Submersed Aquatic Vegetation in Lake Apopka

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Historically, the primary use of Lake Apopka was recreational fishing. However, the multi million-dollar fishery collapsed in the late 1950's due to the loss of submersed aquatic vegetation (SAV), which was the primary habitat in the lake for sportfish reproduction, recruitment and foraging. Therefore, the primary goal for restoration projects should be the restoration of aquatic plants in Lake Apopka to resurrect recreational fishing opportunities. Many fisheries studies have recommended different levels of SAV as optimum for sportfish populations but most agree the level is between 15% and 30% coverage of the lake's surface area (Canfield and Hoyer 1992). Thus, a likely target for a Lake Apopka restoration would be 15% coverage of SAV.

In 1999, Conrow and Peterson (2000) measured 2.7 acres (11,032 m^2) of eel-grass (*Valisineria americana)* in Lake Apopka. In 2004 Murphy (2005) measured 0.2 acres (900 m^2) showing a large decrease in the eel-grass abundance in a five year period. At the most recent Florida Lake Management Society Annual Symposium, Coveney (2016) reported the presence of 48 acres of eel-grass in Lake Apopka suggesting the lake was increasing its SAV coverage because of phosphorus reduction programs carried out for the last few decades. However, the plant abundances reported in these three studies are all much less than 0.1% of the surface area of Lake Apopka way below a target level that would be beneficial to the sportfish population in the lake.

Coveny (2016) cites a chain of trophic state models to support phosphorus reduction as the dominant factor driving the increase in SAV. For example, phosphorus loading was decreased causing a decrease in phosphorus concentrations within Lake Apopka, causing a similar decrease in chlorophyll concentrations and ultimately increase the light penetration for SAV growth. The management assumptions with the chain of eutrophication models for increasing SAV in a lake is that light is the primary factor limiting the abundance of SAV and algal abundance (estimated with chlorophyll) is the primary factor impacting light penetration. This chain of eutrophication models approach was used with great success in the restoration of sea grasses in Tampa Bay (Greening et al. 2011) because light was the factor limiting submersed aquatic plant abundance in the bay. However, Hoyer et al. (2015) used the same chain of eutrophication models to show that eutrophication was not impacting the abundance of SAV in Choctawhatchee Bay, FL because light was not the factor limiting the abundance of aquatic plants.

Using SJRWMD data from 1985 to 2015 shows that in Lake Apopka total phosphorus is significantly related to chlorophyll concentrations (Figure 1) and chlorophyll concentrations are significantly related to water clarity measured with a Secchi disk (Figure 2). Assuming the phosphorus loading rate is driving the total phosphorus concentrations in Lake Apopka then two links in the chain of eutrophication models are connected per conventional wisdom.

Multiple researchers have published relations between water clarity and the maximum depth of plant colonization (MDC), which is the last link in the chain of eutrophication models. For a modeling exercise to determine the potential SAV coverage in Lake Apopka (assuming light is limiting aquatic plant abundance), I used Secchi depth versus maximum depth of plant colonization model developed with more northern lakes (Duarte and Kalff 1987) and one developed in Florida's shallow lakes (Caffrey et al. 2007). I used these two models and the annual mean Secchi depth values from the SJRWMD data to estimate the MDC in Lake Apopka for the following years: 1985, 1990, 1995, 2000, 2005, 2010, and 2015. For the modeling exercise I also constructed a hypsographic curve (Figure 3) with Lake Apopka bathymetric data reported by Danek and Tomlinso (1989) and retrieved annual mean water level data for each year from SJRWMD. Plotting the mean annual water level of lake Apopka and the MDC below that level on the hypsographic curve for each year allows allow for an estimate of the potential surface area of lake Apopka that could maintain aquatic plants.

Figure 4 shows that the Florida MDC model (Caffrey et al. 2007) predicts more potential SAV then the northern MDC model (Duarte and Kalff 1987), which is to be expected because of the much shorter growing seasons and shorter daylight hours in more temperate climates. Both models clearly show that Lake Apopka has significant potential for submersed aquatic vegetation that far exceeds the current SAV area covered of 01% discussed by Coveny (2016). This modeling exercise also shows that for the last two decades there has been enough light penetrating lake Apopka to achieve a target SAV of 15% coverage. These data suggest that factors other than light are limiting SAV in Lake Apopka like the findings of Hoyer et al. (2015) for SAV in Choctawhatchee Bay. This also confirms a similar analysis already conducted by Bachmann et al. (1999) as early as 1999 showing sufficient light for SAV to occupy over 30% of the surface area of Lake Apopka.

This brief analysis indicates that further reductions in phosphorus concentration will not help a goal of increasing SAV to 15% coverage for fisheries habitat. In a different area of concern, however, current chlorophylls are still running more than 80 µg/L, which are levels conducive of blue green algal blooms. Thus, future reductions in phosphorus concentrations may continue to help this management issue. However, to achieve increases in aquatic plant abundance in Lake Apopka, other in-lake management strategies must be considered.

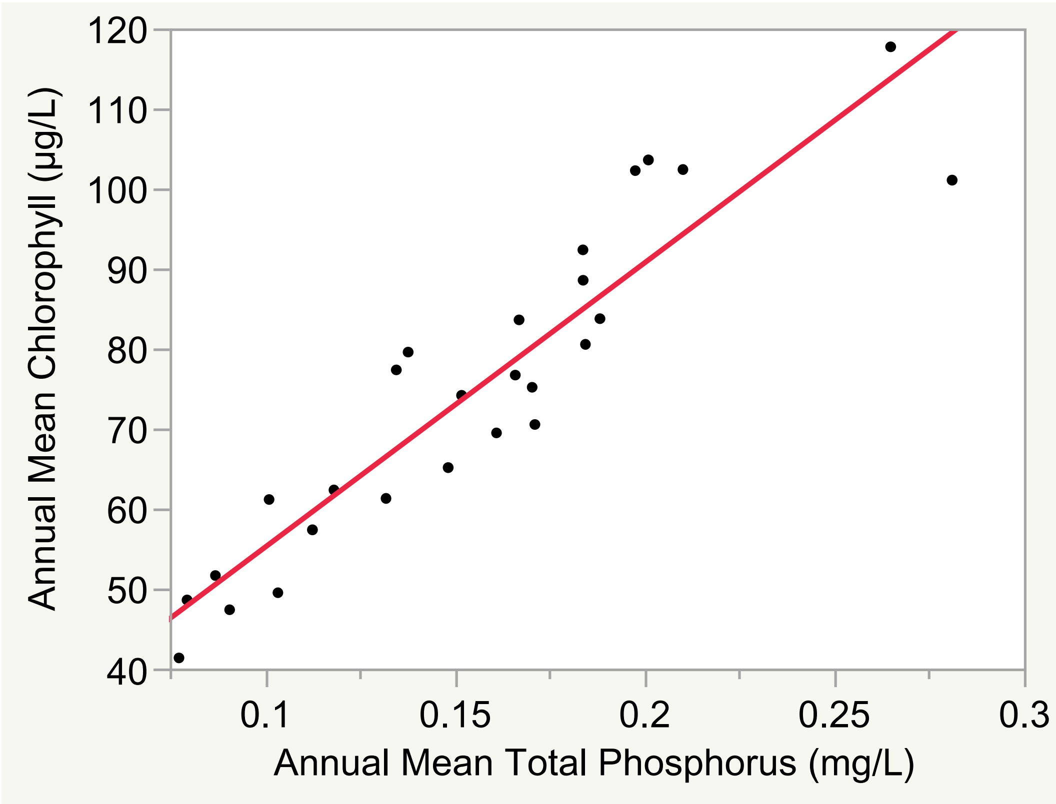

Figure 1. Relation between annual mean total phosphorus and annual mean chlorophyll in Lake Apopka using data from 1985-2015.

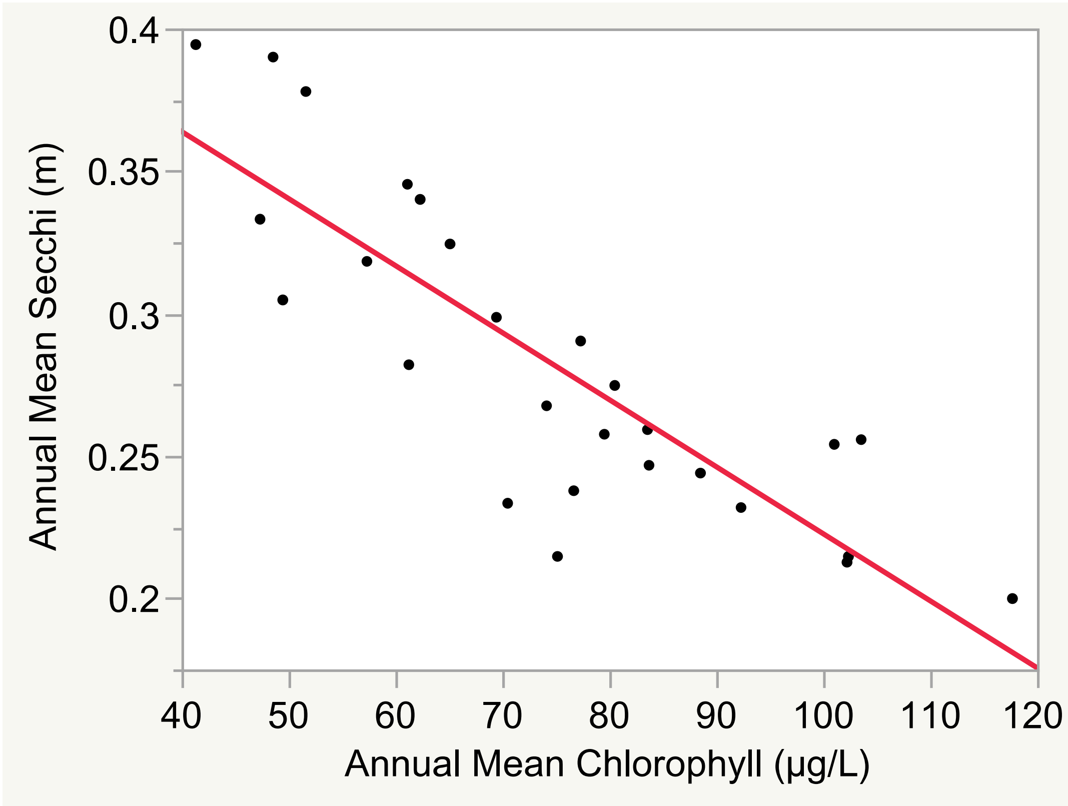

Figure 1. Relation between annual mean Secchi depth and annual mean chlorophyll in Lake Apopka using data from 1985-2015.

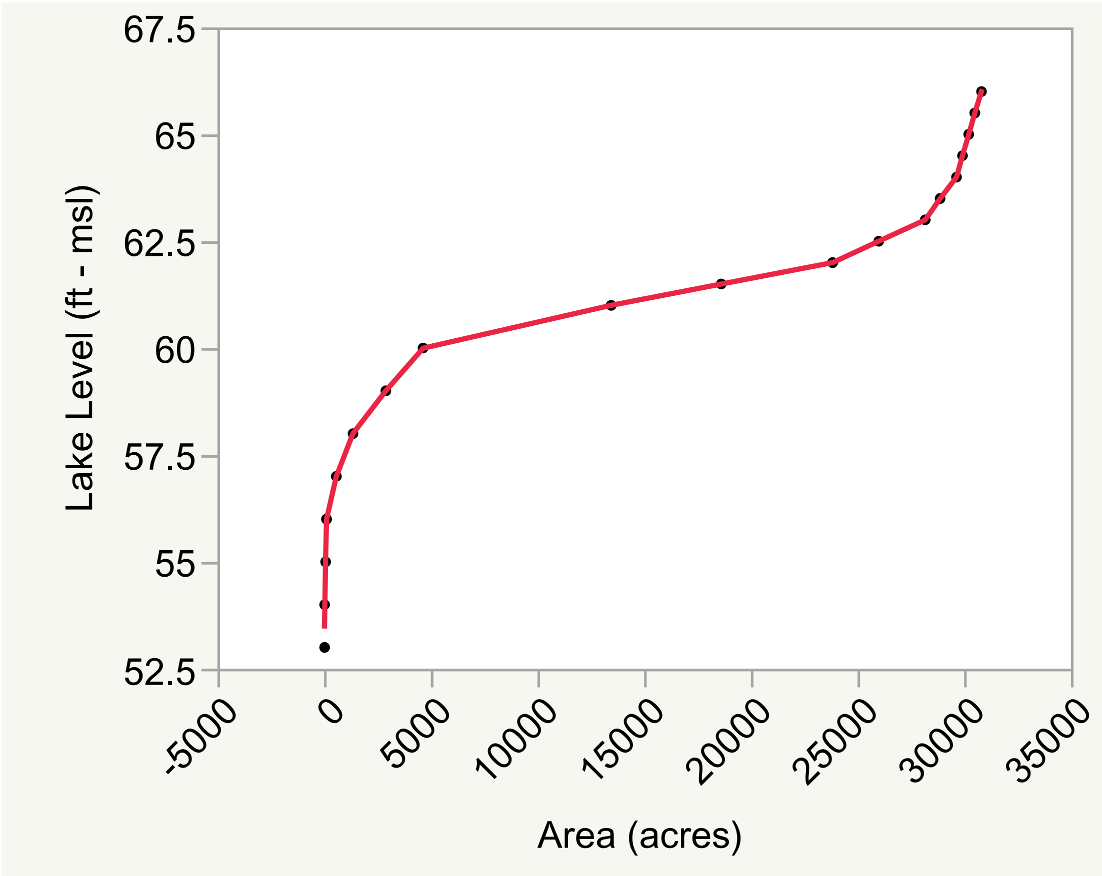

Figure 3. Hypsographic curve of Lake Apopka using data from: Danek, D. J. and M. S. Tomlinson. 1989. Bathymetric analysis of Lake Apopka. Project 10-150-01. St. Johns River Water Management District, Palatka, FL.

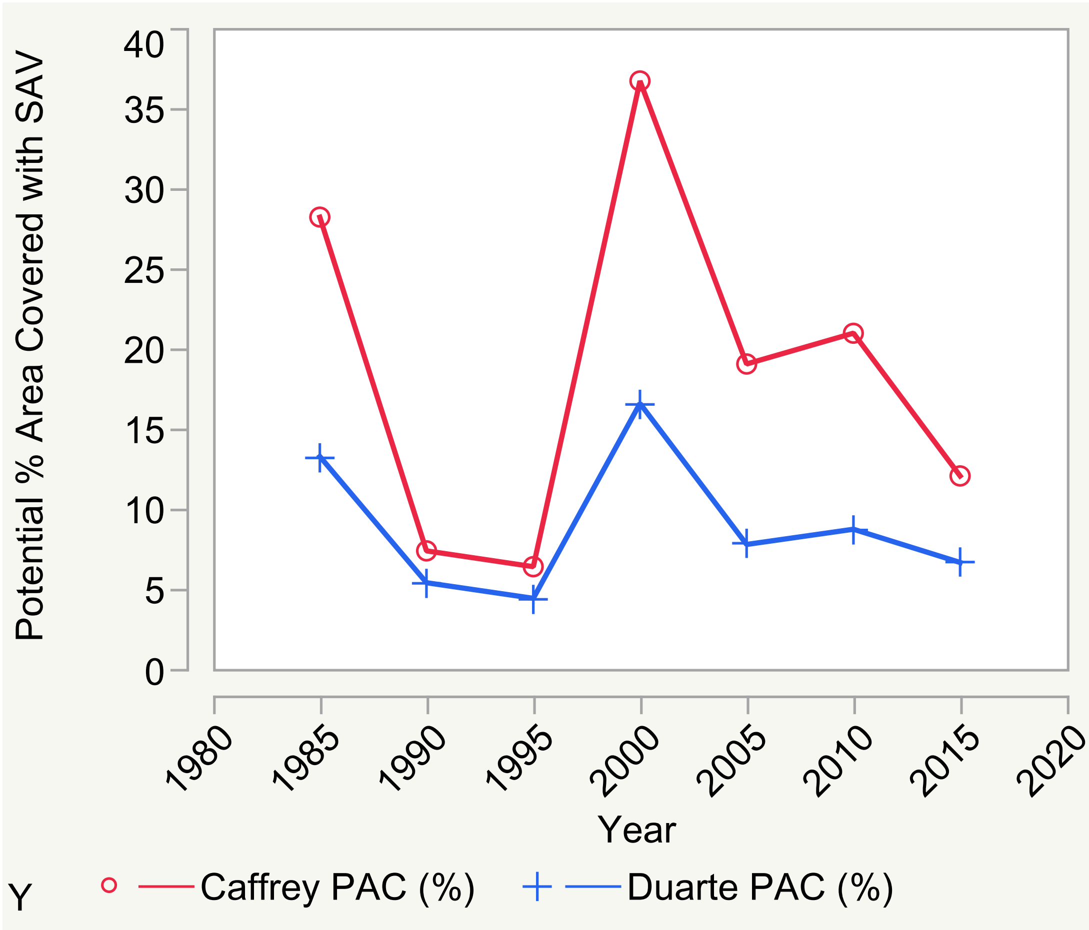

Figure 4. Estimates of the potential surface area covered with submersed aquatic vegetation in Lake Apopka assuming light is the limiting factor for aquatic plant abundance. The estimates were calculated using the following two different published models relating Secchi depth to maximum depth of plant colonization:

Caffrey, A. J., M. V. Hoyer, and D. E. Canfield. 2007. Factors affecting the maximum depth of colonization by submersed macrophytes in Florida lakes. Lake and Reservoir Management 23: 287-297.

Duarte, C. M. and J. Kalff. 1987. Latitudinal influences on the depths of maximum colonization and maximum biomass of submerged angiosperms in lakes. Can. J. Fish. Aquat. Sci. 44:1759-1764.

Literature Cited

Bachmann R. W., M. V. Hoyer, and D. E. Canfield, Jr. 1999. The restoration of Lake Apopka in relation to alternative stable states. Hydrobiologia. 394: 219-232.

Canfield, D. E., Jr., and M. V. Hoyer. 1992. Relations between aquatic macrophytes and the limnology and fisheries of Florida lakes. Final Report. Bureau of Aquatic Plant Management, Florida Department of Natural Resources, Tallahassee, Florida.

Coveny M. F. 2016. Impacts of reduced phosphorus loading and droughts on water quality in Lake Apopka. Oral Presentation at FLMS Annual Meeting.

Conrow, R. and J. Peterson. 2000. A panel atlas of the major aquatic plants of Lake Apopka, Florida using global positioning (GPS) and geographic information (GIS) Systems. Technical memorandum no. 37. SJRWMD, Palatka, FL. 69 p.

Caffrey, A. J., M. V. Hoyer, and D. E. Canfield. 2007. Factors affecting the maximum depth of colonization by submersed macrophytes in Florida lakes. Lake and Reservoir Management 23: 287-297.

Danek, D. J. and M. S. Tomlinson. 1989. Bathymetric analysis of Lake Apopka. Project 10-150-01. St. Johns River Water Management District, Palatka, FL.

Duarte, C. M. and J. Kalff. 1987. Latitudinal influences on the depths of maximum colonization and maximum biomass of submerged angiosperms in lakes. Can. J. Fish. Aquat. Sci. 44:1759-1764.

Greening, H. S., L. M. Cross, and E. T. Sherwood. 2011. A multiscale approach to seagrass recovery in Tampa Bay, Florida. Ecological Restoration 29:82-93.

Murphy, S. J. 2005. Assessment of fish and plant communities in Lake Apopka, Florida. M.S. Thesis, University of Florida, Gainesville, FL. 62 p.