250-mL, acid cleaned, triple-rinsed, Nalgene bottles. Water samples were immediately placed and held on ice until returned at the end of the sampling day to the Florida LAKEWATCH water quality laboratory in Gainesville, Florida. At the laboratory, water samples were frozen until being analyzed by Florida LAKEWATCH staff. Total phosphorus concentrations were determined using the methods of Murphy and Riley (1962) with a persulfate digestion (Menzel and Corwin 1965). Total nitrogen concentrations where determined by the oxidization of water samples using persulfate and determining nitrate-nitrogen with second derivative spectroscopy (D'Elia et al. 1977).

Data (i.e., SD transparency, color, chlorophyll, TP, and TN) obtained from Florida LAKEWATCH were averaged for the year in which plants were inventoried at each lake. For each lake, Florida LAKEWATCH means were first averaged for the day of the month sampled and these monthly means were averaged together for a yearly mean for the lake. Some lakes were represented in the data set more than once if they were sampled multiple years.

If Florida LAKEWATCH was missing water chemistry data for the corresponding year that the lake was measured for MDC, long-term water chemistry means for that lake were used. Long-term means were computed by averaging all yearly means for a lake. For the 279-lake-year study, long-term values used represented 5% of SD transparency readings, 43% of color measurements, and 2.5% of chlorophyll, TP, TN values.

An empirical model was developed using the Florida LAKEWATCH database relating SD transparency to the maximum depth of submersed vegetation in order to increase the representation of Florida lakes. A maximum line relating MDC and SD was also determined by sorting the 279 SD values from lowest to highest and then dividing these into 10 groups. Because 279 is not divisible by 10, there were 28 SD values in each of the first nine groups, and one group of 27 SD readings. The maximum MDC value in each group with its associated SD value was used to run a regression through the 10 pairs of points**.** Linear and multiple regression models were created to quantify the relationship of MDC to color and chlorophyll because these two light-reducing variables have been shown to be hyperbolically related to SD depth (Canfield and Hodgson 1983). Furthermore, because TP and TN have been shown to be positively related to chlorophyll concentrations (Canfield 1983), these nutrients were also examined mathematically with respect to the maximum depth of submersed plant colonization. To meet the assumption of normality, prior to statistical analysis, all distributions were transformed to a base 10 logarithm. A software program, Kaleidagraph version 3.6, was used to generate figures and JMP version 4.0 was used to perform statistical tests. The alpha level of rejection was set at 0.05.

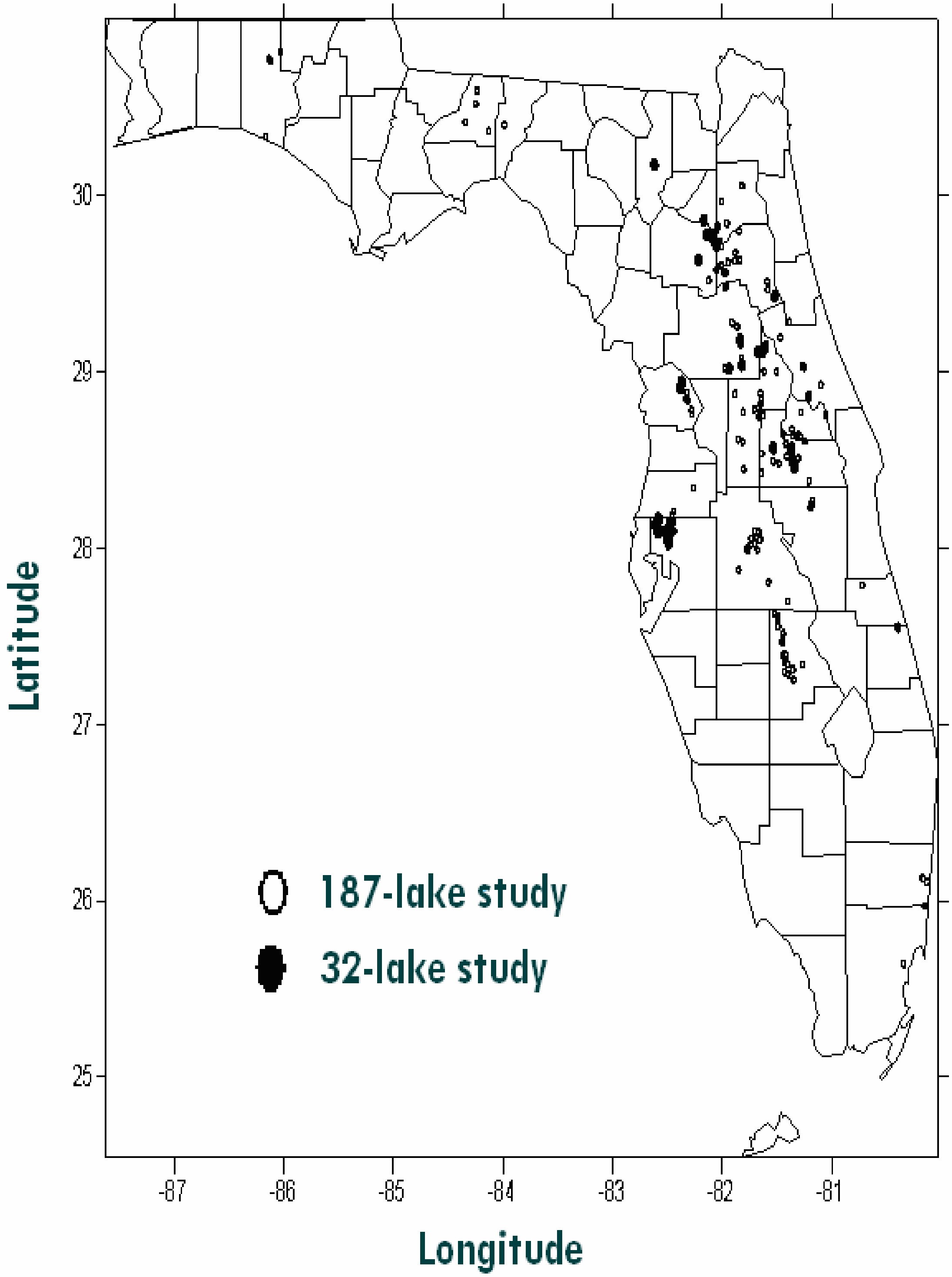


Figure 2-1. Locations of lakes sampled for both studies.

CHAPTER 3
RESULTS AND DISCUSSION

Canfield et al. (1985) sampled 26 Florida lakes with SD transparencies ranging from approximately 1 m to about 6.3 m. For the 32-lake study, there was a wide range in SD transparency from 0.3 m to 5.8 m. The mean transparency for all lakes was 1.8 m. The other measured limnological parameters in the 32-lake study also varied considerably. Measured light extinction coefficients ranged from 0.2 m^{-1} to 6.8 m^{-1} (mean for all lakes 1.8 m^{-1}). True color ranged from 2 PCU to 385 PCU (mean color 50 PCU). The calculated bottom slopes ranged from 0.3% to 13% (mean slope 4%). The maximum depth of plant colonization ranged from 0.7 m to 9.2 m, with mean depth of aquatic macrophyte growth at 3.1 m (Table 3-1).

Canfield et al. (1985) found a significant positive relationship between the MDC and SD depth ($R^2 = 0.49$) using data from Finnish, Florida, and Wisconsin lakes. For the 32 Florida lakes sampled during this study, there was also a significant positive relationship between the MDC and SD depth ($R^2 = 0.46$; $p < 0.0001$; Figure 3-1A). The best fit equation between MDC and SD for the Canfield et al. 1985 study was:

$$\log(MDC) = 0.61 \log(SD) + 0.26 \quad (3\text{-}1)$$

The equation between MDC and SD for the 32 Florida lakes was:

$$\log(MDC) = 0.64 \log(SD) + 0.30 \quad (3\text{-}2)$$

where MDC and SD are expressed in meters. Both equations are similar and provide evidence that the positive relationship between MDC and SD is repeatable.

Canfield et al. (1985) found light meter readings were highly correlated ($r = 0.96$) to concurrently measured SD values. Most light reaching the water surface is reflected, turned to heat, or absorbed by objects in the water column as well as by the water itself (Cole 1983). The intensity of light in the water column (I_z) decreases exponentially with depth (z) depending on the vertical attenuation coefficient (E) of the water and the starting surface illumination (I_o), using the relationship set forth in Beers law: $I_z = I_o e^{-Ez}$ (Scheffer 1998). Wavelengths are absorbed differentially in the water column with infrared light and many of the visible reds being absorbed mostly in the first meter and with blues penetrating the deepest (Cole 1983). Additional substances in the water---dissolved organics (color), algae, and non-algal suspended solids---influence the amount of light penetration through the water column (Havens 2003), and potential SD values.

Light availability to a depth in the water column can be measured directly by the use of a light meter or indirectly by the use of a SD. For the English Channel, the relationship between light attenuation (E) and SD measurements was $E = 1.7 / SD$ (Poole and Atkins 1929). However, the relationship between E and SD varies among studies and many alternatives have been suggested (Holmes 1970; Walker 1980). For the 32 study lakes, the correlation between the measured light attenuation coefficients and SD was significant, but not as strong ($r = 0.81$) as that reported ($r = 0.96$) by Canfield et al. (1985). Color and chlorophyll concentrations were also highly related to SD depth ($R^2 = 0.71$; $p < 0.0001$), light attenuation ($R^2 = 0.74$; $p < 0.0001$), and MDC ($R^2 = 0.65$; $p < 0.0001$) through multiple regression analysis (Table 3-2). Secchi disk transparency, however, can be predicted reasonably well from measured light attenuation coefficients (Figure 3-2A) using the equation:

$$\log(SD) = -0.69 \log(E) + 0.26 \quad (3\text{-}3)$$

and light attenuation coefficient (E) can be predicted from SD (Figure 3-2B) using the equation:

$$\log(E) = -0.96 \log(SD) + 0.30 \quad (3\text{-}4)$$

where SD is in meters and E is per meter.

Although E and SD are highly correlated, the large 95% confidence limit (46-236%) associated with the MDC-SD model published by Canfield et al. (1985) has lead to speculation that the use of light meter readings could lead to the development of a more robust model. The MDC of macrophytes in the 32-lake study was negatively related to the mean light attenuation coefficient (Figure 3-1B) and the relationship was represented by the following equation:

$$\log(MDC) = -0.51 \log(E) + 0.48 \quad (3\text{-}5)$$

where MDC is in meters and E is per meter. Light attenuation, however, did not predict MDC any better than SD transparency and actually had a slightly lower coefficient of determination ($R^2 = 0.41$) than SD readings ($R^2 = 0.46$). This finding demonstrated SD, an easily measured and inexpensive index of water transparency, is as useful for assessing MDC as E values that require the use of complex and expensive equipment.

Canfield et al. (1985) suggested the major factor contributing to the variability in the MDC-Secchi relationship is the type of plant colonizing the lake bottom because different species of plants have different light requirements. The amount of surface light penetrating at the maximum depth at which submersed aquatic macrophytes colonized in the 32 study lakes ranged from < 1% to 47%. The mean percent of incident light at the maximum depth of colonization was 11%, which was in agreement with much of the literature (Table 3-1). For example, Hoyer et al. (2004) found that when the percent of incident light at the surface reaching the substrate was less than 10%, there was little or no submersed aquatic vegetation biomass. Sheldon and Boylen (1977) found the MDC to correspond to 10% of the light intensity hitting the surface. The mean percent of incident light at the maximum depth of colonization for stations with hydrilla, non-hydrilla, angiosperms, and charophytes present in this study was 19%, 10%, 12%, and 7%, respectively (Table 3-1). Although hydrilla has been shown to have low light requirements in laboratory conditions (Van et al. 1976), for the 32 lakes examined in natural conditions, hydrilla was not found at low light levels. There was no significant difference in percent of incident light at the maximum depth of colonization between hydrilla and non-hydrilla species ($p = 0.2$). Similarly, there was no significant difference of mean percent surface penetration present at the depth of maximum plant growth between angiosperms and charophytes ($p = 0.4$). This indicates that for this group of Florida lakes, differences in the light requirements of individual plant types can not be invoked as the major factor contributing to the variability in the MDC-Secchi relationship.

Lake bottom sediment serves not only as a physical anchor for submersed vegetation but also as a source of nutrients (Barko et al. 1991). Bachmann et al. (2001) suggested the flocculent organic sediments in Lake Apopka were deleterious for root anchorage and limited the colonization of submersed aquatic macrophytes. Lake Apopka sediments, however, are unique and the lake was not included in the 32-lake study. For the 32-lake study, the mean MDC for organic, mixed, and sandy soils were 2.9 m, 3.7 m, and 2.7 m, respectively. There was no significant difference in the maximum depth of plant colonization among the three soil types classifications established in this study ($p = 0.07$). Soil type, therefore, was not shown to have a significant effect on the maximum depth of plant growth. However, the means were close to be significantly different with the mixed soil having the largest mean MDC, suggesting that mixed soil tends to promote plant growth in deeper waters.

As early as 1924, H. W. Rickett noticed that aquatic vegetation grew deeper in lakes possessing gentle slopes and shallower in lakes having steeper slopes. Duarte and Kalff (1986) demonstrated a strong influence of littoral bottom slope on the maximum biomass of aquatic macrophyte communities. However, they pointed out that the model generated in their study did not reflect turbid lakes (i.e., Secchi disk readings < 2 m), where irradiance rather than slope is pre-eminent. The mean SD transparency for the 32 lakes was 1.8 m; therefore littoral bottom slope according to Duarte and Kalff (1986) should not greatly influence MDC in Florida lakes. In another study by Duarte and Kalff (1990), they found that 15% was the steepest slope at which aquatic macrophytes were present and able to grow. All of the lakes in the 32-lake study had slopes less than 15%. Lake bottom slope was not significantly related to the maximum depth of submersed plant colonization ($R^2 = 0.03$; $p = 0.35$; Table 3-3) so slope is not a variable that can be used to improve the MDC-Secchi relationship in Florida. Although slope has been found to affect aquatic plant growth in other studies, it seems plausible that slope has a minimal influence on MDC for many of Florida lakes because they are generally shallow, with a majority of them having mean depths less than 5 meters (Florida LAKEWATCH 2003).

Florida lakes display a wide range of limnological conditions (Canfield and Hoyer 1988). Information on MDC, SD, and other water chemistries were obtained from

Florida LAKEWATCH to examine the MDC-Secchi relationship for a wide range of lakes. For the 279-lake-year study, MDC ranged from 0.7 m to 9.2 m. The mean MDC depth was 3.3 m. Secchi disk transparency ranged from 0.2 m to 8.2 m (mean of 2.2 m). Color values ranged from 0 PCU to 430 PCU, with the mean color for all lakes equal to 50 PCU. The minimum and maximum chlorophyll concentrations were 0.5 µg/L and 292 µg/L, respectively, and the overall mean was 17 µg/L. Total phosphorus and TN concentrations ranged from 2.1 µg/L to 402 µg/L and 43 µg/L and 4550 µg/L, respectively, and averaged 28 µg/L and 764 µg/L, respectively (Table 3-4).

For the 279-lake-year study, there was as significant positive relationship between SD and MDC ($R^2 = 0.67$; $p < 0.0001$; Figure 3-3). The best fit MDC-SD regression line was:

$$\log (MDC) = 0.66 \log (SD) + 0.30 \tag{3-6}$$

where MDC and SD are expressed in meters. Equation 3-6 is essentially the same as the regression equations developed by Canfield et al. (1985) (Equation 3-1) and by my 32-lake study (Equation 3-2). This strongly suggests the MDC-SD relationship is applicable to a wide range of lakes.

Inspection of Figure 3-3 clearly shows that for a given SD there is considerable variability in the measured maximum depth of macrophyte colonization. This is evidence that other environmental factors besides water transparency influence MDC. However, there is a clear upper limit for MDC at various SD levels. This upper limit represents where light is the limiting environmental factor and can be described by the following equation:

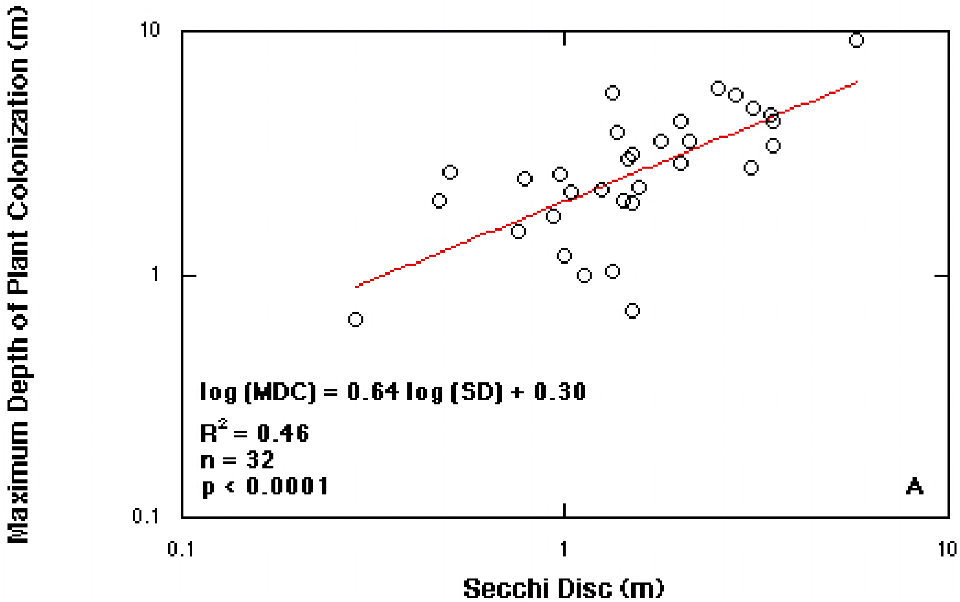
$$\log (\max MDC) = 0.52 \log (SD) + 0.59 \tag{3-7}$$

where MDC and SD are expressed in meters. When MDC values falls below the line, there is some other limiting environmental factor other than solely light that is inhibiting plant growth.

Because SD readings were related to the measured color ($R^2 = 0.49$) and chlorophyll samples ($R^2 = 0.59$), these two light reducing variables were quantifiably related to the maximum depth of submersed plant colonization. Moreover, because chlorophyll readings were related to TP ($R^2 = 0.69$) and TN ($R^2 = 0.53$), regression models were developed to relate these nutrients to the maximum depth of submersed macrophyte colonization. Therefore, the depth at which plants colonized was also significantly inversely related to color ($R^2 = 0.41$; $p < 0.0001$), chlorophyll ($R^2 = 0.30$; $p < 0.0001$), TP ($R^2 = 0.42$; $p < 0.0001$), and TN ($R^2 = 0.33$; $p < 0.0001$). The light attenuating substances, color and chlorophyll, were inversely related to MDC through multiple regression analysis ($R^2 = 0.52$; $p < 0.0001$). Given the significant relationships between MDC and color, chlorophyll, TP, and TN, it is possible to provide a basic assessment of the potential effects of these variables on macrophyte colonization in Florida lakes even without measurements of SD or E.

Table 3-1. Descriptive statistics for the maximum depth of plant colonization (MDC in meters), Secchi disk (SD in meters), light attenuation coefficient (E in m-1), percent of subsurface irradiance penetration (Iz / Io in %), color (PCU), and slope (%) for the 32-lake study.

Parameter	n	Minimum	Maximum	Mean	Standard deviation
MDC	32	0.7	9.2	3.1	1.8
SD	32	0.3	5.8	1.8	1.2
E	32	0.2	6.8	1.8	1.5
Color	32	2	385	50	70
I_Z / I_o	32	0.008	47	11	14
I_Z / I_o hydrilla	9	0.43	99	19	33
I_Z / I_o Non-hydrilla	72	0.0003	78	10	16
I_Z / I_o Angiosperm	68	0.0003	99	12	20
I_Z / I_o Charophyte	13	0.02	19	7	6
Slope	31	0.3	13	4	3



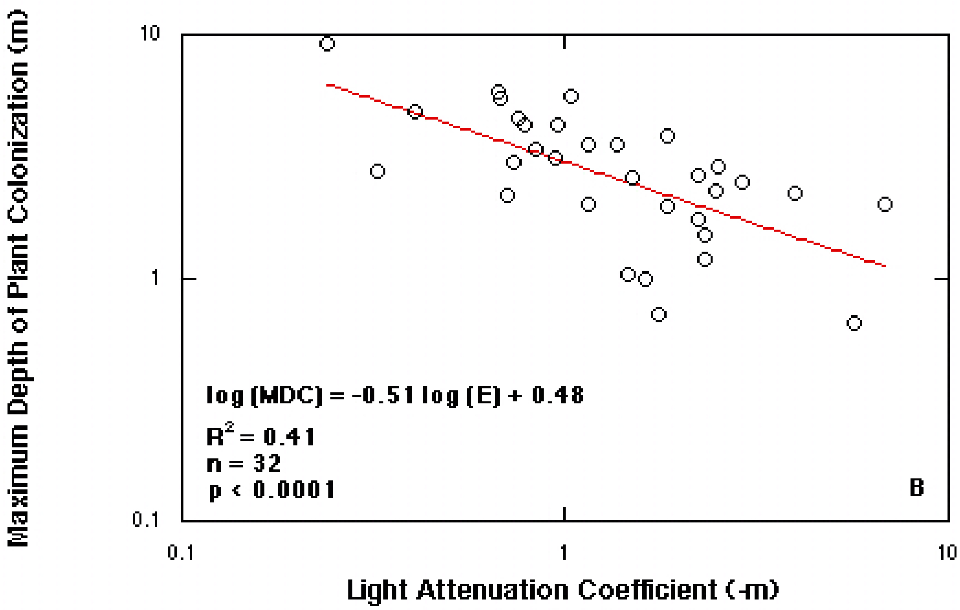


Figure 3-1. Relationship between the mean maximum depth of submersed macrophyte colonization and mean Secchi disc depth (A) and mean light attenuation (B).

Table 3-2. Multiple regression equations relating Secchi disk (SD in meters), light attenuation coefficient (E in m^{-1}) and the maximum depth of plant colonization (MDC in meters) to color (PCU) and chlorophyll (CHL in μg/L).

n	Equation	R^2	p value
29	log(SD) = -0.25 log(COLOR) – 0.39 log(CHL) + 0.88	0.71	< 0.0001
29	log(E) = 0.52 log(COLOR) + 0.22 log(CHL) – 0.82	0.74	< 0.0001
29	log(MDC) = -0.27 log(COLOR) -0.35 log(CHL) + 1.11	0.65	< 0.0001

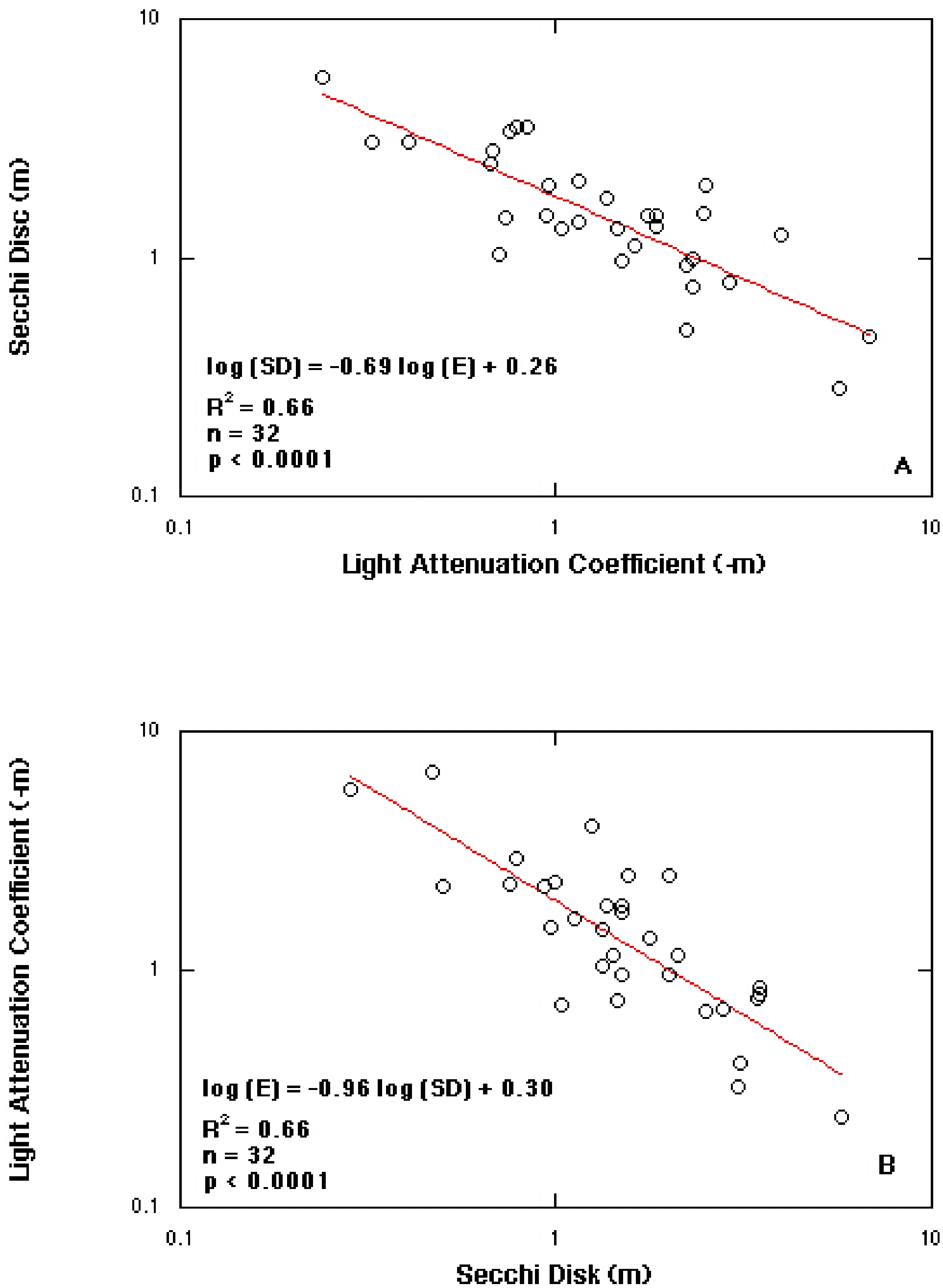


Figure 3-2. Relationships between mean Secchi disc depth and mean light attenuation (A, B).

Table 3-3. Mean maximum depth of plant colonization (MDC in meters) and slope values by lake and the relationship between MDC and mean slope.

Lake	County	MDC	Slope
Alligator	Lake	2.6	0.04
Alto	Alachua	2.5	0.02
Bay	Marion	1.97	0.02
Beakman	Lake	3.4	0.01
Bellamy	Citrus	0.72	0.04
Brant	Hillsborough	1	0.03
Church	Hillsborough	2	0.06
Conway North	Orange	5.5	0.05
Conway South	Orange	5.83	0.04
Dodd	Citrus	1.03	0.10
Doe	Marion	4.23	0.03
Farles Prairie	Lake	4.57	0.05
Grasshopper	Lake	2.25	0.02
Hampton	Bradford	1.73	0.01
Hernando	Citrus	2.27	0.03
Ivanhoe East	Orange	2.17	0.07
Little Conway	Orange	5.57	0.03
Little Santa Fe	Alachua	2	0.01
Magdalene	Hillsborough	3.57	0.02
Maurine	Hillsborough	1.2	0.04
Melrose Bay	Alachua	2.87	0.07
Mill Dam	Marion	2.73	0.03
Newnan	Alachua	0.65	0.003
Osceola	Hillsborough	3.5	0.07
Santa Fe	Alachua	3.87	0.02
Sellers	Lake	9.2	.
Starke	Orange	1.5	0.13
Stella	Putnam	4.27	0.03
Taylor	Hillsborough	3.1	0.03
Twin	Hillsborough	2.65	0.05
Weir	Marion	3	0.01
White Trout	Hillsborough	4.8	0.07

Note: n = 31, R^2 = 0.03, p value = 0.35.

Table 3-4. Descriptive statistics for maximum depth of plant colonization (MDC in meters), Secchi disk (SD in meters), color (PCU), chlorophyll (µg/L), total phosphorus (TP in µg/L), and total nitrogen (TN in µg/L).

Parameter	n	Minimum	Maximum	Mean	Standard deviation
MDC	279	0.7	9.2	3.3	1.9
SD	279	0.2	8.2	2.2	1.5
Color	263	0	430	50	69
Chlorophyll	279	0.5	292	17	34
TP	279	2.1	402	28	40.5
TN	279	43	4550	764	601.2

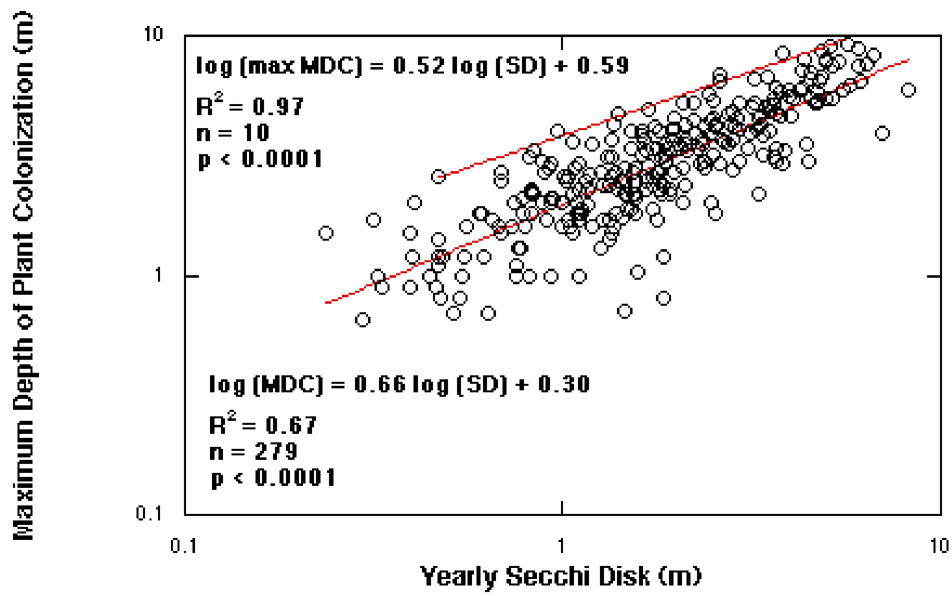


Figure 3-3. Comparison of a calculated maximum line to the best-fit line relating yearly Secchi disk depth to the maximum depth of plant colonization.

Table 3-5. Regression equations of the maximum depth of submersed plant colonization (MDC in meters) related to color (PCU), chlorophyll (CHL in µg/L), total phosphorus (TP in µg/L), and total nitrogen (TN in µg/L).

Input variable	n	Equation	R^2	p value
SD	279	log(MDC) = 0.66 log(SD) + 0.30	0.67	< 0.0001
COLOR	262	log(MDC) = -0.29 log(COLOR) + 0.85	0.41	< 0.0001
CHL	279	log(MDC) = -0.28 log(CHL) + 0.71	0.30	< 0.0001
TP	279	log(MDC) = -0.43 log(TP) + 0.99	0.42	< 0.0001
TN	279	log(MDC) = -0.48 log(TN) + 1.79	0.33	< 0.0001
COLOR & CHL	262	log(MDC) = -0.22 log(COLOR) - 0.18 log(CHL) + 0.93	0.52	< 0.0001

CHAPTER 4
CONCLUSION

For this study, the maximum depth inhabited by an angiosperm was found at 9.2 m. This was similar to the comments of Hutchinson (1975), which concluded that, in lakes, most angiosperms are limited to depths of 9 m. There have, however, been a few exceptions of extreme deep water expansion by freshwater angiosperms. For example, Sheldon and Boylen (1977) found *Elodea canadensis* growing to depths of 12 m in Lake George, New York and *Hydrilla verticillata* has been found growing to a depth of 15 m in Crystal River (Langeland 1996).

This study has confirmed the findings of Canfield et al. (1985) that the maximum depth of macrophyte colonization can be predicted using SD transparency. Furthermore, the maximum depth of plant growth can be predicted reasonably well by light meter measurements. The mean percent of incident light at the maximum depth of plant colonization was 11% for the Florida lakes studied, which was in agreement with much of the primary literature. Although plant species, sediment type and slope have been shown to influence aquatic plant growth on an individual lake basis, no significant influences on MDC were found in this study when looking among lakes. When those variables (plant species, sediment types, slope) where taken into account, they did not increase the predictive capabilities of the Canfield et al. SD-MDC model.

Although this study represents a more comprehensive research effort than those of Canfield et al (1985) to identify and quantify the environmental determinants of MDC, the findings, nevertheless**,** offer no improvement on the predictive value offered by the

SD measurements reported in that study. This suggests that light attenuation, as quantified by SD sampling, is the most important environmental factor in determining MDC. Still, there is substantial variability in SD-MDC correlates from one site to another, suggesting that other factors play a causal role.

It is possible that much of the variability in the MDC-SD model is due to fluctuations in lakes levels that prevent plant depth from attaining a state of equilibrium. Furthermore, light regimes fluctuate through time causing oscillation in the equilibrium depth at which plants grow. For the 279-lake-year study, the use of yearly average SD readings helped account for the changing light regimes in which the plants had been growing and to which they were responding that year, whereas only daily SD readings were used in the 32-lake study. It is significant, therefore, that if yearly SD transparency values from the Florida LAKEWATCH database were used to replace the daily SD values for the 32-lake study, the yearly SD-MDC model accounts for more variablility ($R^2 = 0.57$) than the one using the daily SD values ($R^2 = 0.46$).

Obviously, when herbicides are used or when grass carp are released into a lake, the depth of plant growth should diminish and could cause lakes to deviate below the best fit SD-MDC line. When the Hernando Chain of Lakes in Citrus County was visited during the 32-lake study, the water was being sprayed with a herbicide and an island was being built. Many of the areas visited in this chain had the presence of freshly killed plant material, indicative of continued plant maintenance control.

There are innumerable possible combinations of environmental variables for a specific site over the course of time and this introduces the element of unquantifiable chance into any predictive value for response by a resident organism. The inability of this current research effort to isolate other specific factors as core determinants makes it seem likely that the range of variation in MDC response from site to site is to be expected. In the final analysis, this simply represents a measurable variation in response to an immeasurably complex interaction of environmental factors

An upper limit line relating MDC to SD was developed and describes light limitation when the MDC response falls on or near the response curve and when MDC values fall below the line, there is some other limiting environmental factor. Managers should recognize that the maximum MDC model predicts the upper limit of deepwater growth, but other factors will routinely result in the actual depth of plant colonization less than predicted.

The other water chemistry parameters examined (color, chlorophyll, TP, and TN) were found to provide reasonable estimates for predicting the potential depth of macrophyte growth and could be particularly useful when SD transparency or E of a lake is unknown. Managers should assess each lake independently and consider what water chemistry variable is the dominant factor influencing plant growth. For example, true color would be the best tool to use for predicting MDC for a dystrophic lake.

Submersed aquatic macrophytes play an integral role in the functioning of lake processes, therefore, it is important for managers to understand how submersed plants will respond to changes in lake conditions, such as eutrophication or altered water levels. These models allow managers to assess potential changes in plant coverage that might result from changes in light and water chemistry variables.

APPENDIX A
32-LAKE STUDY DATA

Table A-1. Maximum depth of plant colonization (MDC in meters), Secchi disk transparency (SD in meters), top, middle, and bottom depths that the light meter was measured (Z top, Z middle, Z bottom in meters), top, middle, and bottom deck cell light readings (deck top, deck middle, deck bottom in µmol s-1 m-2 per µA), and top, middle, and bottom underwater light readings (Iz top, Iz middle, Iz bottom in µmol s-1 m-2 per µA), color (PCU), soil type, and plant species identification by station (buoy number) at 32 Florida lakes sampled in 2004.

Date	Lake	County	Buoy	MDC	SD	Z top	Deck top	Iz top	Z middle	Deck middle	Iz middle	Z bottom	Deck bottom	Iz bottom	Color	Soil type	Species
10/29/04	Alligator	Lake	2	2.6	1	0.6	1427	109.3	1.2	947	30.27	2.1	1306	16.41	65	Organic	Hydrilla verticillata
10/29/04	Alligator	Lake	3	2.5	1	0.6	1359	193.4	1.2	1330	50.59	2.1	1224	15.64	63	Organic	Hydrilla verticillata
10/29/04	Alligator	Lake	6	2.7	0.9	0.6	1367	270.2	1.2	1366	63.79	1.8	1357	34.94	69	Organic	Hydrilla verticillata
10/22/04	Alto	Alachua	2	4.3	0.8	0.5	1288	117.2	1	1320	28.66	1.5	1301	6.3	150	Mix	Eleocharis baldwinii
10/22/04	Alto	Alachua	6	1.8	0.8	0.75	825	38.95	1.5	1073	5.59	2.3	831.8	0.55	152	Mix	Eleocharis baldwinii
10/22/04	Alto	Alachua	8	1.4	0.75	0.3	1016	115.6	0.6	773.3	39.99	0.9	1049	20.15	147	Mix	Eleocharis baldwinii
08/11/04	Bay	Hillsborough	2	2.9	1.5	1	1895	247.7	2	1893	12.47	2.5	1829	3.24	38	Organic	Chara sp.
08/11/04	Bay	Hillsborough	3	0.9	B	0.2	1705	1190	0.4	1739	831.2	0.6	1808	609.8	35	Sandy	Chara sp.
08/11/04	Bay	Hillsborough	4	2.1	B	0.2	1233	711.2	0.5	1767	677.2	1	1738	374.7	34	Organic	Chara sp.
08/11/04	Bay	Hillsborough	OWL1	.	.	1	1727	415.9	2	1734	93.2	2.5	1823	49.68	.	.	.
08/3/04	Beakman	Lake	3	3.7	B	1	1088	0.13	1.5	1844	0.28	2	2109	0.08	13	Sandy	Websteria confervoides
08/3/04	Beakman	Lake	5	3.1	B	0.5	1678	808.4	1	1694	825.6	1.5	1727	485.2	17	Sandy	Websteria confervoides
08/3/04	Beakman	Lake	6	3.4	B	1	1374	26.38	1.5	1850	42.8	2	1850	24.48	19	Sandy	Websteria confervoides
08/3/04	Beakman	Lake	SD	.	3.5	.	.	.	.	.	.	.	.	.	.	.	.
10/16/04	Bellamy	Citrus	3	1.3	1.25	0.5	1569	403.6	1	1423	171.3	1.4	1674	86.35	61	Organic	Bacopa caroliniana
10/16/04	Bellamy	Citrus	5	0.8	1.75	0.4	1643	472	0.8	1616	318.3	1.2	1564	179.9	61	Organic	Hydrilla verticillata
10/16/04	Bellamy	Citrus	6	0.2	1.5	0.5	1567	501.4	1	1569	77.87	1.5	1574	46.46	61	Organic	Bacopa caroliniana
10/16/04	Bellamy	Citrus	OWL1	.	.	1	1638	238.7	2	1648	47.23	3	1566	7.86	.	.	.

Table A-1. Continued.

Date	Lake	County	Buoy	MDC	SD	Z top	Deck top	Iz top	Z middle	Deck middle	Iz middle	Z bottom	Deck bottom	Iz bottom	Color	Soil type	Species
06/23/04	Brant	Hillsborough	2	1	B	0.5	1559	0.26	0.7	1552	0.22	.	.	.	88	Mix	Bacopa caroliniana
06/23/04	Brant	Hillsborough	OW1	.	1	1	1473	121	1.5	1525	47.14	2	1572	15.93	89	Organic	.
06/23/04	Brant	Hillsborough	OW2	.	1.25	0.2	1728	684.4	0.4	1637	401.6	0.6	1721	302.6	89	Organic	.
08/4/04	Church	Hillsborough	1	2	1.5	0.5	2014	849.3	1	2028	516.2	1.5	2005	301.6	28	Mix	Chara sp.
08/4/04	Church	Hillsborough	OW1	.	1.25	1	1585	492.1	2	1616	149.2	2.5	1580	82.22	31	Mix	.
08/4/04	Church	Hillsborough	OW2	.	1.5	1	2357	566	2	2378	199.1	3	2359	47.66	25	Mix	.
11/20/04	Conway North	Orange	3	5.1	3	1	565.7	160.5	2	559.3	86.14	3	541.4	47.57	7	Mix	Vallisneria americana
11/20/04	Conway North	Orange	6	5.8	2.6	1	670.9	184.9	2	645.4	100.4	3	646	32.31	8	Mix	Potamogeton illinoensis
11/20/04	Conway North	Orange	9	5.6	2.75	1	757.3	231.1	2	721.2	107.7	3	699.4	60.76	9	Mix	Potamogeton illinoensis
11/20/04	Conway North	Orange	OWL1	.	.	1	1384	653.1	2	1371	313.9	3	1370	178.3	.	.	.
11/20/04	Conway South	Orange	4	5.7	2.5	1	1423	556.9	2	1401	277.6	3	1436	149.8	9	Mix	Vallisneria americana
11/20/04	Conway South	Orange	5	5.5	2.4	1	1637	578.5	2	1627	279.9	3	1642	146.3	8	Mix	Vallisneria americana
11/20/04	Conway South	Orange	8	6.3	2.6	1	1508	576.3	2	1647	313.7	3	1692	172.1	8	Mix	Nitella sp.
10/16/04	Dodd	Citrus	3	0.8	1.25	0.5	935.8	235.4	1	1032	113.9	1.5	1095	35.15	61	Sandy	Ludwigia repens
10/16/04	Dodd	Citrus	5	2.1	1.25	0.5	1173	149.1	1	1069	109.1	1.5	1225	41.69	62	Organic	Utricularia sp.
10/16/04	Dodd	Citrus	6	0.3	1.5	0.4	1366	484.5	0.8	1368	449.4	1.2	1374	221	63	Organic	Hydrochloa caroliniensis
10/16/04	Doe	Marion	3	4	3.5	1	1483	529	2	1485	250.9	3	1486	129.5	9	Mix	Chara sp.
10/16/04	Doe	Marion	5	4.4	3.5	1	1437	563.6	2	1427	220.5	3	1416	116.6	9	Mix	Chara sp.
10/16/04	Doe	Marion	8	4.3	3.5	1	1524	378.2	2	1566	92.13	3	1552	67.59	14	Mix	Chara sp.
9/10/04	Farles Prairie	Lake	2	4.9	3.25	1	787.4	190.2	2	793.9	79.35	3	794	40.76	11	Sandy	Myriophyllum heterophyllum
9/10/04	Farles Prairie	Lake	7	4.2	3.75	1	1454	250.1	2	1058	111.5	3	1055	54.57	12	Sandy	Utricularia sp.
9/10/04	Farles Prairie	Lake	8	4.6	3.25	1	635.9	194.6	2	630.6	74.38	3	626.1	33.09	12	Sandy	Myriophyllum heterophyllum
8/6/04	Grasshopper	Hillsborough	1	2.8	1.25	0.5	287.5	27.54	1	271.7	4.29	1.3	267.2	0.58	78	Sandy	Websteria confervoides
8/6/04	Grasshopper	Hillsborough	2	1.8	1	0.5	552.4	53.26	1	560.5	17.43	1.5	575	3.31	76	Sandy	Utricularia sp.
8/6/04	Grasshopper	Hillsborough	OW2	.	1.5	0.5	1177	206.2	1	1158	13.59	1.5	1127	0.2	80	Sandy	.
8/6/04	Grasshopper	Hillsborough	OWL1	.	.	1	873.1	28.69	2	786.6	2.89	3	767.3	0.95	.	.	.

Table A-1. Continued.

Date	Lake	County	Buoy	MDC	SD	Z top	Deck top	Iz top	Z middle	Deck middle	Iz middle	Z bottom	Deck bottom	Iz bottom	Color	Soil type	Species
10/22/04	Hampton	Bradford	5	1.7	1	0.4	959.8	197.3	0.8	968.7	76.49	0.9	894.9	52.89	89	Sandy	Websteria confervoides
10/22/04	Hampton	Bradford	6	1.8	1	0.4	1231	189	0.8	1213	62.69	1.2	1262	40.78	91	Sandy	Websteria confervoides
10/22/04	Hampton	Bradford	9	1.7	0.8	0.5	1027	133.6	1	1029	53.67	1.4	1041	17.81	87	Sandy	Websteria confervoides
10/16/04	Hernando	Citrus	1	2.2	1.4	0.75	1067	95.33	1.5	1049	23.79	2.1	1047	1.24	61	Organic	Ceratophyllum demersum
10/16/04	Hernando	Citrus	2	2	1.5	0.6	1059	135.2	1.2	1054	22.92	1.8	977.5	7.27	62	Organic	Ceratophyllum demersum
10/16/04	Hernando	Citrus	4	2.6	1.75	1	986.5	79.77	2	970	9.65	2.5	934.2	4.26	56	Organic	Ceratophyllum demersum
11/21/04	Ivanhoe	Orange	2	2	1	1	1228	392.5	2	1236	150.60	3	1058	108.4	10	Mix	Najas guadalupensis
11/21/04	Ivanhoe	Orange	3	2.7	1	1	1150	325.4	2	1156	125.40	3	1150	62.35	11	Mix	Vallisneria americana
11/21/04	Ivanhoe	Orange	6	1.8	1.1	1	1113	214	2	1117	116.30	3	1116	52.07	9	Sandy	Vallisneria americana
11/20/04	Little Conway	Orange	5	6.1	1.25	1	1356	293.8	2	1353	92.37	3	1328	30.61	14	Organic	Vallisneria americana
11/20/04	Little Conway	Orange	6	5.1	1	1	1197	176.6	2	1196	62.83	3	1176	23.21	12	Organic	Hydrilla verticillata
11/20/04	Little Conway	Orange	9	5.5	1.75	1	1183	405.3	2	1169	145.60	3	1169	55.37	12	Organic	Hydrilla verticillata
10/18/04	Little Santa Fe	Alachua	2	2	0.5	0.3	1257	49.92	0.6	1249	14.47	1.2	1275	0.98	375	Mix	Eleocharis baldwinii
10/18/04	Little Santa Fe	Alachua	4	2	0.5	0.2	1053	83.82	0.4	1191	28.53	0.6	1072	7.3	381	Mix	Eleocharis baldwinii
10/18/04	Little Santa Fe	Alachua	OW1	.	0.4	0.2	818.3	86	0.4	786.6	15.02	0.6	801.2	1.63	399	Mix	.
08/11/04	Magdalene	Hillsborough	1	3.8	2	1	1961	502.5	2	1963	488.00	3	1921	15.7	29	Organic	Unidentified plant
08/11/04	Magdalene	Hillsborough	2	3.6	1.75	1	1828	507.7	2	1883	206.10	3	327.1	2.95	29	Organic	Nitella sp.
08/11/04	Magdalene	Hillsborough	6	3.3	1.6	1	2093	336.8	2	2094	424.80	3	2059	86.54	43	Organic	Najas guadalupensis
08/4/04	Maurine	Hillsborough	1	1.3	B	0.2	1972	620.3	0.4	2064	439.40	0.6	2028	152.4	64	Sandy	Bacopa caroliniana
08/4/04	Maurine	Hillsborough	5	1	B	0.2	2010	814.8	0.4	2077	679.50	0.6	2052	397.8	64	Sandy	Bacopa caroliniana
08/4/04	Maurine	Hillsborough	7	1.3	B	0.3	1198	175.4	0.6	1306	109.80	0.9	1480	85.01	65	Sandy	Bacopa caroliniana
08/4/04	Maurine	Hillsborough	SD	.	1	.	.	.	.	.	.	.	.	.	.	.	.
08/12/04	Melrose Bay	Alachua	3	2.8	2	1	307.6	49.92	2	300.9	0.18	2.5	291.8	0.15	27	Mix	Mayaca fluviatilis
08/12/04	Melrose Bay	Alachua	7	2.8	2	.	.	.	.	.	.	.	.	.	27	Mix	Mayaca fluviatilis
08/12/04	Melrose Bay	Alachua	8	3	2	1	752.9	113.70	2	758.4	32.02	3	738.3	18.44	26	Mix	Mayaca fluviatilis
05/27/04	Mill Dam	Marion	4	3	B	1	2031.0	403.20	2	2212	260.80	2.2	2210	323.1	14	Mix	Mayaca fluviatilis

Table A-1. Continued.

Date	Lake	County	Buoy	MDC	SD	Z top	Deck top	Iz top	Z middle	Deck middle	Iz middle	Z bottom	Deck bottom	Iz bottom	Color	Soil type	Species
05/27/04	Mill Dam	Marion	7	2.8	3.05	1	588.3	146.7	2	597.9	99.55	3	1811	185.1	15	Sandy	Mayaca fluviatilis
05/27/04	Mill Dam	Marion	8	2.4	B	1	1878	290.6	2	2182	281.9	.	.	.	14	Sandy	Mayaca fluviatilis
05/18/04	Newnan	Alachua	3	0.9	0.3	0.5	2184	155.4	0.6	2179	106.6	.	.	.	112	Organic	Ceratophyllum demersum
05/18/04	Newnan	Alachua	6	0.4	0.3	0.5	2181	194.3	0.7	2286	90.45	.	.	.	96	Organic	Ceratophyllum demersum
05/18/04	Newnan	Alachua	OW1	.	0.25	0.5	2098	19.37	0.8	2098	1.16	1	2095	0.19	91	Organic	.
08/25/04	Osceola	Hillsborough	2	3.3	2.1	1	1504	160.8	2	1549	99.87	3	1568	39.18	38	Organic	Najas guadalupensis
08/25/04	Osceola	Hillsborough	4	3.2	2.1	1	1778	389.3	2	1779	382.3	3	1781	53.89	35	Organic	Hydrilla verticillata
08/25/04	Osceola	Hillsborough	8	4.0	2.1	1	1794	367.4	2	1732	107.2	3	1695	11.41	37	Organic	Utricularia sp.
10/18/04	Santa Fe	Alachua	1	3.5	1.4	1	1135	96.34	2	1162	17.47	2.5	1116	9.56	52	Organic	Najas guadalupensis
10/18/04	Santa Fe	Alachua	2	4.0	1.3	1	1205	103.6	2	1096	7.47	3	1039	3.65	54	Organic	Najas guadalupensis
10/18/04	Santa Fe	Alachua	3	4.1	1.4	1	999.9	100.7	2	995.2	17.27	3	971.8	0.79	52	Organic	Najas guadalupensis
05/13/04	Sellers	Lake	2	9.2	5.75	1	2327	1199	2	2335	1035	3	2270	729.9	2	Sandy	Utricularia sp.
05/19/04	Starke	Orange	1	1.5	0.75	1	2011	499	1.5	694.6	54.58	.	.	.	14	Sandy	Vallisneria americana
08/12/04	Stella	Putnam	3	4.3	2	1	651.4	143.5	2	650.3	52	3	681.3	19.92	19	Mix	Najas guadalupensis
08/12/04	Stella	Putnam	7	4.1	2	1	1003	244.7	2	975.2	86.04	3	969.6	37.82	18	Mix	Chara sp.
08/12/04	Stella	Putnam	8	4.4	2	1	1014	282	2	1019	102.4	3	989.8	43.92	21	Mix	Najas guadalupensis
09/25/04	Taylor	Hillsborough	1	3.1	1.5	1	1429	216.6	2	1428	206.5	2.5	1437	55.96	36	Organic	Eleocharis baldwinii
09/25/04	Taylor	Hillsborough	OW1	.	1.5	1	1516	44.8	2	1516	41.3	3	1528	8.93	46	Organic	.
09/25/04	Taylor	Hillsborough	OW2	.	1.5	1	1481	193.4	2	1480	57.97	3	1525	16.75	41	Organic	.
06/16/04	Twin	Hillsborough	3	2.8	0.5	1	472.3	28.87	2	474.4	3.13	.	.	.	15	Sandy	Vallisneria americana
06/16/04	Twin	Hillsborough	5	2.5	0.5	1	2028	74.64	.	.	.	.	.	.	14	Sandy	Vallisneria americana
06/16/04	Twin	Hillsborough	OW1	.	0.5	1	1946	35.37	2	2058	22.3	2.5	1956	11.06	16	Sandy	.
06/1/04	Weir	Marion	1	2.9	1.5	1	2065	267.5	2	2118	137.9	2.5	2004	64.73	6	Sandy	Nitella sp.
06/1/04	Weir	Marion	6	2.8	1.4	1	2007	501.5	2	2064	284.2	2.5	2076	161.8	7	Mix	Nitella sp.
06/1/04	Weir	Marion	8	3.3	1.5	1	2104	664.9	2	2093	341.7	2.5	2122	296	8	Sandy	Nitella sp.
06/16/04	White Trout	Hillsborough	1	4.0	3.5	1	477.7	129.5	2	575.1	77.86	3	511.9	50.17	10	Organic	Hydrilla verticillata

Table A-1. Continued.

Date	Lake	County	Buoy	MDC	SD	Z top	Deck top	Iz top	Z middle	Deck middle	Iz middle	Z bottom	Deck bottom	Iz bottom	Color	Soil type	Species
06/16/04	White Trout	Hillsborough	2	5.5	B	0.5	447.4	150.3	0.7	451.3	135.4	0.9	455.4	122.4	10	Organic	Vallisneria americana
06/16/04	White Trout	Hillsborough	3	5.1	3	1	2153	194.2	2	2188	149.6	3	2184	196.5	13	Mix	Hydrilla verticillata
06/16/04	White Trout	Hillsborough	4	4.6	2.75	1	2203	664.4	2	2215	224.7	3	1925	188.8	13	Mix	Utricularia sp.

Note: SD = Secchi disk transparency stations, OW = Open-water stations, OWL = Open-water light stations, B = Secchi disk was visible on lake bottom

APPENDIX B
279-LAKE-YEAR STUDY

Table B-1. Maximum depth of plant colonization (MDC in meters), yearly mean Secchi disk transparency (SD in meters), color (PCU), chlorophyll (µg/L), total phosphorus (TP in µg/L), total nitrogen (TN µg/L) for 279 Florida lake years sampled during 1991 to 2004.

Year	Lake	County	MDC	SD	Color	Chlorophyll	TP	TN
1991	Alto	Alachua	2.5	5.48	35.50	14.27	17.06	566.06
1991	Boll Green	Putnam	4.1	9.60	7.00	1.90	7.40	204.29
1991	Chipco	Putnam	3.9	8.16	8.13	3.05	8.19	245.71
1991	Clear	Orange	2.2	2.73	18.00	53.21	58.30	1144.55
1991	Erie	Leon	2.8	7.80	.	1.58	7.08	377.50
1991	Fanny	Putnam	4.4	8.12	5.00	3.89	6.53	134.72
1991	Georges	Putnam	3.4	6.24	6.50	2.26	10.29	101.39
1991	Gillis	Putnam	3.3	5.48	9.50	5.56	8.36	456.11
1991	Grandin	Putnam	1.3	2.51	35.00	23.67	40.10	687.67
1991	Little Orange	Alachua	2	3.55	90.50	23.33	33.73	980.30
1992	Alice	Hillsborough	5.5	16.33	3.50	1.20	3.77	122.33
1992	Banana	Putnam	1.8	3.67	.	9.09	14.39	709.39
1992	Bass	Pasco	2.7	5.04	28.67	17.07	33.56	779.63
1992	Bear	Seminole	3	11.97	13.71	3.33	12.51	368.65
1992	Beauclaire	Lake	1.7	1.04	58.31	181.87	139.23	3679.33
1992	Bethel	Volusia	1.6	3.25	166.80	19.92	139.47	1385.83
1992	Blue	Volusia	2.9	3.61	128.00	20.40	35.00	1067.67
1992	Brant	Hillsborough	4.5	6.51	65.52	6.25	20.69	774.44
1992	Broward	Putnam	4.3	11.00	6.30	2.46	6.36	180.40
1992	Cherry	Lake	3.3	12.76	122.50	3.11	10.37	533.33
1992	Church	Hillsborough	4.3	6.88	11.00	5.55	16.45	700.61
1992	Como	Putnam	3.4	10.18	3.88	2.00	5.07	158.52
1992	Crenshaw	Hillsborough	2.3	5.48	62.83	10.36	21.67	733.61
1992	David	St Lucie	1.6	4.50	11.31	3.96	10.87	479.67
1992	De Witt	St Lucie	1.9	4.95	21.21	15.96	24.89	764.44
1992	Deborah	St Lucie	1.8	5.13	19.20	3.08	17.61	519.72
1992	Dora West	Lake	0.9	1.09	43.75	166.40	56.20	3389.00
1992	Dorr	Lake	1.3	4.16	70.63	11.82	14.76	411.21
1992	Eaton	Marion	1.6	2.61	380.19	3.97	25.92	1009.44
1992	Emma	Lake	5.5	13.36	128.09	2.58	8.30	563.64
1992	Emporia	Volusia	2.9	8.52	.	3.20	11.42	754.24

Table B-1. Continued.

Year	Lake	County	MDC	SD	Color	Chlorophyll	TP	TN
1992	Floyd	Pasco	2.8	6.83	26.00	3.42	14.47	826.11
1992	Formosa	Orange	2.3	3.61	14.54	42.00	38.17	796.11
1992	Georgia	Orange	5.3	9.67	18.35	3.56	8.22	535.56
1992	Gertrude	Lake	8	16.35	6.28	2.47	7.10	558.61
1992	Halfmoon	Marion	3.1	4.31	47.94	9.92	16.47	620.83
1992	Hall	Leon	6	13.84	6.31	16.07	23.77	412.58
1992	Hampton	Bradford	4.1	6.35	12.06	5.06	11.25	489.72
1992	Hart	Orange	1.8	1.97	183.33	3.39	15.08	1143.06
1992	Henderson	Citrus	2.7	5.92	151.05	7.61	19.17	898.33
1992	Hernando	Citrus	3	7.75	101.78	3.60	10.63	564.00
1992	Hiawatha	Hillsborough	5.2	6.79	36.69	10.17	15.61	508.89
1992	Hickorynut	Orange	5.8	15.46	53.50	1.08	5.88	730.00
1992	Howell	Seminole	4	3.16	.	47.58	46.75	1068.33
1992	Island	Marion	0.8	6.04	3.00	2.83	12.99	298.33
1992	Jean	St Lucie	2.2	6.33	.	2.86	10.97	491.94
1992	Jeffery	St Lucie	2.2	5.14	10.75	2.00	9.33	520.00
1992	Joanna	Lake	3.1	11.95	12.20	2.05	6.33	422.08
1992	Karen	St Lucie	2.3	3.84	14.25	22.04	32.89	1086.30
1992	Keene	Hillsborough	2.1	5.10	119.00	12.33	36.23	1149.67
1992	Keystone	Hillsborough	3.7	9.23	98.71	2.70	9.18	462.73
1992	Kingsley	Clay	8.3	21.81	6.43	3.56	4.59	260.74
1992	Kirkland	Lake	4.1	10.71	.	2.37	7.27	357.17
1992	Little Henderson	Citrus	2.5	5.91	66.19	9.06	15.67	877.78
1992	Little Weir	Marion	3.4	5.85	10.50	9.38	12.38	915.83
1992	Ola	Orange	6.1	12.03	9.50	3.06	12.08	560.00
1992	Osceola	Hillsborough	5.2	15.22	36.50	1.94	6.25	443.06
1992	Sellers	Lake	7.5	20.00	2.50	1.03	3.39	42.50
1992	Seminary	Seminole	6.5	15.63	8.42	2.50	8.19	354.44
1993	Bay	Orange	3	2.91	21.00	47.77	39.23	1455.13
1993	Bear	Seminole	2.2	10.89	9.00	3.15	12.39	391.47
1993	Blue Heron	Leon	2.3	2.70	15.00	51.48	55.15	938.48
1993	Conway South	Orange	6.8	11.38	7.00	7.67	10.00	440.51
1993	Coon	Osceola	1	1.78	217.00	8.37	35.23	1045.00
1993	Cowpen	Putnam	3.9	10.23	1.00	1.67	5.00	86.67
1993	Crescent	Hillsborough	3.3	7.00	22.00	10.75	14.75	549.17
1993	Croft	Citrus	3.4	12.00	19.00	2.31	6.72	601.28
1993	Crooked	Lake	2.8	5.10	15.00	10.36	21.77	971.03
1993	Dead Lady	Hillsborough	2.6	5.65	75.00	31.23	36.69	1104.62
1993	Diane	Leon	4.2	8.31	6.00	2.56	13.19	304.72
1993	Disston	Flagler	0.7	1.69	290.00	7.00	25.36	965.76
1993	Eagle	Polk	2.8	3.00	10.00	27.50	19.33	1110.00
1993	Egypt	Hillsborough	2.5	4.77	12.00	19.25	20.58	745.00
1993	Elbert	Polk	4.9	5.50	9.00	3.33	12.33	553.33
1993	English	Putnam	2.8	4.76	35.00	13.33	13.00	870.00
1993	Erie	Leon	1.7	5.81	.	2.89	5.17	419.44
1993	Fannie	Polk	1.7	2.14	63.00	27.86	56.00	1133.33
1993	Fredrica	Orange	5	10.38	7.00	4.73	12.87	417.33

Table B-1. Continued.

Year	Lake	County	MDC	SD	Color	Chlorophyll	TP	TN
1993	Gillis	Putnam	3.4	7.44	6.00	7.06	9.03	318.06
1993	Grasshopper	Lake	4.6	12.38	0.00	1.41	2.05	235.13
1993	Haines	Polk	1.8	1.99	55.00	99.10	158.21	1804.62
1993	Halfmoon	Hillsborough	3.5	6.89	9.00	6.13	13.88	533.75
1993	Hamilton	Polk	1	3.63	62.00	8.61	116.33	1042.22
1993	Hampton	Bradford	2.7	6.49	28.00	4.74	9.79	511.54
1993	Harney	Volusia	1.7	3.40	108.00	8.75	38.56	1157.92
1993	Harris	Lake	1.8	2.72	12.00	67.53	31.20	1839.67
1993	Hartridge	Polk	4.7	4.62	9.00	1.00	9.00	396.67
1993	Henry	Polk	0.9	1.51	295.00	4.60	131.00	1207.33
1993	Higgenbotham	Putnam	5.1	11.57	7.00	2.46	5.77	389.49
1993	Highland	Orange	2.4	4.17	9.00	22.00	36.13	625.33
1993	Howard	Polk	1.6	2.22	20.00	39.23	31.40	1446.67
1993	Idlewild	Lake	4	5.30	55.00	10.09	15.64	1005.76
1993	Ivanhoe East	Orange	2.6	3.31	14.00	29.48	30.82	770.61
1993	Ivanhoe Middle	Orange	3.5	3.91	15.00	24.03	29.58	612.78
1993	Ivanhoe West	Orange	2.9	3.05	15.00	29.78	31.85	720.37
1993	Lawsona	Orange	1.6	3.46	.	27.28	82.81	996.11
1993	Little Bass	Polk	1.5	2.24	40.00	92.85	344.22	1912.95
1993	Little Halfmoon	Hillsborough	3.2	11.19	9.00	2.67	7.58	451.39
1993	Little Santa Fe	Alachua	3.4	5.67	54.00	7.33	12.63	528.97
1993	Little Spirit	Polk	5.7	8.00	27.00	5.58	20.33	704.17
1993	Lizzie	Osceola	1.8	4.56	97.00	3.74	15.72	738.72
1993	Marsha	Orange	7.8	16.21	13.00	2.64	7.14	391.39
1993	Mary	Marion	3.5	14.50	1.00	1.61	2.58	118.61
1993	Rosa	Putnam	3	14.69	4.00	6.95	5.59	86.92
1994	Ashby	Volusia	2.1	2.56	192.75	3.92	67.14	737.50
1994	Bennett	Orange	2.9	7.56	12.88	7.46	18.30	613.70
1994	Conway North	Orange	6.9	8.60	6.96	11.88	11.15	534.55
1994	Conway South	Orange	6.6	10.49	7.17	9.36	10.09	458.79
1994	Eaton	Marion	1.6	2.40	380.19	6.45	22.67	1276.67
1994	Highland	Orange	2.4	4.38	13.50	16.42	32.00	620.00
1994	Howell	Seminole	3.1	2.67	15.00	32.42	35.83	653.33
1996	Bellamy	Citrus	4.3	9.19	31.00	3.04	11.11	687.04
1996	Blue	Highlands	4.5	10.89	7.00	4.22	10.22	575.56
1996	Broward	Putnam	6.7	15.83	4.00	1.96	6.29	296.46
1996	Clay	Highlands	5.2	10.61	8.00	5.45	11.12	459.70
1996	Crews	Highlands	1.4	4.37	28.00	5.83	13.77	423.67
1996	Denton	Highlands	3.9	23.02	3.00	1.64	3.39	3133.64
1996	Dinner	Highlands	6.4	20.27	4.00	1.67	7.67	633.33
1996	Dodd	Citrus	3.7	8.70	29.00	4.04	10.78	774.07
1996	Eagle Pond	Highlands	1.7	4.19	18.00	13.39	12.50	698.79
1996	Floral City	Citrus	1.7	3.64	157.00	12.83	33.44	974.17
1996	Francis	Highlands	4.1	6.50	5.00	12.40	14.42	510.33
1996	Hall	Leon	9	16.68	6.00	3.52	11.80	320.60
1996	Hampton	Citrus	1.8	3.58	111.00	16.43	30.26	929.64
1996	Henderson	Citrus	2.7	4.52	107.00	9.79	21.67	960.91

Table B-1. Continued.

Year	Lake	County	MDC	SD	Color	Chlorophyll	TP	TN
1996	Hickorynut	Orange	4.6	10.97	19.00	2.85	7.64	694.24
1996	Hill	Highlands	3.2	6.15	13.00	5.81	10.00	347.41
1996	Jackson	Highlands	5	11.22	10.00	4.50	12.28	337.78
1996	Josephine Center	Highlands	1.2	1.81	92.00	24.97	46.10	959.67
1996	Josephine East	Highlands	1	2.46	58.00	24.33	35.30	915.56
1996	Josephine West	Highlands	0.8	1.56	127.00	33.40	82.50	1079.33
1996	Lillian	Highlands	4.5	8.23	6.00	7.73	9.58	631.21
1996	Little Henderson	Citrus	4	5.00	77.00	8.83	18.61	932.73
1996	Little Jackson	Highlands	2.7	2.94	27.50	52.78	51.67	1167.41
1996	Little Santa Fe	Alachua	3.7	5.41	106.70	6.03	10.85	450.30
1996	Ola	Orange	6.6	14.96	8.00	3.42	9.82	525.00
1997	Carroll	Hillsborough	4.6	11.00	8.69	2.33	12.67	463.33
1997	Fanny	Putnam	5.1	11.83	3.63	2.28	4.78	129.44
1997	Lily	Clay	4	11.50	2.76	2.74	6.33	109.26
1997	Lochloosa	Alachua	2.5	2.24	222.00	70.66	52.14	1795.45
1997	Sheelar	Clay	6	26.77	1.39	1.62	3.25	87.08
1997	Winnemissett	Volusia	6.2	18.75	6.50	0.50	5.75	193.33
1998	Ada	Seminole	3.2	8.19	14.00	5.89	16.50	534.67
1998	Alto	Alachua	2.5	4.63	83.30	9.36	17.97	586.11
1998	Bay	Orange	2.1	3.04	25.63	39.15	37.50	1086.67
1998	Chipco	Putnam	5.5	11.86	8.13	5.43	10.50	319.33
1998	Cowpen	Putnam	4.5	9.50	1.00	2.78	6.56	193.33
1998	Crooked	Lake	1.9	5.71	37.31	7.58	13.94	718.89
1998	Crystal	Clay	3.9	7.40	9.00	5.67	11.30	264.67
1998	Dorr	Lake	0.7	2.08	70.63	15.60	18.00	499.33
1998	Gillis	Putnam	2.2	3.47	.	10.77	11.47	912.33
1998	Grandin	Putnam	1.6	3.95	.	19.67	28.76	501.21
1998	Grasshopper	Lake	3.7	6.39	112.42	3.25	5.72	365.28
1998	Joes	Marion	4.2	7.83	11.00	3.88	10.39	598.18
1998	Kingsley	Clay	7.5	16.88	6.43	6.96	8.13	323.75
1998	Little Bear	Seminole	2.9	12.49	16.52	3.17	13.00	474.17
1998	Little Crystal	Clay	2.7	5.87	25.50	7.78	12.50	330.00
1998	Little Orange	Alachua	2.2	2.76	173.65	10.58	129.81	958.33
1998	Little Santa Fe	Alachua	3.1	4.41	106.70	11.42	14.56	530.00
1998	Little Weir	Marion	3.5	6.18	10.50	8.58	11.09	816.67
1998	Lizzie	Osceola	1	2.67	98.33	5.30	22.52	744.81
1998	Sellers	Lake	7.6	21.00	2.50	1.33	3.50	76.06
1998	Seminary	Seminole	5.4	15.49	8.42	2.52	7.94	373.03
1999	Bear	Seminole	5.9	13.01	13.71	4.17	14.35	440.42
1999	Beauclaire	Lake	1.5	0.78	58.31	291.56	169.44	4551.94
1999	Bennett	Orange	3.8	11.15	12.88	2.56	16.74	524.44
1999	Carlton	Orange	1	1.06	41.87	219.25	85.97	3572.22
1999	Disston	Flagler	0.9	1.29	428.47	4.00	25.67	1074.72
1999	Erie	Leon	2.2	4.77	.	2.25	6.82	457.58
1999	Gatlin	Orange	2.7	2.25	15.64	36.81	21.39	1209.17
1999	Halfmoon	Marion	2.2	4.85	47.94	8.00	14.78	774.17

Table B-1. Continued.

Year	Lake	County	MDC	SD	Color	Chlorophyll	TP	TN
1999	Hiawatha	Leon	2.6	4.41	174.17	5.39	19.56	520.56
1999	Josephine Center	Highlands	1.6	1.82	134.05	20.17	57.47	930.56
1999	Josephine East	Highlands	1.8	2.58	87.40	37.70	47.47	1003.67
1999	Josephine West	Highlands	1.4	1.53	158.30	19.78	93.72	977.78
1999	June	Highlands	3.4	4.97	13.70	17.25	13.78	745.00
1999	Juniper East	Walton	3.7	6.93	14.81	6.64	12.94	367.22
1999	Juniper West	Walton	3.5	6.67	14.79	5.33	11.56	717.78
1999	Little Conway	Orange	8.5	12.51	6.00	3.69	11.50	479.72
1999	Lochloosa	Alachua	2.6	1.54	222.00	152.50	62.93	2351.25
1999	Wooten	Jefferson	4.2	10.78	.	4.10	13.52	301.90
2000	Asbury North	Clay	6.5	8.50	14.50	7.81	20.56	409.63
2000	Bedford	Bradford	2.4	5.64	13.00	11.56	44.33	783.06
2000	Deerback	Marion	1.8	8.27	19.56	3.50	10.75	559.58
2000	Dexter	Polk	5.3	15.43	9.60	2.25	9.21	425.83
2000	Diane	Leon	3.7	4.40	9.07	8.78	22.36	529.72
2000	Eagle	Polk	3.6	3.50	9.75	18.54	21.42	807.50
2000	East	Pasco	3.6	8.75	16.98	3.39	18.00	582.22
2000	Florida	Seminole	2.5	5.14	.	12.82	33.36	909.44
2000	Hartridge	Polk	1.7	4.35	11.00	14.50	20.67	625.00
2000	Henry	Polk	1.2	1.31	98.50	8.05	96.24	1122.86
2000	Little Bass	Polk	2	1.33	23.25	148.25	401.64	2643.61
2000	Little Santa Fe	Alachua	3.2	5.34	106.70	9.94	15.83	528.61
2001	Arbuckle	Polk	1	1.46	269.00	17.44	82.22	1258.33
2001	Big	Volusia	2.2	6.00	56.40	5.93	18.57	707.62
2001	Cassidy	Holmes	6	18.15	1.33	1.83	4.71	129.58
2001	Conway North	Orange	4.6	13.29	6.33	4.00	11.83	366.67
2001	Conway South	Orange	7	14.90	7.50	2.58	10.17	359.17
2001	Crooked	Polk	5.4	8.16	15.50	3.97	13.53	580.94
2001	De Witt	St Lucie	2	3.04	20.50	13.82	29.94	988.89
2001	Deborah	St Lucie	1.7	5.80	19.20	2.25	12.13	508.33
2001	Grayton	Walton	1.5	4.42	32.25	3.44	11.92	251.11
2001	Howell	Seminole	3.3	2.75	15.00	38.45	41.95	1032.80
2001	Istokpoga	Highlands	1.7	2.97	55.25	36.75	55.61	1515.56
2001	Ivanhoe East	Orange	1.8	3.63	12.00	30.71	25.74	827.86
2001	Ivanhoe Middle	Orange	1.7	4.17	10.50	25.29	27.19	725.24
2001	Ivanhoe West	Orange	2.7	4.12	13.00	30.43	35.62	692.86
2001	Josephine Center	Highlands	0.8	1.75	105.00	25.08	76.22	1007.78
2001	Josephine East	Highlands	1	2.68	70.50	29.36	51.58	944.55
2001	Josephine West	Highlands	1.2	1.57	121.00	25.33	111.31	1068.06
2001	Jovita	Pasco	4.2	5.79	8.75	10.22	21.47	783.06
2001	June	Highlands	4.7	9.03	7.75	6.83	11.11	499.72
2001	Juniper East	Walton	3.7	7.64	13.67	6.00	11.18	417.64
2001	Juniper West	Walton	2.4	6.93	14.67	7.78	11.42	864.72
2001	Karen	St Lucie	1.9	4.82	14.25	5.10	15.53	665.67
2001	Little Wilson	Hillsborough	4	5.89	31.00	8.63	25.44	875.93
2001	Lochloosa	Alachua	1.5	1.30	222.00	138.00	89.88	3823.75

Table B-1. Continued.

Year	Lake	County	MDC	SD	Color	Chlorophyll	TP	TN
2001	Margaret	St Lucie	2.2	5.02	8.75	6.52	12.19	434.44
2001	Viola	Highlands	5.5	14.90	3.00	2.58	7.92	446.67
2002	Bessie	Orange	8.6	15.79	8.00	2.06	7.08	479.72
2002	E	Miami-Dade	7.8	17.67	3.75	1.41	5.22	321.48
2002	Grassy	Highlands	4.7	12.06	11.80	2.69	9.50	716.11
2002	Sellers	Lake	8.9	19.83	1.83	1.09	3.33	66.67
2002	Verona	Highlands	6.1	14.09	5.10	6.41	10.37	340.37
2003	Alligator	Osceola	2.6	3.37	54.58	5.11	19.63	875.14
2003	Annie	Putnam	3	9.67	9.00	3.78	10.08	428.33
2003	Blue	Lake	2	3.27	72.50	5.78	15.67	385.56
2003	Clear	Lake	4.8	11.65	14.80	2.64	13.31	502.50
2003	Cliff	Broward	4.4	7.33	26.00	5.28	20.89	455.00
2003	Conway North	Orange	8	14.30	8.00	3.47	8.73	412.00
2003	Conway South	Orange	7.1	14.17	8.00	4.67	10.20	434.00
2003	Delevoe	Broward	2.3	6.29	8.00	29.21	44.57	828.57
2003	Farm 13	Indian River	2.1	3.09	85.00	35.94	76.75	1634.44
2003	Florence	Seminole	4.2	9.33	11.00	5.00	12.83	518.33
2003	Flynn	Hillsborough	1.9	3.67	63.08	5.97	10.14	1145.28
2003	Formosa	Orange	3.4	6.77	14.00	30.21	45.03	856.67
2003	Galilee	Putnam	2.5	3.77	8.00	10.00	15.00	230.00
2003	Highland	Miami-Dade	5.2	7.27	17.00	7.00	15.00	462.33
2003	Highland	Orange	2.8	3.52	12.00	39.67	50.17	773.33
2003	Istokpoga	Highlands	2	2.46	62.00	51.75	64.97	1382.50
2003	Ivanhoe East	Orange	2.3	5.91	11.40	14.00	34.72	707.33
2003	Ivanhoe Middle	Orange	2.4	6.04	11.73	15.71	26.85	681.30
2003	Ivanhoe West	Orange	3.4	6.59	11.65	22.33	29.95	633.67
2003	Jem	Lake	3.5	8.98	9.83	5.75	12.06	481.94
2003	John's	Orange	1.3	2.54	125.00	16.42	55.97	1298.50
2003	Josephine Center	Highlands	1.2	1.55	173.00	22.11	74.36	916.11
2003	Josephine East	Highlands	1.2	2.02	113.00	40.61	59.03	1036.39
2003	Josephine West	Highlands	1.1	1.55	212.00	17.33	114.33	928.89
2003	Lochloosa	Alachua	1.1	2.47	222.00	26.57	36.50	1544.50
2003	Winyah	Orange	2	6.83	23.00	30.52	56.57	1019.33
2004	Alto	Alachua	2.5	3.37	102.75	13.88	19.58	763.94
2004	Bay	Marion	2	3.83	19.00	16.04	24.62	813.11
2004	Bellamy	Citrus	0.7	4.76	74.00	9.27	22.90	1207.62
2004	Brant	Hillsborough	1	3.05	107.00	43.50	52.10	1203.67
2004	Church	Hillsborough	2	8.10	11.00	4.81	15.58	656.27
2004	Conway North	Orange	5.5	17.00	7.00	2.00	10.33	404.44
2004	Conway South	Orange	5.8	12.39	6.50	4.11	10.89	388.89
2004	Dodd	Citrus	1.0	5.21	79.75	8.72	19.94	1289.17
2004	Doe	Marion	4.2	4.50	.	4.33	11.33	283.33
2004	Grasshopper	Lake	2.2	2.71	208.67	4.36	8.70	958.18
2004	Hampton	Bradford	1.7	4.71	10.00	5.25	11.58	490.83
2004	Hernando	Citrus	2.3	4.61	71.40	9.08	20.25	1112.08
2004	Ivanhoe East	Orange	2.2	4.88	9.50	21.04	17.10	537.62

Table B-1. Continued.

Year	Lake	County	MDC	SD	Color	Chlorophyll	TP	TN
2004	Little Conway	Orange	5.6	12.97	8.00	4.11	11.33	496.67
2004	Little Santa Fe	Alachua	2	2.91	180.75	6.97	18.77	925.67
2004	Magdalene	Hillsborough	3.6	7.68	32.80	6.75	19.42	811.39
2004	Maurine	Hillsborough	1.2	6.07	.	7.26	20.66	801.14
2004	Melrose Bay	Alachua	2.9	5.52	41.00	8.80	13.90	562.67
2004	Mill Dam	Marion	2.7	9.27	14.00	3.83	10.27	471.33
2004	Newnan	Alachua	0.6	0.97	206.83	223.84	121.64	3479.12
2004	Osceola	Hillsborough	3.5	6.89	40.00	7.08	20.25	847.50
2004	Santa Fe	Alachua	3.9	5.34	45.50	8.00	12.13	564.33
2004	Sellers	Lake	9.2	18.68	5.00	2.52	4.70	250.30
2004	Starke	Orange	1.5	3.48	18.67	25.50	24.67	881.67
2004	Stella	Putnam	4.3	8.33	.	5.50	7.67	598.33
2004	Taylor	Hillsborough	3.1	5.95	35.50	8.00	22.04	717.92
2004	Twin	Hillsborough	2.6	3.89	12.50	22.96	24.70	802.28
2004	Weir	Marion	3	6.17	6.92	11.00	13.50	863.33
2004	White Trout	Hillsborough	4.8	9.28	12.60	4.67	13.67	437.14

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