Pros and Cons of Issues Identified by Citizens and Professionals Regarding the Future Management of the Forest Hills Lakes

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Sponsored by:

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Introduction

Dear Participant:

We at Florida LAKEWATCH recognize that lake management is part science and part politics. These are two professions that the everyday citizens sometimes fear to involve themselves with. Why? Well-educated professionals practice science and citizens often feel threatened by scientists because the scientists often talk using words the everyday person cannot understand. The citizen, however, practices science in some form everyday through the making of daily decisions. People typically think only elected officials practice politics, but politics is also practiced by virtually everyone. Science and politics are prevalent in virtually every form of human interaction and they are how the compromises of life are reached. For many individuals, however, the scientific and political processes are considered to be very different. There are indeed many differences, but there is one commonality -- people!

The importance of people in lake management rests on the singular fact that all people regardless of whether they are directly involved in the scientific or political processes have opinions. When beginning the formulation of a lake management plan, all opinions must be considered valid. Overtime, as facts become better known, opinions will change. The importance level of individual problems may also change over time, depending on the social, economic and political attitudes of the day. Consequently, any lake management plan must be considered a "living document," just like the constitution of United States.

On September 24, 2005, a workshop was held to determine citizens' concerns regarding the future management of the Forest Hills Lakes. A representative group of citizens was assembled to advance their concerns/opinions regarding potential problems at the Forest Hills Lakes (see Appendix I). This effort yielded a report listing and prioritizing the following five major issues that the citizens felt where most important to the management of the Forest Hills lakes:

Citizen Issues

1. Hydrology
   -How water moves lake to lake
2. Monitoring
   -Water quality
   -Plants
   -Fish
   -Wildlife
   -Trends
3. Environmental Education
4. Muck/Aquatic Plants
5. Who is in Charge?
   -Who caused the problems?
   -Who will fix the problems?
   -Who pays for it?

We subsequently gathered existing data, collected some new information, and assembled scientists and other professionals with direct knowledge of the major issues advanced to discuss the facts as best known at this time.

The document that you are receiving represents a compilation of the available information. We recognize that there is a tremendous amount of reading material. Please do not be discouraged or frightened by the amount of material. You have been given a summary of the available information related to each issue. Following this information, some viable options are given for the management of the Forest Hills Lakes. In September, you will be meeting with your fellow citizens to discuss the options and advance your ideas about how to manage the Forest Hills Lakes.

You should remember that it is not always possible for science to give absolute answers in a given time, especially considering the large natural variability accompanying most ecological processes involved with lake management. Sometimes

scientific answers even take centuries to evolve. Given this uncertainty, you will be trying to provide the best available approaches known at this time. This does not mean that there will not be opposing views regarding the right approach. Your job will be to find out where the compromises exist.

When there are opposing views as to the approach that should be taken, it should be remembered that these concerns could be monitored in the future to determine if they are correct. Lakes are very resilient and corrections in the management plan can be made in the future if need be. Even at this time, there are scientific studies underway to provide better information on certain issues. Do not allow yourself to become trapped in the "Do Nothing" option. This option is often the worst thing that can be done for your lake. There are, of course, times when doing nothing is a correct choice. However, it is generally best to consider different views as hypotheses that can be tested in the future. If a particular view is correct then changes in the management plan can be made at a later date. This allows all opinions to remain valid until the facts convince the community that the opinions or concerns are no longer valid. Again, it is extremely important to remember that a lake management plan is a "living document".

Section 1 - Who is in Charge Here?

The citizens involved in Phase 1 of developing the Forest Hills Lakes Management Plan prioritized the “who is in charge” question last in their list of issues. We, however, are addressing this issue first because it is the most frequently asked question by citizens attempting to develop a management plan that addresses complex issues and needs monetary resources. Also, the successful implementation of an effective lake management plan requires an agreed upon format for information flow and advocacy within the various bureaucracies. Someone or some group needs to shepherd the plan in order for it to work and be effective!

The "who is in charge here" question gets asked by citizens because there are a myriad of federal, state, and local agencies that have statutory responsibilities in the arena of lake management. There are also a host of judicial questions that revolve around whether the lake is public or private. And as mentioned above, there is always the question of who pays. To the everyday citizen, the interaction among agencies seems to be similar to a giant bowl of spaghetti. There seems to be no beginning and no end, and there certainly seems to be no timely answer to their questions.

The agencies are doing nothing wrong and they do not have a lack of caring. Committed public employees staff the agencies, but the agencies are also following statutory requirements and agency policy. Unfortunately, the bureaucracy can lead to intense citizen frustration. Consequently, it is very important for the involved citizen to understand history as it relates to lake management. So, let us begin with history.

Who is in charge here? The answer to this question was simple prior to the United States becoming a sovereign nation or Florida joining the Union. The king or queen was! Royalty once considered themselves owners of all natural resources. After the American Revolution, the courts struck down the exclusive rights previously given royalty and all the rights and responsibility of being the trustee of public resources was transferred to state governments (States Rights!!!). The question of how a public trustee should treat a lake, including its fisheries and wildlife, has been answered by a tradition as old as government itself; most lakes (but not private waters) are common property. Common properties are those resources owned by the entire populace, without restriction on who may use them and, at least in earlier times, on how they may be

used. People have found the common property principal to be a good one, at least under certain circumstances.

Water played the dominant role in the settlement of the western United States and Florida. Water was a liquid highway for transporting people and goods. At the federal level, involvement in water resource management essentially began with the U.S. Army Corps of Engineers. In the mid-1820s, the U.S. Army Corps of Engineers under the guise of improving national defense began digging canals and deepening river channels. While these efforts were important to national defense, they were the key to economic development. By the 1890s, the Corps had assumed additional responsibilities, including the control of aquatic plants (primarily water hyacinth) in the waters of the Southeast. Since then, water development projects have been a dominant feature in U.S. domestic policy and the Corps oversees many of these projects. As a result of these efforts and passage of federal statutes such as the National Environmental Policy Act and the Fish and Wildlife Coordination Act, the Corps has been given immense regulatory and oversight responsibilities (the Corps reviews and then accepts or rejects permits related to water movement or dredging).

In the late 19th century, the conservation movement was born. The federal government in 1871 created the U.S. Fish Commission, a forerunner of the U.S. Department of Interior' s Fish and Wildlife Service. The Commission was originally created for the purpose of investigating the decline in commercial fisheries. After short time, the Commission was charged with the task of raising fish and distributing them throughout the United States for the promotion of commercial fisheries. While conservation was a concern, economic development and sustainability were very important. With the rise of the U.S. Fish and Wildlife Service, considerable research was done on fish and wildlife. Ideas on how to manage these animal populations emerged and the States began to create their own fish and wildlife agencies. This allowed the U.S. Fish and Wildlife Service to transition into a more regulatory/oversight role.

By the 1960s, concern for the environment began to emerge as a political concern. Numerous federal statutes were created including the Endangered Species Act, the Clean Water Act, the National Environmental Policy Act, and the Fish and Wildlife Coordination Act. The U.S. Environmental Protection Agency was also formed in the 1970s. All these actions brought greater protection to the environment, but also brought

more rules and regulations at the federal level. The States to a large degree have to abide by these rules and regulations too!

At the state level, economic development was the primary concern in the 19th and early 20th centuries. For example, Florida's government prior to 1850 sought to encourage settlement by offering land to anyone who would establish a homestead and defend it for five years. Transportation, however, was the great problem of early farmers and how to get their products to market became a major concern for many of Florida's communities. Florida responded by creating the Board of Trustees of the Florida Internal Improvement Fund. The Board of Trustees implemented programs to create canals and drain wetlands, including lands around lakes. They also helped sell the drained lands. It is important to remember that Florida was an extremely poor state at that time and economic development was needed for the betterment of all Floridians.

By the early 20th century, states like Florida began establishing their own fisheries and wildlife agencies for the purpose of research, management, and regulating the take of fish and wildlife. Regulations by agencies such as the Florida Fish and Wildlife Conservation Commission increased dramatically. Regulations of fish-catching methods, however, were usually politically motivated and designed to restrict the effectiveness of some people while enhancing that of others. Therefore, political involvement caused many state fish and wildlife agencies to become constitutional agencies; hence the Florida Fish and Wildlife Conservation Commission is a constitutional agency.

Despite increased regulatory power and federal funding, state fish and wildlife agencies continued to be embroiled in controversies that affected the economic well being of many people. One of the most controversial issues involved the take of fish by commercial fishermen and recreational anglers. Overtime, commercial fishermen in states like Florida were largely displaced from the freshwater lakes by recreational anglers. Society had determined that fish in lakes were more valuable to the developing recreational interests. This change by itself might not have seemed important to many individuals but began to affect the common properties principal. States as the public trustee of fish and wildlife could now allocate resources to specific groups and decide which waters were under their jurisdiction (public agencies began excluding private waters).

Concern about the environment not only influenced federal law after the 1960s, but the states responded too. For example, Florida with its increased economic wealth developed many environmental regulation organizations. These included the Department of Natural Resources and the Department Environmental Regulation. Florida further created five water management districts, including the Southwest Florida Water Management District, with constitutional authority over water. Local governments that had sufficient economic resources also created environmental departments with their own regulations and policy. Given these developments and the passage of so many new environmental laws with their associated rules and regulations, many individuals thought environmental issues would go away. Unfortunately, this has not been the case because there are many conflicts yet to be resolved!

Many natural resource managers and the public believe the law is the law and it remains static unless a new law is passed. They also believe the many rules and regulations passed by agencies are also static law. Agencies, therefore, are considered to be the enforcers of clear rules. Thus, any legal problem must be seen as cut and dried. The police power of the federal, state and local governments means that they can abridge the rights of private property owners in order to protect natural resources, but only under certain circumstances. The seriousness of abridging the rights of any individual is taken very seriously by the judicial system. Consequently, the law is not a set of static principles. It is dynamic and sets the rules for resolving conflicts. The courts provide a formal remedy only when conflicts cannot be resolved outside the judicial system.

It is the conflict-resolution process that most natural resource managers and the everyday citizen find most uncomfortable. When serious situations arise, the conflict-resolution process is generally passed to lawyers. The lawyers recognize that the law is dynamic and arguments can be made within the judicial system to change the law. However, most lawyers will try to negotiate a settlement outside of the courts!

There are many ways in which law impacts lake management. Four of the most important, as described by Berton Lamb and Beth Coughlan (1993) in their article "Legal Considerations in Inland Fisheries Management," are: (1) prescribing rules of conflict, (2) balancing the powers of government branches, (3) finding the powers of

central government, and (4) describing the boundary between legal and political issues. For many public employees and concerned citizens, they will not end up in court when conflicts arise. They will participate in negotiations and enforcement actions outside the courtroom. The law does more than just guide conflict into the judicial system. It helps set the behavior of agencies, their missions, and their powers, as well as constrained their actions. The law also balances power between the legislative and executive branches of government. These two branches of government have a dynamic equilibrium that works itself out over time and which branch has the most power at any given time may be hard to determine until court action takes place. The third major impact of law defines the power given to the central government versus the states. Here the Constitution defines basic government powers, but again there is always the struggle between the states and the federal government. The fourth major impact is deciding what is a legal question and what is political. In the United States, everything is open to debate, but some things are regarded to be beyond partisan politics. For example, there is no longer any serious debate that fish and wildlife populations are largely under the control of state governments.

There are some important legal doctrines that need to be considered when developing the lake management plan. One of these doctrines is the Riparian Doctrine. This doctrine simply states that persons owning land that abuts a water body have the right to use the water. Persons whose land does not abut the waterbody have no right and typically must rely on groundwater. During times of scarcity, however, there must be reasonable use. Another important doctrine is the Public Trust Doctrine. The government has trust responsibilities for the management of natural resources. In some jurisdictions, these responsibilities include the protection of fish and wildlife habitat, wetlands, access, and aesthetic characteristics. Failure to consider the Public Trust Doctrine may result in a court reversing a management decision even after the decision was made years ago. One of the most important doctrines is “The Taking of Private Property.” The Constitution of United States provides that the government cannot take private property without just compensation under due process of law. Property rights stand for a host of legal doctrines and policies that essentially tell landowners what they can or cannot do with their property. In as much as legislation protecting wetlands, rivers, and other environmental values are becoming commonplace, the principal of private property rights remains in the state of flux.

A final concern for individuals trying to develop a lake management plan is an understanding of politics. In the 2000s, politics is often not viewed in a favorable light. Politics, however, is an honorable pursuit. It is often remarked, "politics is the art of possible." Learning what can be done and how to accomplish management goals is a key to the political art. Working with elected leaders is perhaps one of the most important things concerned citizens can do!

One of the first tasks for concerned citizen is becoming involved in the process of selecting good leaders. This means becoming involved in electoral politics. Once a person is elected to office, they still need the help of concerned citizens and natural resource managers. It is extremely important to work with elected officials to help them understand the issues. It is also extremely important to remember that the implementation of politics requires a unique skill. The political arena deals with the process of working out how statutes will be administered by the executive branch. Because a law is passed, even what seems to be a clearly stated law, there still may be considerable interagency bargaining to implement the law. The bottom line is that the establishment of a lake management plan does not end citizen involvement. Concerned citizens must remain actively involved and always remember a lake management plan is a "living doctrine."

So what does this mean to the citizens helping develop the Forest Hills Lake Management Plan? First, the electors of Hillsborough County were granted the power in 1966 to adopt a charter for government, the “Home Rule Charter.” Home Rule was adopted by the voters in 1985. Establishment of home rule permits Hillsborough County to exercise any and all powers for county and municipal purposes the Florida constitution or the legislature, by general, special or local law, has conferred upon Hillsborough County or any municipality therein. For lake management issues, the “Home Rule Charter” clearly means citizens need to first engage Hillsborough County Commissioners or their designees (for example, the Hillsborough County Public Works Department) before trying to navigate state and federal bureaucracies. The Commissioners or their designees may not be able to fix the problem right away, but they should know who to call and who to best negotiate with.

Second, the Florida Legislature established in 1995 the Hillsborough County Port District, which comprised and included all of the territory within Hillsborough County.

Within the 1995 legislation, the Legislature conveyed all state-owned submerged lands within Hillsborough County to the Port District. Title to, right of entry upon, and the right to regulate the improvement of any and all submerged lands (your lake bottoms) belonging to the State of Florida contained within the Port District were granted to the Tampa Port authority (TPA), subject to the riparian rights of the respective owners of the uplands adjacent the submerged lands. No submerged lands owned by TPA can be sold or leased or otherwise disposed of by the TPA to any party or parties other than the owner or owners of the uplands adjacent thereof unless approved by the majority of qualified electors in the Port District. In the Forest Hills lakes, TPA claims no title to any of the lakes. While the courts might rule differently, the “no claim” decision effectively makes the Forest Hills lakes private lakes!

The Forest Hills lakes are also viewed by most federal and state agencies as private lakes because of their small size and lack of public access. What this means in practical terms, is the citizens living around the Forest Hills lakes cannot expect federal or state money to be expended on the lakes. The agencies, however, retain the regulatory authority and require permits for many activities. For example, the Florida Department of Environmental Protection and the Florida Fish and Wildlife Conservation Commission are stewards of the aquatic plants, fish, and wildlife that inhabit the Forest Hills lakes. Any lake management activity, that might affect these biological components of the lakes, needs to be permitted. In general, the permit is issued to the individual riparian landowner. This is done to insure the rights of any riparian landowner who might object to the activity on their land (for example, use of herbicides). However, a lake-wide permit will be issued for the lake if something was to happen (for example, herbicides or grass carp for hydrilla control) that would affect the entire lake.

Section 1 - Management Options

Option I - Select a lead lake management agency from existing public resource agencies with responsibilities in the arena of lake management.

When a lake management plan is developed, there will be a strong need for a lead agency to implement the plan unless there is strong riparian ownership involvement. Despite perceptions, the federal, state, and local agencies involved at the Forest Hills lakes have reasonably good to excellent working

relations. Each agency, however, focuses on its own regulatory or work responsibilities. Without citizen guidance as to who should lead, no one agency can be expected to step out to provide the necessary leadership.

Any Federal agencies with regulatory authority at the Forest Hills lakes are probably not a good choice to be the lead agency. These agencies have responsibilities way beyond the Forest Hills lakes and cannot provide the intense local involvement necessary. Plus, they would not accept the responsibility. The choice must be made between a state agency and a local agency.

Among the state agencies, the choice seems to be between the Florida Department of Environmental Protection, the Florida Game and Fresh Water Fish Commission, and the Southwest Florida Water Management District. The Department of Environmental Protection is involved most intensely in the management of aquatic vegetation, but their involvement is limited to the issuance of permits. The Florida Fish and Wildlife Conservation Commission has virtually no or limited involvement at the Forest Hills lakes because fish and game populations are not considered to be in bad shape and the lakes are considered to be private lakes. The Commission also has very limited staff and financial resources to commit to the management of private lakes and therefore limit their involvement to permitting. The Southwest Florida Water Management District at this time is primarily involved in setting minimum lake levels for lakes in their region or overseeing permit applications. While all three of these agencies can be worked with to accomplish some lake management activities that the citizens discussed in phase one of the development of a lake management plan for the Forest Hills lakes, it is unlikely that they would have the resources or desire to lead and shepherd the plan.

Given the “Home Rule Charter”, the logical choice of local agencies would either be the Hillsborough Environmental Protection Commission (EPC) or the Hillsborough County Public Works Department’s Stormwater Management Section. The EPC probably would not be a good choice because of their regulatory responsibility. The Stormwater Management Section would be a

good choice under one condition. The Section has a lake coordinator on staff that could work with the citizens living on the Forest Hills lakes, but the Section does not have the financial resources to deal with many potential lake management issues. Selection of the Stormwater Management Section as the lead lake management agency at the Forest Hills lakes will need the support and concurrence of the Hillsborough County Commission. Homes around lakes in Hillsborough County represent a tremendous tax base so the Commission should be approached on the basis of establishing the Stormwater Management Section, with funding, as the lead lake management agency throughout the County. With sufficient and additional funding, the Section would have the resources, including knowledgeable staff, to lead and shepherd lake management plans. The Section would also be a logical agency because it must consider hydrology throughout the County to provide for the management of stormwater. Hydrology is a key component of any lake management plan.

Option II – Establish the Forest Hills Special Tax District with a governing board selected from riparian owners around the Forest Hills lakes.

The total assessed value of property surrounding the Forest Hills lakes is about $31,000,000 with the average assessment value per property being about $132,000 (Table 1). Owners around the Forest Hills lakes, therefore, have a tremendous investment, based in part on the lakes, that needs to be properly taken care of through management activities. While owners may pay for lawn care services or other non-government services, there is no dedicated fund for lake management. In this situation and when there is clear evidence that the citizens wish to control the destiny of their lakes, there is an old saying that applies to the Forest Hills lakes - “ He Who Controls the Gold Rules the World!”

It is clear from numerous discussions the Forest Hill lakes are considered private lakes and the ability of agencies outside Hillsborough County to direct tax dollars to these lakes in order to solve problems is extremely limited. Hillsborough County Commissioners could redirect some tax dollars to the

lakes, but other lakes in the County would want similar treatment and it is unclear if the County Commission would wish to allocate sufficient funds for a county-wide lake management group when the benefits would be viewed as applying to a select few.

The Hillsborough County Commissioners could by their actions establish a Forest Hills Special Tax District with tax revenues dedicated to the management of the Forest Hills lakes. A special taxing district could raise funds by assessing a fee on the lake bottoms adjacent to each riparian owner. The Property Appraiser, using existing tools, could assign each property owner their fair share of the lake bottom, levy an appropriate amount of tax determined by the Special Tax District's governing board, and transfer the monies to the District's governing board, whose members would be elected from Forest Hills lake riparian owners.

The primary advantage of establishing an official taxing district with a governing board elected from riparian owners is it would give greater power to citizens regarding the management of their private lakes. A governing board with a member from each of the Forest Hills lakes would be an ideal governing board for a special tax district as the concerns of citizens on each lake could be addressed within an acceptable frame-work and in a timely manner. Problems that arise at lakes often occur suddenly and unexpectedly. The Special Tax District would have the authority to establish a "rainy day fund" critical to meeting future challenges.

Citizens typically do not want to support new taxes. A special tax district governed by riparian owners from the Forest Hills lakes can established limits on the taxing district's operating budget and surplus reserve. Once the needed money is raised, The District's governing board can direct the Property Appraiser to reduce millage rates. If the governing board decided by vote to increase millage rates because a major problem has surfaced, tax rates could also be increased.

An advantage of having an established operating budget and a surplus reserve fund is the fact that the District could partner with various agencies to

accomplish specific lake management tasks. Often times, a taxing district that can share the financial burden of a given lake management activity to get the work accomplished much more quickly by an agency, get matching dollars, or at least enlist technical assistance at no or minimal cost.

Option III - Select the North Forest Hills Neighborhood Association, INC. as the lead lake management group with a governing board composed of one Individual elected from each lake.

The North Forest Hills Neighborhood Association INC. is a viable organization with a well-defined interest in the lakes of the area. The Association could step up to become the lead organization much like the Special Tax District, but needs to make sure all riparian owners would share the burden of managing the lakes. The Association should establish a special Lake's Committee composed of one resident from each lake to lead the lake management efforts at the different lakes (each lake will likely have management objective based on use). Much like the governing board of the special taxing district the lake, the Committee could determine an assessment each riparian owner should contribute to manage the lakes. The Association members could vote in caps on the operating budget and the surplus reserve fund. By controlling all the money the members would have the power, but they may find it difficult to partner with public agencies because of the private designation of the lakes.

Another advantage of establishing the North Forest Hills Neighborhood Association INC. as the lead lake management organization is in the area of communication. The Association could provide public agencies with a single point of contact that they could call before any projects were implemented on the Forest Hill lakes. The Association could establish a communication network where at least one individual is the contact for each lake. Having knowledge of pending action would permit the Association to discuss pertinent issues in a timely manner and then speak as one voice. By providing information pipeline to individuals living alongside the lakes miscommunication would be limited.

The North Forest Hills Neighborhood Association INC. should also establish an Advisory Committee to work directly with the Hillsborough County Commission or other parties involved in local lake issues. The Advisory Board would probably be most effective in today's political climate at the Forest Hill Lakes if it were constituted with a member from each lake. The members would then reflect the diversity of users and provide elected officials or action agencies with relevant advice, It is suggested that a representative from the Hillsborough Environmental Commission and the Stormwater Management Section of the Hillsborough County Public Works Department serve as non-voting adjunct members to facilitate information transfer. As a former Speaker of the U.S. House of Representatives once said, “All Politics are Local!” so the Neighborhood Association must engage for the long-term good of the lakes and for the protection of long-term property values.

Section 2 - Hydrology

The project that triggered concerns for the development of a comprehensive Forest Hills Lakes Management Plan was the implementation of a Forest Hills stormwater management program by the Stormwater Management Section of the Hillsborough County Public Works Department. What to do with stormwater has been a challenge for Hillsborough County since the County was established in 1834. Stormwater management has also traditionally been controversial and governmental action typically only takes place when dictated by the population of the County and climatic conditions. The population of Hillsborough County has grown tremendously since 1900 (Table 1).

Table 1. Population of Hillsborough County as estimated by the U.S. Census Bureau.

Year	Number of Individuals
2004	1,101,261
1990	834,054
1980	646,960
1970	490,265
1960	397,788
1950	249,894
1940	180,148
1930	153,519
1920	88,257
1910	78,374
1900	36,013

At the turn of the 20th century, the County's population was only 36013, but by 2004 the population had grown to 1,101,261 individuals. In 1960, the population of Hillsborough County was about 400,000. About that time, the United States Geological Survey in cooperation with the Florida Geological Survey, Hillsborough County and the City of Tampa conducted an investigation and assessment of the water resources of Hillsborough County (Menke et al. 1961). The report noted that between 1900 and 1956

the area was hit by 29 hurricanes and that the heavy rainfall associated with the tropical disturbances had a major effect on the region's hydrology. The report also noted that as more people occupy the County pressure will be placed on governmental agencies to have drainage and flood-control works performed.

The need to have governmental drainage and flood-control works performed exists because land elevations of the majority of Hillsborough County are not that far above sea level (highest point is 160 feet at Keysville) and the land contours are relative flat (water does not run off very fast). More importantly, Hillsborough County averages 52.8 inches of rain per year with many years receiving over 60 inches per year (Table 2).

Table 2. Annual rainfall totals for Hillsborough County between 1915 and 2005.

Year	Inches	Year	Inches	Year	Inches	Year	Inches
1915	47.70	1931	48.49	1947	70.67	1963	52.78
1916	39.91	1932	43.88	1948	51.30	1964	55.81
1917	45.99	1933	59.14	1949	54.74	1965	54.09
1918	44.53	1934	54.77	1950	50.55	1966	48.59
1919	60.19	1935	51.74	1951	46.41	1967	44.62
1920	53.55	1936	52.85	1952	49.45	1968	53.57
1921	52.32	1937	56.44	1953	66.98	1969	61.31
1922	55.88	1938	45.88	1954	51.42	1970	43.06
1923	41.06	1939	57.34	1955	45.92	1971	56.28
1924	61.07	1940	43.30	1956	37.43	1972	48.21
1925	62.07	1941	56.75	1957	68.90	1973	56.25
1926	54.72	1942	46.34	1958	56.57	1974	46.31
1927	37.93	1943	54.23	**1959**	**80.69**	1975	53.16
1928	58.70	1944	40.61	1960	70.04	1976	46.91
1929	59.39	1945	62.11	1961	38.10	1977	46.03
1930	60.02	1946	48.54	1962	52.10	1978	48.12

Table 2. Annual rainfall totals (Continued).

Year	Inches	Year	Inches	Year	Inches
1979	66.67	1991	50.95	2003	54.68

1980	48.04	1992	49.89	2004	70.51
1981	46.64	1993	47.27	2005	56.33
1982	59.27	1994	56.03		
1983	68.32	1995	55.29		
1984	42.56	1996	47.86		
1985	47.37	1997	67.76		
1986	51.58	1998	57.35		
1987	56.42	1999	48.96		
1988	58.48	**2000**	**34.11**		
1989	44.87	2001	47.36		
1990	38.75	2002	67.31		

In 1959, Hillsborough County received 80.69 inches of rain, but it is not always the annual rainfall that aggravates drainage and flooding problems. The cumulative rainfall over years can become the biggest problem as periods of above average rainfall saturate soils (Table 2). For example, rainfall in 1959 (80.69 inches) and 1960 (70.04 inches; the year of Hurricane Donna) resulted in an additional 45.13 inches of rain falling on the County. This extra water cause the initiation of many drainage and flood control projects and resulted in the formation of what today is known as Florida's water management districts.

In the case of the Forest Hills lakes, the stormwater management project of concern was initiated after 67.76 inches of rain fell in 1997 and 57.35 inches fell in 1998 (Table 2). During the El Nino weather pattern, Hillsborough County received an additional 19.51 inches, which resulted in significant flooding in the Forest Hills area (HBOCC 2004). According to records from the Public Works Department, Round Pond overflowed onto Veronica Avenue, Round Pond Avenue, and Rome Avenue. Round Pond also flooded surrounding properties. Lake Sophia rose to water levels that flooded Pond Lake Drive, Rome Avenue and surrounding properties. The water in Pine Lake rose to levels where septic fields were flooded. Pine Pond flooded surrounding properties and Noreast Drive before overflowing into Noreast Lake. The Public Works Department had to conduct 24 hour-a-day pumping to help provide relief to the affected areas (HBOCC 2004).

To reduce the risk of flooding, the Public Works Department implemented a series of stormwater capital improvement projects (total cost - $613,447). The primary focus was to reduce the flooding of Rome Avenue by improving the storage capacity of Round Pond and Lake Sophia. Discharge from these lakes would then be piped to Pine Lake. At Pine Lake, a water control structure was built to regulate the flow of water from a high-water Pine Lake and a pipe was installed to reestablish an existing connection between Pine Lake and Pine Pond. From Pine Pond, another pipe was established to remove high water to Noreast Lake where Noreast Lake's outlet pipe would convey the stormwater to Curiosity Creek.

During the permitting process, the Hillsborough County Environmental Protection Commission and the Southwest Florida Water Management District sought assurances that efforts would be made to provide in-lake treatments to minimize impacts on water quality. The Public Works Department included work on the littoral zones at Round Lake, Lake Sophia, and Pine Pond to minimize any adverse impacts from the stormwater project on these waters as well as Pine Lake and Noreast Lake (HBOCC 2004). Six months after the completion of the project, a major algal bloom occurred on Noreast Lake (see water quality section), which generated concern over the impact on water quality of the stormwater project (HBOCC 2004).

As just noted above, the 1997-98 El Nino weather pattern caused significant flooding in the Forest Hills area. While attention has focused on the impact of stormwater on the quality of the Forest Hills lakes since the Noreast algal bloom in 2004, Hillsborough County only received 34,11 inches of rain in 2000 (Table 2). Menke et al. (1961) commented that surface–water problems in Hillsborough County are caused by the distribution of water during three basic relative conditions – low water, medium water, and floods. Flooding becomes a problem of eliminating excess water, but the low water and medium water conditions relate to Hillsborough County's need to maintain aquifer recharge. In Hillsborough County, lack of adequate surface recharge can result in salt-water intrusion to groundwater. Consequently, retarding the loss of excess rainfall by holding water in lakes or wetlands can greatly improve regional aquifer recharge. Therefore, government agencies have to strike a balance to meet the needs and protect the greatest number of citizens possible!

Section 2 - Management Options

Option I – The "Do Nothing Option".

The Public Works Department implemented a series of stormwater capital improvement projects (total cost - $613,447) to reduce flooding risks in the Forest Hills area. Flooding did not occur following completion of the project and 70.51 inches of rain in 2004. Thus, the project can be deemed successful if flood mitigation is the concern. However, flooding can still occur under the "right" rainfall conditions.

Many lake management professionals working on urban/suburban lakes often deem non-point source pollution by stormwater the greatest threat to lake water quality. There, however, still remains considerable debate about non-point source pollution because many lakes do not seem to respond adversely on the long-term to nutrient enrichment (Terrell et al. 2000). Specifically, the increased nutrient concentrations or decreased water clarity, that is often speculated to occur with population growth and watershed *development* have not been documented for many Florida lakes.

If the stormwater capital improvement projects have caused negative limnological changes (e.g., algal blooms at Noreast Lake) in the Forest Hills lakes, the changes have been short term (see monitoring section). Available water quality information suggests the lakes are functioning as they were prior to the construction projects. If the analyses of Terrell et al. (2000) about the long-term effects of population growth and watershed development on nutrient concentrations and water clarity are correct, the *"Do Nothing Option"* becomes more viable at this point in time. The option becomes very viable if long-term monitoring of the lakes is implemented.

Monitoring with LAKEWATCH volunteers is cost-effective and the information collected can point to viable, cost-effective mitigative actions to quickly resolve problems. It is also possible that the monitoring and mitagative actions could be budgeted by the Hillsborough Public Works Department not only for the Forest Hills lakes, but other Hillsborough County lakes. This

would provide Hillsborough County with a monitoring program that could be easily moved into a problem-solving mode.

Option II – Reroute stormwater inputs from the Forest Hills lakes.

The series of stormwater capital improvement projects implemented by the Public Works Department to reduce flooding risks in the Forest Hills area cost $613,447. Rerouting stormwater inputs from the lakes now is feasible from the engineering standpoint, but rerouting would have significant costs associated with it. Other types of projects such as large French drains under the roads have been used in other cities such as the City of Orlando, but such projects would involve disrupting road traffic, expensive construction projects and significant long-term maintenance costs. Taxes would increase.

Flooding did not occur in the Forest Hills area following completion of the capital improvement projects and 70.51 inches of rain in 2004. If total costs are a concern, the water leaving Pine Lake and Pine Pond could be piped around Noreast Lake to Noreast Lake's outlet pipe, but there are less expensive alternatives. It should also be remembered that water currently flows from Noreast Lake into Pine Pond under certain hydrological conditions and then reverses flow so specific attention will have to be paid to Pine Pond to alleviate potential problems. Overall, this management option seems to be less viable then other management strategies used either alone or in combination.

Option III. Consider Applying Alum to Tie Up Nutrients in the Lakes.

Alum (aluminum sulfate) is a material routinely used for water clarification and phosphorus inactivation. Typically alum is used in very productive lakes with algal problems. Hillsborough County has used alum as a phosphorus-inactivator at select productive lakes with mixed results (i.e., short duration of treatment). Most of the Forest Hills lakes are not in the highly productive category so the objective would not be providing extremely clear water for a

long-time frame. The primary objective would be to enhance the ability of bottom sediments to bind phosphorus and reduce internal phosphorus recycling. The alum application should provide an insurance against long-term increases in in-lake phosphorus concentrations resulting from stormwater inputs.

If the decision is made not to alter stormwater drainage, the application of alum is an approach that could be incorporated into Hillsborough County Stormwater Management Section's operational protocol and budget. Alum can be applied safely in the Forest Hills lakes and a long-term benefit for algal control of 5 to 10 years would most likely be gained. If this approach is linked to the construction of deep areas in each lake, the alum and bound phosphorus would move overtime to areas where it could be removed along with accumulating sediments and organic matter. Applying alum once every ten years is relatively inexpensive and offers the best insurance against a slow and progressive increase in in-lake phosphorus concentrations.

Option IV – Provide alum treatment to Pine Pond.

Pine Pond is a small lake and the primary source of concern for many residents around Noreast Lake. Pine Pond has a high average total phosphorus concentration (41µg/L) compared to Noreast Lake (25 µg/L). Given the small size of this lake alum treatment is an extremely viable management approach. If the citizens decide they do not want alum in all lakes because of costs, focusing on Pine Pond would provide a very cost-effective for reducing phosphorus inputs to Noreast Lake.

There are of course other small lakes like Mid Lake that could benefit from the use of alum. Selection of alum as a lake management strategy for managing stormwater phosphorus and sediment inputs may be extremely viable because the Hillsborough County Public Works Department can fund such work and they have done so at other lakes within the county.

Option V - Dredge and Remove Sediments in Front of Some or All Stormwater Pipes Entering the Forest Hills Lakes.

Sediment deposition from stormwater pipes is execrating the filling in of Lake some lakes suggesting that the removal of all of these sediments would reverse this trend. Creation of deep holes off the pipes would effectively trap sediments and provide a location where sediments could be easily removed in the future. A shallow underwater area where aquatic emergent aquatic plants like bulrush could grow could front each hole. These plants would become habitat for fish and aquatic birds, but they would also trap any floating debris before it could enter the lake proper.

Removing sediments from the points of entry would remove considerable quantities of nutrients. These sediments could be directly transported to the county landfill where soil is always needed for covering trash. Placement of the sediments in the landfill also eliminates any disposal contamination issues.

Section 3 – Monitoring

The events that triggered concerns for the development of a comprehensive Forest Hills Lakes Management Plan were two major algal blooms that occurred during 2004 in Noreast Lake (Figure 1). The Florida LAKEWATCH volunteer on Noreast Lake collected water samples having chlorophyll concentrations (an index to algal biomass) in excess of 40 µg/L during March and September 2004. The March algal bloom occurred approximately six months after the stormwater project implemented by the Public Works Department was essentially complete. The timing of the blooms led to concern that the blooms occurred because the project permitted stormwater from Pine Pond to enter Noreast Lake (HBOCC 2004). Shortly after the blooms, anglers on Noreast Lake also reported what they thought were leeches on largemouth bass, heightening concerns about the “health” of Noreast Lake and other Forest Hills lakes receiving stormwater.

Water Quality

Managing water quality in the Forest Hills lakes, as with all lakes, is a difficult objective because defining "water quality" itself is a difficult task. Water quality can only be defined after first establishing the desired use or uses for each waterbody. For example, a productive lake with a Secchi depth of three feet has poor water quality for swimmers who want to see the bottom of the lake as they swim. The same lake, however, would have good water quality to anglers because highly productive Florida lakes produce abundant fish (Bachmann et al. 1996). After determine the primary use or uses for the lake, it then require an identification of which specific water quality parameters should be monitored. This illustrates the primary difficulty in managing water quality at lakes in that a lake cannot be “all things to all people” and it is difficult for agencies to determine the specific water quality parameters to monitor. Consequently, when the goal is to improve the lake’s “health” it is important to ask for whom and for what!

The Forest Hills lakes are best described as private urbanized lakes where the riparian owners enjoy the lakes primarily for aesthetics and recreation. The Forest Hills lakes are part of the Land-o-Lakes Region, which is described as a sandy upland region with many lakes (Griffiths et al. 1997). A Lake Region represents an area of Florida where lakes have similar geology, soils, chemistry, biology and hydrology. Terrestrial vegetation in the Land-o-Lakes Region was originally dominated by longleaf pine and turkey oak, but the region was largely cleared for citrus groves and then residential development. The lakes typically are characterized as having low to moderate nutrient concentrations and relatively clear water.

Nutrients - Long-term Information (prior to 1980) on in-lake nutrient concentration are generally lacking for the Forest Hills lakes. This is also the case for most Florida lakes. In the mid-1990s, lakes like Eckles (June 1996; Figure 2) and Cedar (November 1996; Figure 3) joined the Florida LAKEWATCH program to begin monitoring monthly nutrient and algal (chlorophyll) concentrations. Noreast Lake joined LAKEWATCH in 2002 (Figure 1). What is clear from the available algal data (Figure 1, 2, and 3), Eckles, Cedar and Noreast have all experienced algal blooms (an algal bloom is defined as a chlorophyll concentration greater than 40 µg/L) during the period of record. The reason or reasons for the blooms are unknown.

The total phosphorus concentration (phosphorus is generally considered the primary limiting nutrient for algae) data available from LAKEWATCH for the Forest Hills lakes indicate average total phosphorus concentrations range from a high of 56 µg/L in Mid Lake to a low of 19 µg/L in Lake Dorsett (Table 3). These values are in the range reported by other professional agencies (e.g., Hillsborough Environmental Protection Commission; Hillsborough County Stormwater Management Section), thus indicating the lakes are moderately rich to rich with phosphorus. Noreast Lake has an average total phosphorus of 25 µg/L. Based on studies of lakes through North America and Florida (Brown et al. 2000), the maximum amount of chlorophyll that could develop in each lake if phosphorus were the sole limiting environmental factor exceeds 40 µg/L (defined as an algal bloom) at all lakes except Cedar East and Dorsett. Both of these lakes have predicted chlorophyll values of 38 µg/L, which is very close to the accepted

Table 3. Predicted maximum chlorophyll concentrations at the Forest Hills lakes using Florida LAKEWATCH total phosphorus data and the maximum chlorophyll/phosphorus equation from Brown et al. (2000). Estimated Percent of Time an algal bloom could occur are taken from Bachmann et al. (2003).

Lake	Total Phosphorus (µg/L)	Predicted Maximum Chlorophyll (µg/L)	Estimated Percent of Time Chlorophyll > 40 µg/L
Mid Lake	56	160	60
Pine Pond	41	106	35
Pine Lake	33	79	14
Cedar Lake	39	99	35
Cedar East	19	38	1
Cedar West	30	70	14
Eckles	29	67	13
Noreast	25	55	8
Dorsett	19	38	1

algal bloom value of 40 µg/L (Table 3). Based on this evidence, citizens at all the major Forest Hills lakes have the chance of encountering an algal bloom with the current levels of total phosphorus in the lakes.

Perhaps what is most disconcerting to homeowners is the fact that it is extremely difficult to predict the occurrence of an algal bloom or the factor or factors that caused the bloom. For example, Noreast Lake experienced two major algal blooms in 2004 (chlorophyll concentrations > 50 µg/L). These events were not in the experience of long-time residents. Did the stormwater project trigger the blooms or did other human or environmental factors (e.g., reported intense jet ski usage or hurricane impacts) trigger the blooms. Based on the long-term total phosphorus concentrations recorded (47 months), the residents at Noreast Lake could expect an algal bloom (chlorophyll > 40 µg/L) during 4 of the months of their sampling (Bachmann et al. 2003). So far blooms have only occurred in two months, which is well within the expected range for the measured total phosphorus concentrations. But, these findings do not rule out the possibility that the introduction of new stormwater to Noreast Lake was a triggering event for algal blooms.

The sporadic nature of algal blooms at Noreast Lake and other lakes in the Forest Hills suggests that stormwater runoff, while being one of many possible-contributing factors, is not the sole determinant of whether an algal bloom occurs. Other environmental factors such as aquatic macrophytes (see below for section on aquatic macrophytes) can influence the amount of algae in the water column. Examination of the Noreast Lake chlorophyll trend (Figure 1) also shows no algal blooms after 2004. Total phosphorus concentrations at Noreast Lake averaged 24 µg/L prior to the first algal bloom (February 2002 thru February 2004). Since the last algal bloom in September 2004, total phosphorus concentrations have averaged 25 µg/L (October 2004 thru December 2005), suggesting Noreast Lake now has the same total phosphorus concentration as it did before the first algal bloom. When other trophic state water quality parameters (i.e., total nitrogen, chlorophyll, and water clarity as measured by use of a Secchi Disc), environmental conditions are similar to those that existed prior to the first algal bloom. For example, total nitrogen concentrations averaged 773 µg/L prior to the blooms and 744 µg/L after the blooms. Chlorophyll concentrations and water clarity averaged 9.4 µg/L and 6.6 ft. respectively prior to the blooms and 8.5 µg/L and

7.1 ft. after the blooms.

The current conditions at Noreast Lake do not rule out the stormwater inputs in 2004 as triggering events for algal blooms, but they do suggest the lake is now functioning as it did before the first bloom. It should also be noted here that lakes have an assimilation capacity for nutrient inputs. Thus, the initial response of a lake to a perturbation like construction might cause an immediate and short-term adverse impact on algae, but the long-term impact may be negligible. This seems to be the scenario that is occurring at Noreast Lake as algal blooms (chlorophyll > 40 µg/L) have not occurred since 2004. The current and past water quality conditions also strongly indicate that removal of the stormwater inputs from Pine Pond *does not* eliminate the possibility of an algal bloom at Noreast Lake.

Bacteria concentrations and possible contamination - There are many possible sources of bacterial contamination in Florida lakes, but the sources can be grouped into three broad categories: human waste contamination, domestic animal waste contamination, and natural sources of contamination (i.e., aquatic birds). The disposal of untreated human waste into the nearest water body, which was once a common practice, is no longer practiced or condoned. There are also legal requirements for the treatment of wastes. In the highly developed areas of Florida, large municipal wastewater treatment plants usually provide treatments. Small package plants and septic tanks are generally used in rural areas.

The detection of human pathogens (bacteria and viruses) in water is extremely difficult. When attempts are made, it is an extremely costly and time-consuming operation. The attempts are also seldom successful. Therefore, nearly all-bacterial monitoring programs use certain groups of non-disease causing (nonpathogenic) bacteria as bacterial indicator organisms of fecal contamination. If the indicator organisms are present in a water sample, it is traditionally assumed that disease-causing bacteria could be present. Historically, agencies charged with insuring public health used two groups of bacteria universally to detect fecal contamination - the total coliform and fecal coliform bacterial groups.

The coliform group consists of several major types of bacteria (genera) belonging to a family of bacteria that the professionals call the Enterobacteriaceae. Bacteria have historically been assigned to the coliform group defined based on the ability of scientists to detect lactose fermentation (the production of gas). Based on this definition, all aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria were included in the coliform group. Total coliform counts were obtained after incubating (keeping the sample at an elevated temperature) the water sample for 48 hours at 35 C. Fecal coliforms were separated from total coliforms by incubating samples at 44.5 C for 24 hours. Regardless of the seemingly complex definition for the coliform group of bacteria, the total and fecal coliform groups were chosen at the time because they were the only tests readily available and the measurements were easy to make. Their use continues in the 21st century not only because of the ease of measurement, but also because the tests are relatively inexpensive.

When many cities and towns were contaminating water with untreated waste discharges, the total and fecal coliform tests were an extremely important detection tool and problems with the tests were not considered important. The vast majority of cities and towns have constructed wastewater treatment plants and eliminated the major health threats. Due to shortcomings with the older total and fecal coliform tests, there were demands to establish new criteria before using a group of bacteria as an indicator of fecal contamination. However, the agencies continue to use these tests to determine the safety of water for recreation.

As noted earlier, it was assumed by many agencies that the detection of coliforms meant that recent fecal contamination was present and that a health threat could be posed by the possible presence of pathogens. Many state governments, including Florida, enacted legislation establishing numerical coliform counts as criteria for determining the safety of water for drinking and recreation. However, the use of total coliforms became problematic as the major sources of fecal contamination were corrected. Total coliforms are a natural part of the bacterial community (microfauna) of plants. When there is no major source of contamination, the bacteria originating from plants can dominate and provide elevated total coliform counts. The presence of total coliforms, therefore, cannot always be used to indicate the possible presence of pathogens. Their presence is only indicative of the presence of plant material in water.

The more reliable indicator of fecal contamination is the fecal coliform bacteria test. Use of this test, however, has been based on the assumptions that fecal coliforms are only from warm-blooded animals and that fecal coliforms do not survive in water for an extended period of time. When dealing with massive human contamination from untreated wastes or from an inoperative wastewater plant, these assumptions are typically good. Unfortunately, the assumptions have become *dogma* among many public health workers. Studies of fecal coliform bacterial tests have shown that non-harmful bacteria can yield false positive results with the standard tests. The studies have also definitively shown that fecal coliforms can survive and even multiply in the natural environment. Perhaps even more important is the fact that the fecal coliform counts do not correlate with the incidence of gastrointestinal illness in recreational waters.

Florida, like many other states, has established numerical criteria for fecal and total coliform contamination in fresh waters classified as Class III waters (Florida Department of Environmental Protection: Chapter 62-302.530, Florida Administrative Code). Class III water is defined as water designated for the purpose of recreation and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife. In Florida, the fecal coliform standard is:

> *MPN or MF counts shall not exceed a monthly average of 200, nor exceed 400 in 10% of the samples, nor exceed 800 on any one-day. Monthly averages shall be expressed as geometric means based on 10 samples taken over a 30-day period.*

The total coliform standard is:

> *Less than or equal to 1000 as a monthly average; nor exceed 1,000 in more than 20% of the samples examined during any month; less than 2,400 at any time. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period using either the MPN or MF counts.*

MPN represents the "most probable number" of bacteria per 100 mL of water sample and MF represents the number of bacterial colonies counted on a membrane filter per 100 mL. As with any bacterial indicator, it is impossible to guarantee with 100%

certainty that some individual will not become ill upon contact with water. However, if the number of total coliform and fecal coliform colonies isolated from a water sample is below the state-established criteria, there is a very strong probability that the water is safe for recreation!

To obtain a quick picture of what the bacteria levels have been or currently are in the Forest Hills lakes, past bacteria information was collected from agency studies (Table 4)

Table 4. Fecal coliform results from sampling by Hillsborough County (Stormwater Section and Environmental Protection Commission) and the Southwest Florida Water Management District.

Lake	Number of Samples	Fecal Coliform colonies/100 mL Range	Number of Samples > 800 Colonies/ 100 mL
Pine Pond	11	90 - 720	0
Pine Lake	22	10 - 11,200	2
Cedar Lake	2	14 – 20	0
Cedar East	19	20 - 1000	1
Noreast	34	20 - 4,800	0
Sophia	7	20 – 300	0
Veronica Pond	11	20 - 2400	1

and water samples were collected from select lakes (Noreast Lake, Pine Pond and Cedar East) at 10 stations by LAKEWATCH in May 2006 (Table 5). For the LAKEWATCH samples, both total coliforms and *E. coli* were counted.

A review of the fecal coliform information collected by the agencies indicates the vast majority of samples are within state standards so the water would be deemed satisfactory for recreation (Table 4). The May 2006 *E. coli* (a better indicator of human

Table 5. Total Coliform and *E. coli* counts from sampling by Florida LAKEWATCH at 10 stations in May 2006.

Lake	Number of Samples	Total Coliforms colonies/100 mL Range	Number of Samples > 2400 Colonies/ 100 mL
Pine Pond	10	1,000 - 1,900	0
Cedar East	10	7,800 - 10,900	10
Noreast	10	600 - 2,900	1

Lake	Number of Samples	*E. coli* colonies/100 mL Range	Number of Samples > 800 Colonies/ 100 mL
Pine Pond	10	100 - 600	0
Cedar East	10	0 - 200	0
Noreast	10	0 – 200	0

contamination) samples collected by LAKEWATCH at Pine Pond, Cedar East, and Noreast Lake also indicate the waters at three of the waters of concern are meeting state fecal coliform standards for recreational waters (Table 5). Samples exceeding state standards for fecal coliform, however, have been collected at various times (Table 4) and the total coliform levels at Cedar East (Table 5) are elevated. The Hillsborough County EPC also expressed concern (personal communication) about average fecal coliform counts at Pine Pond and some of the other Forest Hills lakes, raising question about the source of the bacteria,

When fecal coliforms are detected in a waterbody, the first question asked is often what is the source of the bacteria. In the Forest Hills area, domestic wastes are handled by both septic tanks and central sewer systems (Table 6). Septic tanks, while being one of

Table 6. Septic and sewer ratios for lakefront properties in the Forest Hills Subdivision (Hillsborough County Health Department, Department of Environmental Health; City of Tampa Utilities).

Lake	Number of Residences	Percent on Septic System	Percent on Sewer System
Mid Lake	20	0	100
Pine Pond	18	0	100
Pine Lake	34	29	71
Cedar East	11	0	100
Cedar West	23	65	35
Eckles	68	4	96
Noreast	25	15	85
Dorsett	20	100	0
Round Pond	7	43	57
Sophia	8	100	0

the best ways to treat domestic wastes in rural areas, are often viewed with suspicion in urbanizing areas. One of the earliest fecal coliform samplings occurred at Noreast Lake in 1971 when the Hillsborough County Health Department sampled the lake to determine if swimming was safe. Although bacterial counts at that time were slightly greater than 100 per 100 mLs of sample, all bacterial counts were within state standards and Noreast Lake was declared satisfactory for swimming. Examination of the Forest Hills lakes where bacterial samples exceeding state standards have been

collected (Pine Pond and Cedar East) shows all the homes no longer use septic tanks (Table 6), thus suggesting septic tanks are not a problem for the Forest Hill lakes.

The fecal coliform counts are also low enough at the lakes that leakage from the collecting lines of the central sewer is probably not a problem. If leakage was a problem, the LAKEWATCH sampling in May should have identified either a “hot spot” at Pine Pond or Cedar East or collected water samples having *E. coli* counts above the state fecal coliform standard. Finding neither and collecting water samples exceeding state total coliform standards at Cedar East (Table 5) strongly suggests the detected bacterial
contamination at the Forest Hills lakes is due to natural sources.

Total coliform bacteria were not within the acceptable range as defined by the Florida Administrative Code (FAC), Section 62-302.530 for all 10 water samples collected by LAKEWATCH at Cedar East and one-water sample collected at Noreast Lake. The elevated total coliform counts are probably the result of bacteria derived from either plants or soils (see Florida LAKEWATCH Informational Circular 106). While the high total coliform counts probably do not indicate fecal contamination, the counts may still indicate a potential health risk for certain lake users like children. High total coliform counts are often indicative of the presence of a bacteria know as *Pseudomonas aeruginosa*. This bacterium is consider being of non-fecal origin and posing no serious health risk to the majority of lake recreationists. *Pseudomonas aeruginosa* has been associated with skin rashes and is known to be a major cause of ear infections!

Fecal coliform bacteria (indicated by *E. coli* counts) were within the acceptable range as defined by the Florida Administrative Code (FAC), Section 62-302.530 at Pine Pond, Cedar East, and Noreast Lake during the May sampling. The highest counts, however, were found at Pine Pond. Fecal coliform and *E. coli* are typically viewed as indicators of warm-blooded animal contamination and most individual immediately focus on human or domestic animal sources. High bacterial counts, however, can be the direct result of aquatic birds (Donze 2004). For example, large concentrations of roosting seagulls (not septic tanks) were determined to be the source of significant fecal contamination that was occurring at Lake Fairview in Orlando, Florida (Ayres Associates 1998).

Hoyer et al. (2006) studied 30 Hillsborough County lakes (none of the Forest Hills lakes) between October 2001 and June 2003 and found that average total coliform and average *E. coli* counts were correlated with aquatic bird abundance. They also found that *E. coli* counts were strongly correlated to bird counts on the Hillsborough County lakes even after accounting for lake trophic status (i.e., lake productivity). During the May 2006 sampling, LAKEWATCH observed many ducks on Pine Pond and the other lakes. Given this observation and the findings of Hoyer et al. (2006), it is highly possible that the source of the higher fecal and *E. coli* counts are due to aquatic birds, especially ducks.

Hoyer et al. (2006) collected 4055 total coliform and *E. coli* samples from 99 Florida lakes (including the 30 Hillsborough County lakes) and found that 25% of the total coliform and 2% of the *E. coli* samples exceeded state standards. Their findings are similar to what is occurring at the Forest Hills lakes. Hoyer et al.'s conclusion that the probability of having a human health concern other than a skin rash or ear infection is low also seems applicable to the Forest Hills lakes. More importantly, their conclusion that aquatic birds should not be overlooked as an important source for bacterial contamination seems equally applicable to the Forest Hills lakes.

Hoyer et al. (2006) noted that the method of waste management is often a concern to many people citing septic tanks systems for polluting aquatic systems. The data collected by Hoyer et al. (2006) showed no significant difference in bacterial counts between lakes managing waste with septic tanks and those with central waste water treatment systems. They did, however, recommend that a routine inexpensive bacterial monitoring program be implemented at lakes used for body-contact recreational activities to be safe and relieve concerns of the public about potential health problems.

General chemical and heavy metal contamination - Many citizens were concerned about the possible contamination of fish by heavy metals and other chemicals. The concerns arise because many studies have shown certain stormwaters can bring in contaminants. Little or no information, however, is available on the concentrations of heavy metals or other chemicals in the lakes or the fish of the Forest Hills lakes. The general lack of information is undoubtedly the direct result of the cost of sampling for parameters other than nutrients. Costly studies also are generally not

conducted unless there is a specific source of contamination and the chemicals of concern have been identified. With this said, examination of other studies around Florida would lead to the conclusion that it would be very costly to obtain meaningful information for the Forest Hills lakes.

While there seems to be no reason for undue concern about nutrient inputs or contamination with heavy metals or other chemicals, it is obvious that stormwater is a potential contamination source. An obvious way of ascertaining the magnitude of stormwater inputs is to examine sediment build-up in front of stormwater culverts. When there is a major input of sediments, a delta forms. The sediment is accelerating the filling in of the Forest Hills lakes, but probably not at a rate that would drastically affect the lake systems. The sediment build up in front of the stormwater pipes also allows the growth of some terrestrial and aquatic vegetation that otherwise would not grow. This habitat is used by some aquatic bird populations and may be deemed a benefit. The deltas can also be viewed as beneficial because heavy metals and other chemicals associated with sediments are deposited in a limited area. This opens the opportunity for an inexpensive removal of the majority of contaminants (see management options). However, the sediment is also covering substantial hard substrate that could also be used for fish spawning habitat making the additional substrate a negative attribute. This once again points out the difficulty in lake management; “a lake cannot be all things to all people or to all plants and animals”!

Aquatic Plants and Shoreline Vegetation

Many of the citizens expressed concerns about the growth of aquatic plants in the Forest Hills lakes. As noted previously, the Forest Hills lakes are part of the Land-O-Lakes Lake region. Land-O-Lakes lakes are moderately productive and aquatic weed problems have occurred in many lakes. An aquatic weed problem is defined as plants growing where they are not wanted.

In the late 1980s and early to mid 1990s, aquatic weed problems occurred at West Cedar Lake, East Cedar Lake, and Lake Eckles. The aquatic weed problems were severe enough that the Florida Fish and Wildlife Conservation Commission issued permits for the stocking of grass carp (*Ctenopharygodon idella*). West Cedar Lake was

permitted for 150 grass carp and 150 grass carp were purchased for stocking in 1989. East Cedar Lake was permitted for 115 grass carp and 74 grass carp were purchased for stocking in 1992. Lake Eckles was permitted for 300 grass carp and 90 grass carp were purchased for stocking in 1993. The primary use of the all lakes was designated as fishing.

There is little current quantitative information on the aquatic communities in most Forest Hills lakes because of their designation as private lakes by most agencies. Citizens living alongside some of the lakes have reported problems with various types of plants and some herbicides have been used to mitigate local problems. In October 2004, Florida LAKEWATCH sampled aquatic plants in Lake Eckles (Table 7) and Noreast Lake (Table 8). At that time both lakes had moderate bottom coverage of aquatic plants (34% for Eckles and 20% for Noreast). The plant communities were diverse with 21 plant species found at Eckles and 17 plant species collected at Noreast. The dominant (plants found at more than 50% of the 10 plant transects) plants at Eckles were spatterdock (*Nuphar luteum*), alligator-weed (*Alternanthera philoxeroides*), water pennywort (*Hydrocotyle umbellata*), torpedograss (*Panicum repens*) and water primrose (*Ludwigia octovalvis*). The dominant plants at Noreast were torpedograss, alligatorweed, slender spikerush (*Eleocharis baldwinii*) and fragrant water-liy (*Nymphaea oderata*). Many of the dominant plants are non-native (e.g., alligator-weed and torpedograss) and known to become under the right circumstances an aquatic weed problem. Native plants species that are present (e.g., spatterdock) are also known to cause aquatic weed problems because of their prolific growth.

Table 7. Aquatic plants sampled by Florida LAKEWATCH at Lake Eckles in October 2004.

Percent area covered with aquatic vegetation (PAC, %)	34.0
Percent of lake's volume filled with vegetation (PVI, %)	5.0
Average emergent plant biomass (kg wet wt/m^2)	1.9
Average floating-leaved plant biomass (kg wet wt/m^2)	2.1
Average submersed plant biomass (kg wet wt/m^2)	0.0
Average width of emergent and floating-leaved zone (ft.)	58.1
Average lake depth (m)	2.2

Frequency that plant species occur in 10 evenly spaced transects around the lake.

Common Name	**Plant Species**	**Frequency (%)**
spatterdock	*Nuphar luteum*	90
alligator-weed	*Alternanthera philoxeroides*	70
water-pennywort	*Hydrocotyle umbellata*	70
torpedograss	*Panicum repens*	70
water primrose	*Ludwigia octovalvis*	50
slender spikerush	*Eleocharis baldwinii*	40
maidencane	*Panicum hemitomon*	40
melaleuca	*Melaleuca quinquenervia*	30
willow	*Salix spp.*	30
cypress spp.	*Taxodium spp.*	30
lemon bacopa	*Bacopa caroliniana*	20
red ludwigia	*Ludwigia repens*	20
Australian pine	*Casuarina equisetifolia*	10
coinwort	*Centella asiatica*	10
elephant-ear	*Colocasia esculenta*	10
umbrella sedge	*Cyperus alternifolius*	10
rush fuirena	*Fuirena scirpoidea*	10
smartweed	*Polygonum hydropiperoides*	10
duck-potato	*Sagittaria lancifolia*	10
.	*Scirpus cubensis*	10
cat-tail	*Typha spp.*	10

Table 8. Aquatic plants sampled by Florida LAKEWATCH at Noreast Lake in October 2004.

Percent area covered with aquatic vegetation (PAC, %)	20.0
Percent of lake's volume filled with vegetation (PVI, %)	3.0
Average emergent plant biomass (kg wet wt/m^2)	4.2
Average floating-leaved plant biomass (kg wet wt/m^2)	2.0
Average submersed plant biomass (kg wet wt/m^2)	5.0
Average width of emergent and floating-leaved zone (ft.)	30.5
Average lake depth (m)	2.6

Frequency that plant species occur in 10 evenly spaced transects around the lake.

Common Name	**Plant Species**	**Frequency (%)**
torpedograss	*Panicum repens*	100
alligator-weed	*Alternanthera philoxeroides*	60
slender spikerush	*Eleocharis baldwinii*	60
fragrant water-lily	*Nymphaea odorata*	50
water primrose	*Ludwigia octovalvis*	40
maidencane	*Panicum hemitomon*	40
musk-grass	*Chara spp.*	30
melaleuca	*Melaleuca quinquenervia*	30
cat-tail	*Typha spp.*	30
red maple	*Acer rubrum*	20
rush fuirena	*Fuirena scirpoidea*	20
willow	*Salix spp.*	20
common salvinia	*Salvinia rotundifolia*	20
floating water-hyacinth	*Eichhornia crassipes*	10
water-pennywort	*Hydrocotyle umbellata*	10
knot grass	*Paspalum distichum*	10
cypress spp.	*Taxodium spp.*	10

Surveys of the shoreline plants also showed the presence of non-native plants that can cause problems if not managed. The non-native water hyacinth (*Eichornia crassipes*) was collected from Eckles and both lakes had melaleuca (*Melaleuca quinquenervia*). The shorelines, however, also have pockets of the native cat-tail (*Typha spp.*) that can expand along the shoreline as well as well into the lakes where water depths are appropriate. Given the presence of potentially aquatic weed causing plant species at Eckles and Noreast, it is highly likely the same types of plants are found at the other Forest Hills lakes. Residents, therefore, need to strongly consider maintaining these weed-causing types of aquatic plants at the lowest possible levels (*maintenance control*) because maintenance control ultimately improves and encourages native fish and wildlife habitat while maintaining lake conditions for recreational activities.

Maintenance control (or management) refers to controlling plants at low levels and doing it before the plants reach a problem level. It has been defined in a Florida Statute as follows:

> *....a maintenance program is a method for the control of non-indigenous aquatic plants in which control techniques are utilized in a coordinated manner on a continuous basis in order to maintain the plant population at the lowest feasible level as determined by the department [Department of Natural Resources now Department of Environmental Protection.] F.S. 369.22*

Maintenance control of aquatic weeds (both native and non-native) reduces the detrimental environmental effects caused by the weeds and reduces the potential for environmental impacts from aquatic plant control activities. Maintenance control offers the following advantages:

1. Detrimental impacts of aquatic non-indigenous weeds on native plant populations are reduced.
2. Detrimental impacts of aquatic weeds on water quality are reduced.
3. The amount of organic matter deposited on the lake bottom from natural processes is reduced.

4. The amount of organic matter deposited on the lake bottom after control of aquatic plants is reduced.
5. Less herbicide and therefore money is used in the long term.

For example, maintenance of water hyacinth to less than 5% coverage under experimental conditions and reduced herbicide usage by a factor as great as 2.6; reduced deposition of detritus by a factor of 4.0; and reduced depression of dissolved oxygen that occurred beneath the vegetation mats.

A problem experienced when conducting a maintenance control program is that people do not perceive a weed problem and question the need to spray or conduct activities like mechanical harvesting. Therefore, public education is an important part of a successful maintenance control program. Maintenance management is the most environmentally sound method for managing invasive non-native plants. For example, unmanaged water hyacinths can double every 7 - 10 days. Ten plants under the right environmental conditions can grow to cover one acre in a single growing season, often weighing 200 tons. Therefore, the benefit of controlling those 10 plants early should be obvious.

Once a decision is made to manage plants, the issue of how many plants should be left in the lake. Lakes with abundant submersed aquatic macrophytes sometimes are very clear because aquatic macrophytes can limit the growth of free-floating algae, which are usually estimated with measurements of chlorophyll concentrations. If macrophyte coverage is less than about 30% then the presence of macrophytes does not seem to impact whole lake algal abundance, however, lakes with aquatic macrophytes covering over 50% of the lake bottom area typically have reduced algal levels and clearer water (Hoyer and Canfield 1996). One explanation is that either aquatic macrophytes, or perhaps the algae attached to them, use available nutrients competing with the free-floating algae. Another explanation is that aquatic macrophytes anchor the nutrient rich bottom sediments in place, buffering the action of wind, waves and human effects, and thereby depriving the free-floating algae nutrients contained in the sediments that would otherwise be stirred up. Macrophytes also provide calm water conditions within their

beds allowing large algal cells to settle and be lost to the water column. Whatever the mechanism, it is clear that once a decision is made to reduce plant coverage on a lake bottom to less than 30% by any type of plant management whole-lake water quality is not impacted by plant management.

When the abundance of aquatic plants is not impacting water quality issues such as water clarity and algal concentrations (plant coverage < 30%), the primary concern becomes fish and wildlife habitat. Studies of 60 Florida lakes by the University of Florida /Department of Fisheries and Aquatic Sciences demonstrated the probability of encountering what would be deemed a “poor” fish population increases when whole-lake plant coverage on the bottom (PAC) exceeds 85% PAC or is less than 15% PAC (Canfield and Hoyer 1991). When plant coverage is between 15% and 85% PAC, “poor fish populations were not encountered, thus providing a large envelope of opportunity for implementing a whole-lake management plan. At many lakes, users prefer a moderate amount of plants as long as access is available. In many cases keeping plant coverage between 15% PAC and 30% PAC seems to be acceptable for most users.

The Florida Department of Environmental Protection and the Florida Fish and Wildlife Conservation Commission are stewards of the aquatic plants, fish, and wildlife that inhabit the Forest Hills lakes. Any lake management activity, that might affect these biological components of the lakes, needs to be permitted. In general, the permit is issued to the individual riparian landowner. This is done to insure the rights of any riparian landowner who might object to the activity on their land (for example, use of herbicides). However, a lake-wide permit will be issued for the lake if something was to happen (for example, herbicides or grass carp for hydrilla control) that would affect the entire lake. Both agencies, however, prefer to work with citizens to develop a comprehensive aquatic plant management program for each lake and issue a lake-wide permit.

Fish

Attendees of the September 24, 2005 workshop expressed concerns regarding fish populations at the Forest Hills lakes. A special concern was the presence of an organism on largemouth bass in Noreast Lake that many anglers thought were leeches. Hillsborough County EPC and Florida LAKEWATCH collected largemouth bass with the "leeches" from Noreast Lake for a pathological work-up by fish veterinarians. LAKEWATCH also sampled fish populations at Lake Eckles, Lake Dorsett, Cedar East, Cedar West, Noreast Lake, and Pine Lake in early 2006 (Table 9).

Identification of the organisms infesting the skin of largemouth bass in Noreast Lake by University of Florida veterinarians and fish experts at the University of Florida Tropical Aquaculture Laboratory in Ruskin demonstrated the organisms were not "leeches", but fish lice (*Argulus sp.*).

Fish lice are parasitic crustaceans that can be found on the eyes, fins, gills and scales of fish. There are several species common in Florida waters, but fish lice typically do not reach levels in lakes where they hurt fish populations. Fish lice, however, can become a problem in aquaculture facilities where fish are raised at very high numbers. There are no problems associated with eating fish if fish lice are present. LAKEWATCH and the Florida Fish and Wildlife Conservation Commission observed increased incidences of fish lice on largemouth bass and bowfin at several Florida lakes following the 2000 drought. Several LAKEWATCH volunteers have also noticed the presence of fish lice on fish from their lakes suggesting the severe drought may have created conditions favorable for fish lice.

Table9. Fish populations sampled by Florida LAKEWATCH in 2006.

Eckles (Hillsborough County)

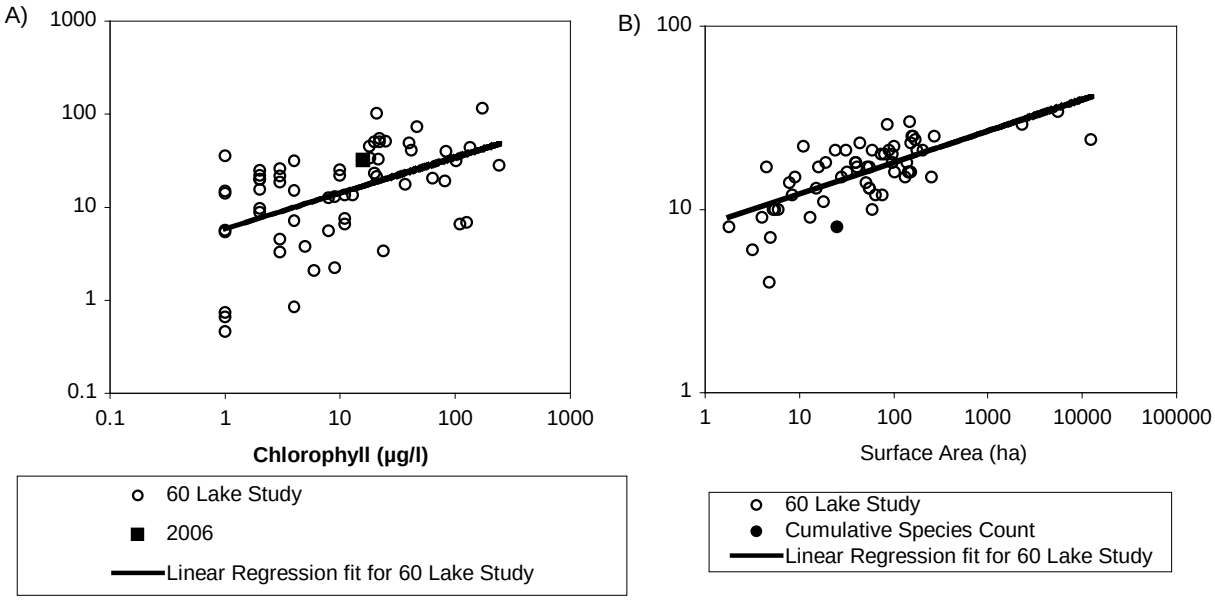
2006 LAKEWATCH Electrofishing Data

			Canfield and Hoyer (1992) Ranges		
Species[1]	**#/hr**	**kg/hr[2]**	**min weight (kg/hr)**	**mean weight (kg/hr)**	**max weight (kg/hr)**
Blue tilapia	6	8.98	0.611	2.31	5.57
Black crappie	3	0.18	0.007	0.606	2.837

Bluegill	248	3.21	0.039	4.495	28.118
Brook silverside	24	0.07	0	0.011	0.085
Florida gar	11	7.35	0.08	5.083	32.858
Golden shiner	18	0.59	0.004	0.591	4.221
Largemouth bass	24	8.29	0.112	8.552	28.464
Redear sunfish	15	3.19	0.037	2.316	18.31
Total	349	31.86			

[1] Total # of species = 8.

[2] Weights calculated using regressions from Hoyer and Canfield 1994 and from Florida Fish and Wildlife Conservation Commission (personal communication).



A) Catch per unit of effort (kg of fish / hour of sampling) versus total chlorophyll (µg / l) for 60 Florida lakes sampled by Canfield & Hoyer (1992) (O) & Lake Eckles (Hillsborough County) for electrofishing sampling from 2005.

B) Number of fish species collected versus surface area for 60 Florida lakes sampled by Canfield & Hoyer (1992) (O) & Lake Eckles (Hillsborough County) (1999-2004) (•) electrofishing. The power lines represent linear regressions of 60 Florida lakes.

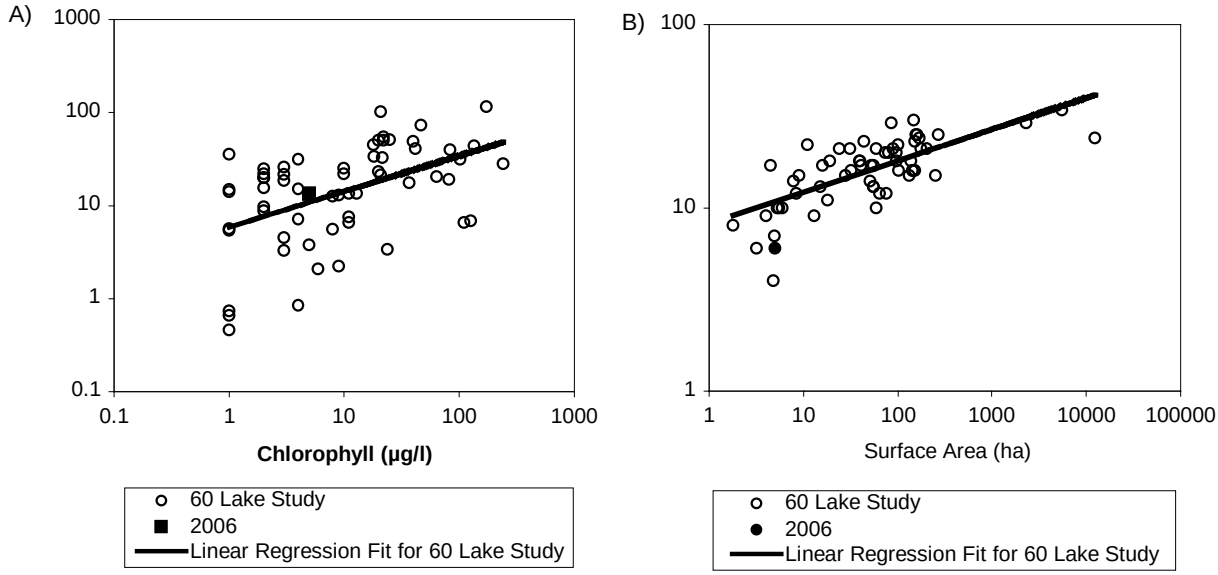
Cedar East (Hillsborough County)

2006 LAKEWATCH Electrofishing Data

Species[1]	#/hr	kg/hr[2]	Canfield and Hoyer (1992) Ranges min weight (kg/hr)	mean weight (kg/hr)	max weight (kg/hr)
Bluegill	72	4.16	0.039	4.495	28.118
Florida gar	6	1.30	0.08	5.083	32.858
Golden shiner	14	0.14	0.004	0.591	4.221
Largemouth bass	14	3.64	0.112	8.552	28.464
Redear sunfish	20	4.00	0.037	2.316	18.31
Taillight shiner	2	0.00	0	0.008	0.04
Total	128	13.24			

[1] Total # of species = 6.

[2] Weights calculated using regressions from Hoyer and Canfield 1994 and from Florida Fish and Wildlife Conservation Commission (personal communication).



A) Catch per unit of effort (kg of fish / hour of sampling) versus total chlorophyll (µg / l) for 60 Florida lakes sampled by Canfield & Hoyer (1992) (O) & Lake Cedar East (Hillsborough County) for electrofishing sampling from 2006.

B) Number of fish species collected versus surface area for 60 Florida lakes sampled by Canfield & Hoyer (1992) (O) & Lake Cedar East (Hillsborough County) (2006) (•) electrofishing. The power lines represent linear regressions of 60 Florida lakes.

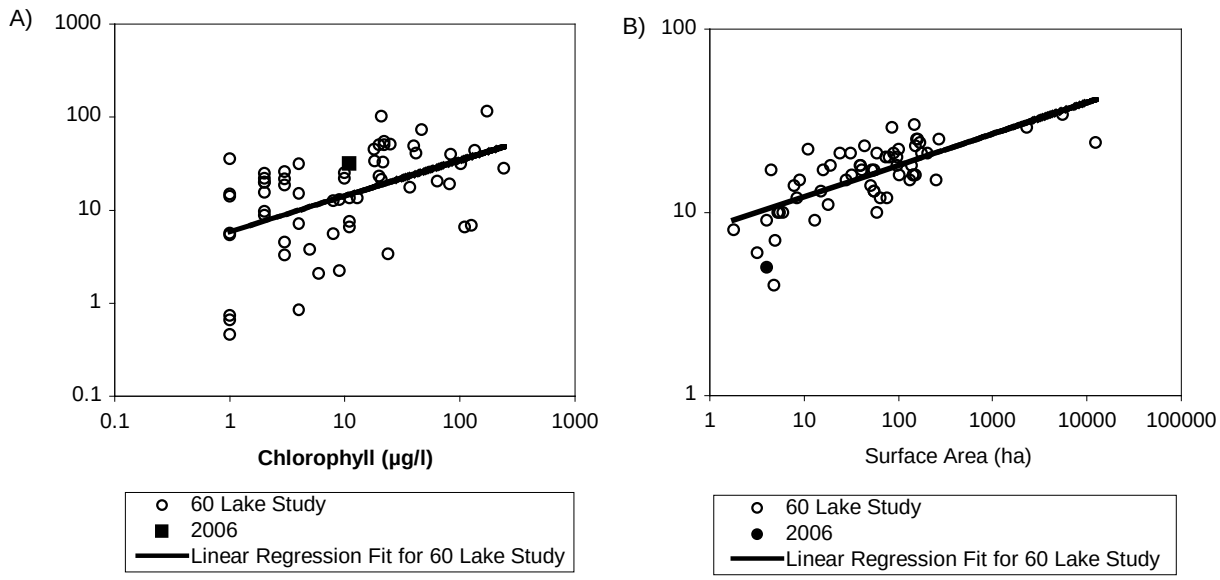
Cedar West (Hillsborough County)

2006 LAKEWATCH Electrofishing Data

Species[1]	#/hr	kg/hr[2]	Canfield and Hoyer (1992) Ranges min weight (kg/hr)	mean weight (kg/hr)	max weight (kg/hr)
Bluegill	170	9.62	0.039	4.495	28.118
Brook silverside	2	0.00	0	0.011	0.085
Largemouth bass	32	16.30	0.112	8.552	28.464
Redear sunfish	52	5.62	0.037	2.316	18.31
Swamp darter	4	0.00	0	0	0.001
Total	260	31.54			

[1] Total # of species = 5.

[2] Weights calculated using regressions from Hoyer and Canfield 1994 and from Florida Fish and Wildlife Conservation Commission (personal communication).



A) Catch per unit of effort (kg of fish / hour of sampling) versus total chlorophyll (µg / l) for 60 Florida lakes sampled by Canfield & Hoyer (1992) (O) & Lake Cedar West (Hillsborough County) for electrofishing sampling from 2006.

B) Number of fish species collected versus surface area for 60 Florida lakes sampled by Canfield & Hoyer (1992) (O) & Lake Cedar West (Hillsborough County) (2006) (•) electrofishing. The power lines represent linear regressions of 60 Florida lakes.

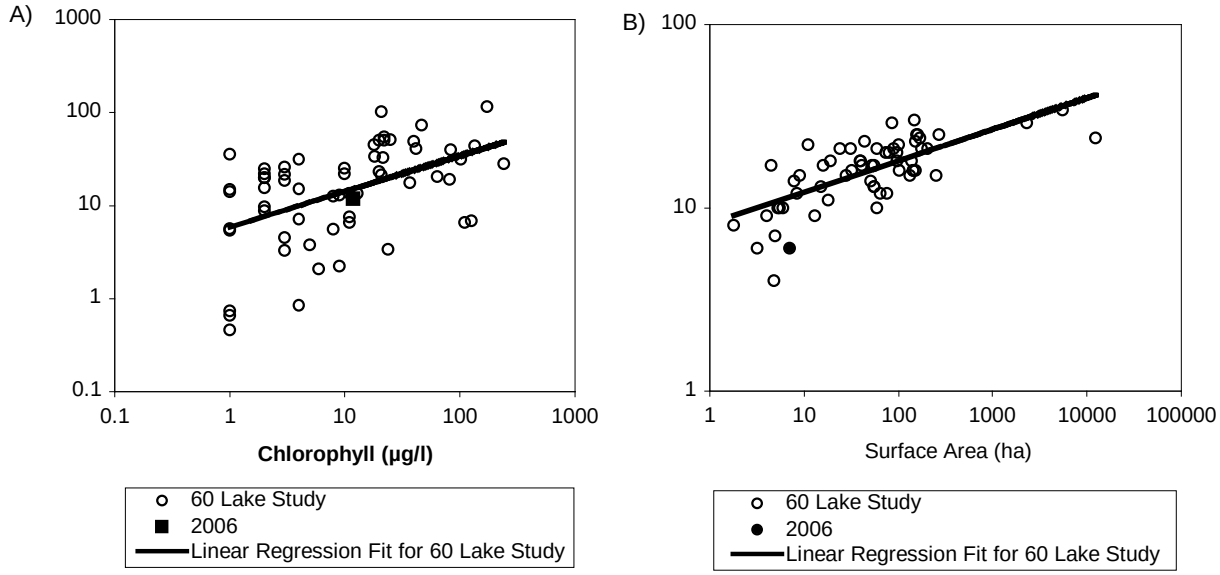
Noreast (Hillsborough County)

2006 LAKEWATCH Electrofishing Data

Species[1]	#/hr	kg/hr[2]	Canfield and Hoyer (1992) Ranges min weight (kg/hr)	mean weight (kg/hr)	max weight (kg/hr)
Bluegill	40	1.04	0.039	4.495	28.118
Brook silverside	2	0.00	0	0.011	0.085
Florida gar	10	5.24	0.08	5.083	32.858
Golden shiner	2	0.02	0.004	0.591	4.221
Largemouth bass	16	4.04	0.112	8.552	28.464
Redear sunfish	30	1.46	0.037	2.316	18.31
Total	100	11.80			

[1] Total # of species = 6.

[2] Weights calculated using regressions from Hoyer and Canfield 1994 and from Florida Fish and Wildlife Conservation Commission (personal communication).



A) Catch per unit of effort (kg of fish / hour of sampling) versus total chlorophyll (µg / l) for 60 Florida lakes sampled by Canfield & Hoyer (1992) (O) & Lake Noreast (Hillsborough County) for electrofishing sampling from 2006.

B) Number of fish species collected versus surface area for 60 Florida lakes sampled by Canfield & Hoyer (1992) (O) & Lake Noreast (Hillsborough County) (2006) (•) electrofishing. The power lines represent linear regressions of 60 Florida lakes.

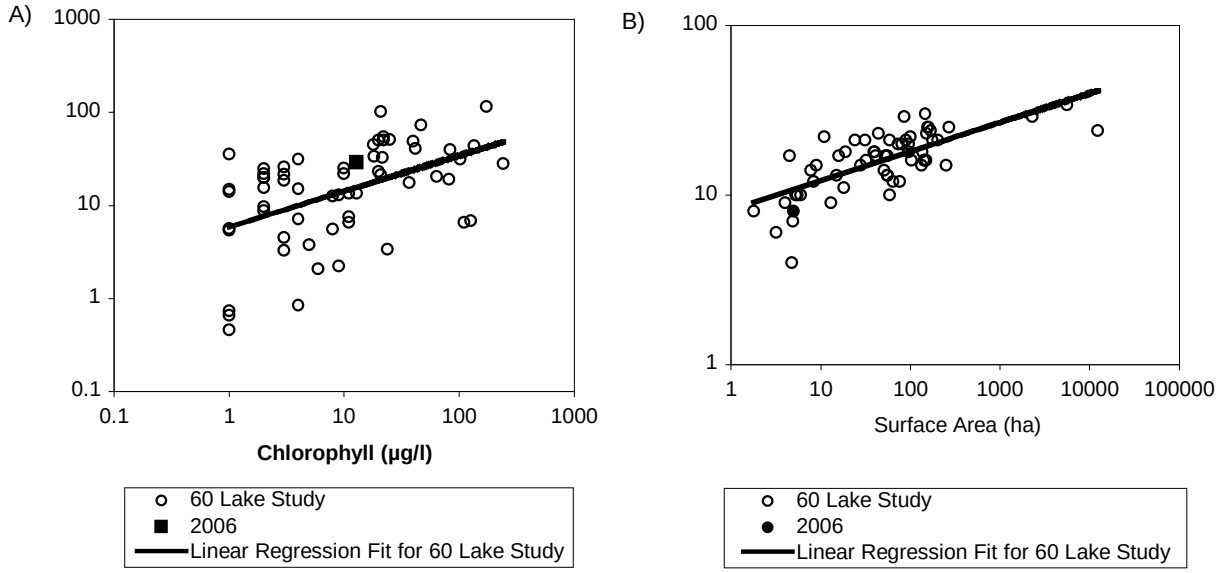
Pine (Hillsborough County)

2006 LAKEWATCH Electrofishing Data

Species[1]	#/hr	kg/hr[2]	Canfield and Hoyer (1992) Ranges min weight (kg/hr)	mean weight (kg/hr)	max weight (kg/hr)
Blue tilapia	2	2.22	0.611	2.31	5.57
Bluegill	22	0.60	0.039	4.495	28.118
Bowfin 4	7	0.746	5.765	22.497	
Brook silverside	6	0.02	0	0.011	0.085
Florida gar	8	6.92	0.08	5.083	32.858
Largemouth bass	76	11.92	0.112	8.552	28.464
Redear sunfish	2	0.44	0.037	2.316	18.31
Swamp darter	2	0.00	0	0	0.001
Total	122	28.92			

[1] Total # of species = 8.

[2] Weights calculated using regressions from Hoyer and Canfield 1994 and from Florida Fish and Wildlife Conservation Commission (personal communication).



A) Catch per unit of effort (kg of fish / hour of sampling) versus total chlorophyll (µg / l) for 60 Florida lakes sampled by Canfield & Hoyer (1992) (O) & Lake Pine (Hillsborough County) for electrofishing sampling from 2006.

B) Number of fish species collected versus surface area for 60 Florida lakes sampled by Canfield & Hoyer (1992) (O) & Lake Pine (Hillsborough County) (2006) (•) electrofishing. The power lines represent linear regressions of 60 Florida lakes.

Electrofishing of the fish populations at Lake Eckles, Lake Dorsett, Cedar East, Cedar West, Noreast Lake, and Pine Lake collected from 4 to 8 species of fish per lake (Table 9). The list of species at each is not complete as electrofishing tends to collect the dominant species of fish and the presented results represent only one day of sampling. What is clear is the species richness for the fish populations is within the expected range for Florida lakes. Bluegill, redear and largemouth bass are the dominant fish in most of the lakes and the sampling demonstrates that sportfish dominate. The highest weights of fish caught per hour were at Cedar West (32 kg/hr), Pine Lake (29 kg/hr) and Eckles 32 (kg/hr). These lakes have some of the highest average total phosphorus concentrations at the Forest Hills indicating any nutrient enrichment is enhancing sportfish populations as is the case at other more enriched Florida lakes (Bachmann et al. 1996). Noreast Lake with an average total phosphorus concentration of 25 µg/L had an electrofishing catch rate of 12 kg/hr with largemouth bass being the dominant sportfish caught. These results suggest that despite the presence of fish lice the fish population at Noreast Lake is within the expected range for Florida lakes.

Wildlife

No quantitative information on wildlife at the Forest Hills lakes was found. Participants at the September 2005 workshop suggested changes in wildlife abundance at the lakes had occurred. Interpreting the changes, it seems many of the observations are related to the abundance of aquatic plants. Studies of Florida lakes have shown the type of wildlife and the abundance is related to the abundance and type of plants (Hoyer and Canfield 1994). During the fish surveys, the LAKEWATCH staff observed similar associations at the sampled lakes, suggesting a comprehensive aquatic plant management plan at each lake could mitigate many if not all of the major wildlife concerns.

During the bacteriological surveys, observations by the LAKEWATCH staff confirmed the observations of some of participants at the September 2005 workshop about an overabundance of ducks in some areas. The bacterial studies indicate some of the high

levels of bacteria are probably related to the abundance of ducks and other aquatic birds (see bacteria discussion). At the September meeting, some participants asked about a duck removal program. Such an activity can occur if permitted by the Florida Fish and Wildlife Commission. Conversations with the Commission indicate the Forest Hills lakes are candidates for a duck removal program, but conditions of the permit need to be abided by those authorized to remove animals.

Recreation and Aesthetics

Many riparian owners use the Forest Hills lakes for recreation by, the “looks” of the lakes is a major factor that cannot be overlooked in developing any lake management plan. A 2005-2006 survey of lake-users in the Southwest Florida Water Management District demonstrated that 77% of the respondents saw their lake as moderately beautiful to very beautiful (Hoyer et al. 2006). The lakes exhibited a wide range of environmental conditions, but to the individual “their” lake was the best. This strongly suggests there are visual cues that provide the owners great pleasure.

A negative “look” of a lake could involve algae or aquatic macrophytes on the water surface. Dense overgrowths of shoreline vegetation or floating trash can trigger a negative thought or recreational experience. Sometimes, situations occurring offsite enhance the negatives. Based on the comments of the participants of the September 2005 workshop and comments from other riparian owners all of the above seems to be at play in the minds of Forest Hills residents.

Some general management actions could enhance certain aspects of the recreational uses and aesthetics of the Forest Hills lakes. As mentioned previously, a comprehensive aquatic plant management plans needs to be developed for each lake. An aquascaping program at each individual lake could be useful in beautifying barren shorelines and assisting with the control of dense growths of shoreline vegetation or the removal of non-native plant species. Increasing trash pick-ups around the lakes would

increase the aesthetic enjoyment of the lakes and neighboring streets could be managed to reduce trash inputs to the lakes via stormwater. Volunteers could accomplish many of the tasks, but a private/public partnership between the owners and different government organizations will be needed to insure the work is completed in a timely manner.

Sometimes different government agencies should be encouraged to partner for the good of the area. For example, north of Cedar Lake is a public park. The park receives stormwater runoff from streets and commercial areas further north. Park personnel and personnel from the Stormwater Section could work together to improve the aesthetics of the area and remove trash that is in the waterbody. By improving the “look” of this area there would be benefits albeit small to the aesthetics of the area and the area could serve as a useful trap for debris before it reaches Cedar Lake.

Trends

Determining if there are any definitive time trends in the limnology (the physical, chemical, and biological features) of the Forest Hills lakes is very difficult because of the lack of long-term information for most limnological parameters. Lake Eckles, Cedar Lake (including Cedar West) and Noreast Lake have sufficient information to conduct statistical time series analyses.

As noted above in the section on water quality, many of the changes in nutrients and algal biomass as indicated by chlorophyll are within the expected range of natural variability for Florida lakes. The time series analyses for Lake Eckles, Cedar Lake and Noreast Lake also show most sampling points are within the expected range for natural variability. However, there are some statistically significant changes in nutrients and water clarity at the lakes for the time series analyses.

For Lake Eckles, no seasonal patterns were detected for the primary trophic state parameters (total phosphorus, total nitrogen, chlorophyll, and Secchi depth). There also

were no significant long-term trends for total phosphorus, total nitrogen, or chlorophyll. Secchi depth, however, showed a statistically significant decreased over the long-term, but this relationship was dominated by very clear water that occurred in 1997 and 1998. The decrease seems to coincide with the heavy rainfall that occurred with the onset of the El Nino rains.

Cedar Lake showed no seasonal patterns for any of the primary trophic state parameters. There also was no significant long-term trend for total nitrogen. However, significant long-term decreasing trends were found for total phosphorus and chlorophyll. Secchi depth showed a statistically significant increase over the long-term. Again, El Nino rains seem to be influencing the total phosphorus and chlorophyll trends. The increasing water clarity is dominated by clearer water in 2004, which may be related to increasing plant growth. Water clarity decreased following the hurricanes in the fall of 2004.

Noreast Lake, like Lake Eckles and Cedar Lake, demonstrated no seasonal patterns for any of the primary trophic state parameters. There also were no significant long-term trends for total phosphorus, total nitrogen, chlorophyll or Secchi depth. However, there were times when individual months were outside the general expected range for lakes, but the lake seems to be stable.

While the weight of evidence suggests the lakes are “doing fine,” potential changes that could occur with stormwater input over decades need to be considered. Long-term monitoring, management of problems if they occur, or removal of the stormwater inputs are all viable options for the Forest Hills lakes, but each choice has risks, costs and benefits.

Section 3 - Management Options

Option I – The “Do Nothing Option”.

This option is again a viable option, but it probably is the least viable option if problems emerge in the future. One of the difficulties encountered in trying to address citizen concerns at the Forest Hills lakes has been the lack of sufficient quantitative information to definitive answers. The lakes are considered private lakes so most government agencies only work on the lakes when problems occur. For the lakes involved in Florida LAKEWATCH for a long enough period, trend analyses can provide early warnings for potential changes and provide professionals with a better scientific foundation for management recommendations. However, LAKEWATCH information like all scientific studies can only deal with possibilities and probabilities. Absolute answers are not typically possible.

Option II. Continue and Expand Monitoring of Lake Trophic State Parameters.

Currently, citizen volunteers working under the auspices of Florida LAKEWATCH are measuring water clarity (Secchi Depth), algal biomass (as measured by chlorophyll concentrations), and total phosphorus concentrations and total nitrogen concentrations at select Forest Hills lakes. With the continued support of the citizens this monitoring effort should be sufficient to detect any significant future changes that might occur to the trophic status of the lakes. Forest Hills lakes not currently enrolled should be encouraged to join. The North Forest Hills Neighborhood Association INC., if they accept being the lead group for the future management of the lakes, could become the primary recruiter for future volunteers.

Option III. Expand Lake Monitoring to Include Aquatic Macrophytes, Fish, and Aquatic Birds.

The Florida LAKEWATCH program is not funded to continually monitor aquatic plants, fish, or aquatic birds However, if these issues are of concern

to citizens using the Forest Hills lakes, additional funding could be appropriated to expand the monitoring of the Forest Hills lakes as well as other lakes in Hillsborough County. Most state agencies will not work on the lakes because the lakes are considered private. LAKEWATCH has statutory authority to work on the lakes. Currently, LAKEWATCH is funded through the Hillsborough County Stormwater Management Section to monitor trophic state parameters and occasionally fish and plants. Increase funding by the County or other partnering could establish a more comprehensive and cost-effective monitoring program for the Forest Hills lakes as well as other Hillsborough County lakes. Placing the increase in funding with the Stormwater Management Section would insure coordination at the local level and the timely transfer of information to those individuals needing it.

Option IV. Initiate a Comprehensive Aquatic Plant Management Program.

Riparian owners around the Forest Hills lakes need to work with the Florida DEP to establish a comprehensive aquatic plant management program for each individual lake. The management program should emphasize maintenance control of both non-native and native plants. Consideration especially needs to be given to the expansive growth of floating-leafed vegetation. While pads have many benefits, inspection of old aerial photos suggests the coverage of floating leafed vegetation was greater in the past than now. If left unmanaged the pads will interfere with various lake uses and contribute significantly to muck accumulation. Herbicides may represent the best control strategy in the near-term, but an integrative strategy with mechanical harvesting conducted by the riparian owners may be the best long-term strategy.

Option V. Expand Lake Monitoring to Include Potential Biological and/or Chemical Contaminants.

Bacterial and/or chemical contaminations are not routinely monitored at the Forest Hills lakes. Research for this report has not detected any cases in which biological or chemical contamination seems to have caused major environmental degradation or human health problems. Obviously, concerns may still persist among individuals and future conditions are unknown. The Stormwater Management Section funded LAKEWATCH to conduct a countywide survey of bacteria on select lakes. While that study also showed no potential health concerns, bacteria from birds was identified as a potential source of bacteria. The Forest Hills residents could work with their County Commissioners to establish a routine (summer months) bacterial (total coliform and *E. coli*) monitoring program. Discussions should be had with public health in Hillsborough County, Hillsborough EPC and the Stormwater

Section to determine which agency would take the lead. If costs are too high and no local group will take the lead, LAKEWATCH could become involved.

LAKEWATCH and other governmental agencies do not typically monitor for chemical contaminants in the water because of costs. The least expensive approach would be examining fish tissue contamination. This approach is advantageous because most individuals are concerned either directly or indirectly are the fish safe to eat. LAKEWATCH can collect fish and other groups can analyze fish tissue for contaminants. The price tag will depend upon what are the identified potential contaminants. For example, Florida DEP can analyze mercury for some fish if the fish are delivered to Tallahassee. These analyses are inexpensive because of an ongoing program. Such would not be the case for other contaminants.

Option VI - Apply for Duck Removal Permit and Reduce Duck Population.

Ducks are undoubtedly a prominent source of bacterial nutrient contamination at some lakes. If homeowners are concerned about ducks the Florida Fish and Wildlife Conservation Commission will issue removal permits. Each lake group needs to decide what constitutes a reasonable amount of ducks on each waterbody. Benefits to removal would be reduced duck feces, bacteria and nutrients, but these benefits need to be weighed against the enjoyment of seeing birds, especially if the birds are not posing a risk to human health.

Section 4 – Environmental Education

The citizens attending the September 2005 workshop and professionals contacted throughout the project all agreed that public education was needed to enhance the management of the Forest Hills lakes. While it is virtually impossible to find anyone who would disagree with the establishment of environmental education programs, effective long-term lake management requires that the lake-users and those charged with implementing the plan receive information from a variety of sources to insure all sides of an issue are presented.

Education is simply a process of helping individuals or groups develop a knowledge base for making life-long decisions. When the educator or educators present only ideas, facts, and other information to further their cause and deliberately damage an opposing cause, the educational material becomes propaganda!

Many of the professionals involved at the Forest Hills lakes agreed on the need for environmental education, but they had a strong sense that the information they posses and are using to base management decisions on is not being transferred to the general public. It was felt that this lack of communication was the cause of many conflicts. The professionals agreed that all forms of educational transfer should be used to help fill the information gap between agencies and the public. The information transfer should also be pro active, trying to educate before a problem starts, not because of a problem.

There was also a consensus that communication among agencies was lacking and there was a need for a forum where all the management issues for the Forest Hills lakes can be discussed proactively. Another suggestion that came up several times was maybe there should be a lake manager contact for the Forest Hills lakes who helps with communication among agencies, professionals and the public. Nearly everyone also emphasized that any educational program needs to be a continuous effort because the riparian owners at the Forest Hills lakes are constantly changing and new owners continually need to be updated on why certain past decisions were made. But, the professionals agreed the citizens should control how they would like to be educated as

this may make the educational material stay with the affected individuals longer.

Section 4 - Management Options

Option I – The "Do Nothing Option".

This option is again always a viable option, but it probably is the least viable option at this time because of the time and effort spent to develop a comprehensive management plan for the Forest Hills lakes. It is clear communication or the lack of communication has been a problem in years past as different activities were initiated at the lakes. If the lake management plan is to truly be a living document, future riparian owners need to be informed of the "whys" that supported initiated lake management activities and where uncertainties exist.

Option II – Implement a Community Education Program.

The North Forest Hills Neighborhood Association INC. should guide a community education program for the Forest Hills lakes. This Association having been strongly involved with he development the management plans for the lakes will maintain sufficient interest in implementing agreed upon recommendations. Overtime the Association will have the ability to insure the plan is a "living" document and that changes to the plan can be made in a timely manner when the facts dictate.

The Association is also in an excellent position to identify riparian owner concerns and reach out to existing community education programs to provide the information needed to make cost-effective management decisions. The association is positioned to take advantage of educational resources already available through local and state governmental agencies as well as educational institutions. For example, Hillsborough County Stormwater

Section has a lake coordinator who can become an excellent resource for the Forest Hills lakes and assist the Association with finding professionals who can address important citizen issues. There is also the Hillsborough County Environmental Protection Commission that has a well-trained staff in a variety of areas. The Southwest Florida Water Management District, the Florida Department of Environmental Protection, and the Florida Fish and Wildlife Conservation Commission represent important sources of educational outreach material and professional insight into real or perceived problems. There are the University of Florida and the University of South Florida, which are major research universities and have many faculties who can provide insights to the management of the lakes. Finally. The University of Florida's Hillsborough County Extension Service is in place to assist groups like the North Forest Hills Neighborhood Association INC. provide important community education programs.

Section 5 – Muck and Aquatic Plants

The bottom material identified as "muck" by homeowners living around the Forest Hills lakes is primarily decomposing plant material. The source of "muck" is of terrestrial and aquatic origin. What lake-users encounter on their lake bottoms is organic material that is resistant to decomposition. The terrestrial plant material that was examined is largely of leaf origin from surrounding near-shore trees. The material linked to aquatic plants was primarily from emergent plants.

Quite often, the public generally does not understand that aquatic plants through their productivity and growth habits contribute large amounts of organic matter to lake sediments. When thoughts of organic deposition emerge to the forefront (particularly in nutrient-rich lakes) algae are often the plant of concern. As a rule of thumb, phytoplankton produce about 2.6 mt/ha/yr and most of that organic matter is decomposed in the water column (see Joyce et al. 1992). Cattails and Bulrush, in comparison, produce 25 mt/ha/yr of organic matter and much of the material is resistant

to decay.

As lakes become older, they become shallower due to sedimentation of inorganic and organic material. For most lakes, materials entering from the lakes' watershed dominate and contribute most directly to the filling in process. Early in the life of a lake, algae represent the primary source of in-lake organic material. As aquatic macrophytes become more abundant, they become the more dominant source of organic material, but even early in the life of a lake, the macrophytes can influence the filling in process along the shore.

Dead plant material originating from emergent plants, like cattails and grasses, is the most resistant plant material produced by aquatic plants (Joyce et al. 1992). When oxygen is not available, the resistance to decomposition increases. The practical result is the plants, over periods of time, extend the shoreline into the lake (shoreline accretion). Organic material not trapped along the shoreline is moved into deeper portions of the lake by water currents where lower oxygen levels reduce plant decomposition. Under the right circumstances, this material can become peat.

The timing and rate of "muck" varies from lake to lake because of a host of different, physical, chemical, and biological reasons. For most lake-users, they do not readily see any changes in the short duration, but lake-users who have been at a Florida lake for decades will most likely see changes in the lake that can be associated with the deposition of organic material originating from aquatic plants. However, every interested Floridian associates the deposition of plant material to muck when aquatic plants are managed by aquatic herbicides.

Individuals often oppose the use of aquatic herbicides because the plants killed by the herbicides fall to the bottom of the lake and contribute to "muck" accumulations on the lake bottom. Research on hydrilla has shown that hydrilla management with herbicides actually produces less organic matter (as much as 2.1 times less) than leaving the plants untreated (Joyce et al. 1992). Consequently, maintenance control of aquatic plants has ecological advantages at the lake besides reduced usage of the absolute

amount of herbicides and reduced costs.

When discussing aquatic plant control with herbicides, many lake-users and individuals opposed to the use of herbicides advocate using mechanical harvesting (with plant removal) to reduce the build-up of “muck” on the bottom of lakes. Mechanical harvesting is the most expensive approach to weed control when a lake is infested with invasive exotics. The high costs are associated with the cost of personnel and equipment. Mechanical harvesting, however, does have a role in aquatic plant management at many lakes if the right conditions exist. The Forest Hills lakes are not so productive that plants could not be managed by mechanical harvesting. Issues to be addressed would be who would operate the machinery and who would buy and maintain the harvester or harvesters. It is possible Hillsborough County could purchase the machinery and loan the harvester to the lakes as needed. The County could assist with plant removal if designated sites could be established at each lake for pickup of plants. However, aquatic herbicides will be needed if plant growth exceeds harvesting rates. The Forest Hills lakes will need to develop an integrated aquatic plant maintenance program to reduce “muck” accumulations and keep aquatic plants at desirable levels.

Section 5 - Management Options

Option I – The “Do Nothing Option”.

This constitutes a viable option at this time because the “muck” problem may not be deemed a priority management issue at this time. With time (perhaps 10 to 20 years), however, the “muck” problem will be viewed by more riparian owners as more severe and action will need to be contemplated.

Option II – Initiate a comprehensive shoreline vegetation management plans to remove non-desirable terrestrial and emergent vegetation.

Along the shores of each of the Forest Hills lakes, there are pockets of terrestrial and aquatic vegetation that consist of non-native vegetation or native vegetation that will produce significant amounts of organic debris. The optimal approach would be the mechanical removal of the material. This approach involves personnel and equipment like trucks. It is possible for the homeowner associations to pool their money and hire a private contractor. It is also possible under certain circumstances to establish a public-private partnership with the homeowner associations, the Sheriff Department, and County government. The Sheriff Department can provide labor through their work or community service programs. The County could provide dump trucks for hauling debris. This approach was used successfully at Lake Wailes (Polk County) and cost very little to accomplish.

Option III – Construct strategically placed deep areas in each lake to trap existing bottom muck.

Bottom muck exists in each of the Forest Hills lakes. The muck is fairly flocculent so water currents can move it. Flocculent muck accumulates in the deeper areas of lakes. If deep holes (8 to 10 feet) are constructed at near-shore locations with access, normal lake processes will move the muck material to the holes. This would reduce muck along shorelines and provide a convenient location for future muck removal by commonly used equipment like trackhoes and backhoes. If the sites were located near the storm drains, the deep areas would trap muck and incoming sediments, thus providing a duel benefit to the lake.

This type of approach would benefit the Stormwater Section and would justify the expenditure of public funds. Materials trapped in the deep areas, however, would contain heavy metals and other contaminants. Disposal using conventional methods would be expensive, but the soils could be taken to

Hillsborough County's lined landfills and used to cover trash. This would then eliminate any concerns regarding possible ground-water contamination.

Option IV – Initiate lake-wide dredging to remove sediments and mucks.

Dredging is the most commonly used approach for removing sediments and muck from lakes. Although this tends to be the most expensive approach, it is the fastest removal mechanism for removing bottom materials. Typically, dredging is not used in many urban areas because of the cost of disposal for the materials. However, there are new approaches where membrane filtration is used to remove sediments from the lake water. This equipment requires very little land space for operation. Costs of the entire operation increase dramatically and treatment of the return water to prevent nutrient enrichment would be need. Whole lake dredging could cost as little as a few hundred thousands at the small Forest Hills lakes to millions for the larger lakes.

Conclusions

As mentioned in the introduction, this document represents a compilation of the available information. While there is a tremendous amount material, you may not have answers to all of your questions. We have presented our ideas regarding potential management documents. You may feel comfortable using just one option or a combination of options. You may have new ideas that we have yet to consider. At the next meeting you will be meeting with your fellow citizens to discuss the options and advance your ideas about how to manage the Forest Hills Lakes. The findings of the September meeting shall result in a comprehensive lake management plan.

Again, you should remember that it is not always possible for science to give absolute answers in a given time, especially considering the large natural variability accompanying most ecological processes involved with lake management. You will be trying to develop a workable management plan for the situation that exists today. This does not mean that there will not be opposing views regarding the “right” approach. Your job will be to find out where the compromises exist.

When there are opposing views as to the approach that should be taken now, it should be remembered that these concerns could be monitored in the future to determine if they are correct. Lakes are very resilient and corrections in the management plan can be made in the future if need be. It is generally best to consider different views as hypotheses that can be tested in the future. If a particular view is correct then changes in the management plan can be made at a later date. This allows all opinions to remain valid until the facts convince the community that the opinions or concerns are no longer valid. Again, it is extremely important to remember that a lake management plan is a "living document".

The document that you are receiving represents a compilation of the available information. We recognize that there is a tremendous amount of reading material. Please do not be discouraged or frightened by the amount of material. You have been

given a summary of the available information related to each issue. Following this information, some viable options are given for the management of the Forest Hills Lakes. In September, you will be meeting with your fellow citizens to discuss the options and advance your ideas about how to manage the Forest Hills Lakes.

You should remember that it is not always possible for science to give absolute answers in a given time, especially considering the large natural variability accompanying most ecological processes involved with lake management. Sometimes scientific answers even take centuries to evolve. Given this uncertainty, you will be trying to provide the best available approaches known at this time. This does not mean that there will not be opposing views regarding the right approach. Your job will be to find out where the compromises exist.

When there are opposing views as to the approach that should be taken, it should be remembered that these concerns could be monitored in the future to determine if they are correct. Lakes are very resilient and corrections in the management plan can be made in the future if need be. Even at this time, there are scientific studies underway to provide better information on certain issues. Do not allow yourself to become trapped in the "Do Nothing" option. This option is often the worst thing that can be done for your lake. There are, of course, times when doing nothing is a correct choice. However, it is generally best to consider different views as hypotheses that can be tested in the future. If a particular view is correct then changes in the management plan can be made at a later date. This allows all opinions to remain valid until the facts convince the community that the opinions or concerns are no longer valid. Again, it is extremely important to remember that a lake management plan is a "living document".

See You in September!!!!!!

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Appendix I

Lake User's Perceptions Regarding Impacts of Lake Water Level on Lake Aesthetics and Recreational Uses.

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