Pros and Cons of Issues Identified by Citizens and Professionals Regarding the Future Management of the Tsala Apopka Chain-of-Lakes.

August 20, 1999

Sponsored by:

Citrus County
and
Southwest Florida Water Management District

Conducted By:

Department of Fisheries and Aquatic Sciences, University of Florida/Institute of Food and Agricultural Sciences.

Table of Contents

Appendices

Appendix I - A workshop on citizens' concerns regarding the future management of the Tsala Apopka Chain-of-Lakes.

Appendix II - A workshop on professional's concerns regarding the future management of the Tsala Apopka Chain-of-Lakes.

Appendix III - Historical (approximately 1965 to 1996) water chemistry data from Southwest Florida Water Management District.

Appendix IV - Summary of aquatic plant management expenditures in Tsala Apopka Chain-of-Lakes, Citrus County Florida. Fiscal years 1993-1998

Appendix V - An article entitled "Aquatic Herbicide Safety" written by Dr. Paul Thayer and published in the proceedings of the Florida Lake Management Society's 1996 Annual Meeting.

Appendix VI - Fish population data collected by Florida Game and Fresh Water Fish Commission between 1975 and 1988 in Tsala Apopka Chain-of-Lakes

Appendix VII - Aerial duck counts conducted by Florida Game and Fresh Water Fish Commission from 1994 to 1998.

Appendix VIII - Four rivers basin project water control plan for Tsala Apopka area. U. S. Army Corps of Engineers Jacksonville District.

Appendix IX – The TEAM Approach, “Together for Environmental Assessment and Management”: A Process for Developing Effective Lake Management Plans or Water Resource Policy.

Introduction

Dear Participant:

LAKE MANAGEMENT is part science and part politics. Science is generally practiced by those individuals called "professionals," although science in some form is also practiced everyday by the lay citizen. Politics is often thought to be practiced solely by elected officials, 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 commonalty -- 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. Over time, as information becomes available and facts become better known, opinions may change. Consequently, any lake management plan must be considered a "living document," just like the constitution of United States.

On May 9, 1998, a representative group of citizens was assembled to advance their concerns (opinions) regarding potential problems at Lake Tsala Apopka. Following this meeting a representative group of scientific professionals was gathered on September 1 & 2, 1998 to discuss their concerns (opinions) regarding the management of Lake Tsala Apopka. Despite differences in their experiences, both groups had many similar concerns. We subsequently assembled scientists and other professionals with direct knowledge of the issues advanced to discuss the facts as best known.

The document that you are reading represents a compilation of the available information. We recognize that there is a tremendous amount of reading material. Please do not be discouraged 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 Lake Tsala Apopka. In September, you will be meeting with your fellow citizens to discuss the options and advance your ideas about how to manage Lake Tsala Apopka.

You should remember that is not possible for science to give absolute answers in a given time. Sometimes scientific answers take many years 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 at Tsala Apopka 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".

Who is in Charge Here?

When controversies arise regarding the management of lakes and citizens become intimately involved in the issues, the most frequently asked question is: "Who is in charge here"? This question gets asked because there are a myriad of federal, state, and local public agencies that have statutory responsibilities in the arena of Lake Management. 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 certainly do not have a lack of caring. Committed public employees staff the agencies, but the agencies are also following the statutory requirements. Unfortunately, the bureaucratic process can lead to intense citizen frustration. Consequently, it is very important for the involved citizen to understand history as it relates to Lake Management.

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. Since that time, state governments have been the principal guardians of natural resources.

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; lakes 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 US Army Corps of Engineers (ACOE) 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 responsibilities.

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 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, many states including 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 Game and Fresh Water Fish Commission, now the Florida Fish and 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.

Despite increased regulatory power and federal funding, state fish and wildlife agencies continued to be embroiled in controversies that affected 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 effect the common properties principal. States as the public trustee of fish and wildlife could now allocate resources to specific groups.

Concern about the environment influenced federal law after the 1960s. 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, which are now joined and called the Florida Department of Environmental Protection. Florida further created five water management districts, including the Southwest Florida Water Management District. Local governments that had sufficient economic resources also created environmental departments with their own regulations. 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 problems and 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 and state 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 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 waterbody 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, 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 without just compensation under due process of law cannot take private property. 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 1990s, politics is often not viewed in a favorable light. Politics, however, is an honorable pursuit. It is often remarked that "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 the 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 legislators 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 appears 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."

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. Despite perceptions, the federal, state, and local agencies involved at Lake Tsala Apopka 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.

Federal agencies working at Tsala Apopka are probably not a good choice to be the lead agency. These agencies have responsibilities beyond Lake Tsala Apopka and cannot provide the intense local involvement necessary. 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 Fish and Wildlife Conservation Commission, and the Southwest Florida Water Management District. The Department of Environmental Protection is involved most intensely in the management of aquatic vegetation. Staff from their Bureau of Aquatic Plant Management work very well with the Southwest Florida Water Management District and Citrus County Aquatic Services, the two other agencies directly involved the management of aquatic plants. The Florida Fish and Wildlife Conservation Commission has limited involvement at Lake Tsala Apopka because fish and game populations do not seem to be in bad shape and the Commission has very limited staff and financial resources to commit to the management of Lake Tsala Apopka. The best agency for the job, given its breadth of responsibilities and qualified staff, appears to be the Southwest Florida Water Management District.

The District is committed to the management of Lake Tsala Apopka. This commitment is evident in part by the fact that they are a partner with Citrus County in funding the development of the lake management plan for Lake Tsala Apopka. The biggest problem with selecting the District is the public perception that the leadership of the District is remote from local concerns and not trustworthy (see Option III). The location of the District in Brooksville may contribute to this perception, but the district is not intently trying to be aloof or untrustworthy. Working through the Withlacoochee River Basin Board might help alleviate some concerns as the Board is composed of citizens, but the Board may not be the sole answer. Regardless, the concerns cannot be swept under the rug.

Another approach may be selecting Citrus County as the lead agency. The County does not have the sizable staff that the District has, but with some modifications and additional funding the County could deal with many Lake Management issues. The County, however, will have to continue to partner with the District to successfully manage Lake Tsala Apopka. The advantage of selecting Citrus County is that the County could provide necessary political leadership and advance lake management issues through the other agencies in a timely manner.

Option II - Re-establish the Tsala Apopka Basin Recreation and Water Conservation Control Authority.

In 1955, the Florida Legislature passed a special act creating the Tsala Apopka Basin Recreation and Water Conservation Control Authority. The Governor appointed three local members to administer the Act. The Authority did considerable work in the management of water levels at Lake Tsala Apopka. This included dredging canals and diking-off sink holes. The Authority had its own budget, but still had to work with other agencies to obtain of permits.

The Authority experienced its own problems over time. At one time, the Authority believed it did not represent Citrus County in its entirety and tried to get a member from the southern part of the County. It struggled with a lack of qualified staff. When the Authority completed many of its goals, individuals interested in serving on the Authority waned. Eventually, the Southwest Florida Water Management District assumed the Authority and its responsibilities.

The advantage of re-establishing the Authority as lead agency for the management of Lake Tsala Apopka would be that the Authority could focus the political leadership into doing what is necessary for the management of the lake. The Authority could also work directly with the existing agencies to make sure that bureaucratic delays are minimized. The Authority, however, probably cannot be reconstituted as it once was, if it is to be effective in today's political climate. One possibility is to create a five-member board. The Citrus County Board of Commissioners would appoint three members. Ideally, each pool (the Floral City, Inverness, and Hernando Pool) of Lake Tsala Apopka would be represented. The other two members would be directly appointed by the area's two state representatives. This is needed because the State of Florida and its agencies will be directly involved in the funding and implementation of any management activities. If the state representatives are to be effective advocates of the management plan and its activities, reality dictates that they have representation on the Authority that they trust. The five-member board should select its own chairperson.

Operation of the Authority will require some budgetary commitments. At this time, it might be appropriate for the Southwest Florida Water Management District and Citrus County to share operational costs. This is recommended because the District and County have shown a commitment to the development of a lake management plan for Lake Tsala Apopka. Operation of a functional Authority would benefit the District and County by providing a local authority that could focus on Lake Tsala Apopka and deal directly with other federal, state, and local agencies with responsibility in the region. The financial commitment will probably involve secretarial support, funds for mailing Authority business, and funds for running public meetings.

Option III - Establish an Ombudsperson Position for Lake Tsala Apopka at Citrus County.

The biggest problem in trying to develop the lake management plan for Lake Tsala Apopka has been the prevailing lack of trust amongst the various groups that have interests at the lake. A noticeable lack of trust exists between some citizens and the group of agencies charged with the management of the lake. The lack of trust, however, is not limited to these two groups alone. Citizens don't trust fellow citizens, agencies don't trust agencies, and scientists don't trust other scientists.

Another problem is the fact that there's no single point of contact for citizens that have concerns about the lake. A citizen has to contact numerous agencies and divisions within the agencies in an attempt to get an answer to their concerns. This leads to intense frustration and a feeling that the agencies do not deserve support. There is also no one charged with checking with the various professional authorities to determine what the prevailing opinions of different experts are on the issues.

One solution to these problems is to establish an Ombudsperson position. The person holding this position would take no side in the various issues, but would represent a single point of contact for the citizens. Not taking sides would help this person build trust with all interested parties. If it is recognized that a lake management plan is a "living document," this person should also have the responsibility of bringing together scientists with different opinions to discuss issues of concern. By doing this, agreements amongst the scientists as well as their disagreements can be determined. This was done in developing the section of management plan you are about to read and it was determine that there was often more agreement than disagreement.

There is already an Ombudsperson working at the Southwest Florida Water Management District. This person has the responsibility for the entire district. However, there appears to be, as noted above, a need for one individual Ombudsperson to work strictly on the Tsala Apopka Chain-of-Lakes. Because the amount of work that this person will be required to do is an unknown quantity, it is suggested that the person be housed with Citrus County Aquatic Services. This person's salary should come from both the District and Citrus County to help maintain the partnership that was initiated with this project. Depending on the unknown workload, this person would be able to assist Citrus County Aquatic Services in other lake management efforts and maintain lines of communication with the District.

Section 1 - Management of Water Quality in the Tsala Apopka Chain-of-Lakes

Managing water quality in the Tsala Apopka Chain-of-Lakes is an extremely difficult objective, primarily because defining "water quality" itself is a difficult task. Water quality can only be defined after first establishing a desired use for a given waterbody. For example, a productive lake with a Secchi depth of two 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 lakes produce abundant fish. This illustrates the primary difficulty in managing water quality--a lake cannot be all things to all people.

The first step in developing a management plan for water quality in the Tsala Apopka Chain-of-Lakes is to define desired lake uses and issues associated with water quality. Thus, on May 9, 1998 a group of citizens identified the following issues as major concerns with respect to the management of water quality in the Tsala Apopka Chain-of-Lakes (see Appendix I):

1a) Clearly define the term "water quality" and how it relates to the use of the Tsala Apopka Chain-of-Lakes.

1b) Maintain and control current trophic status of the lakes.

1c) Monitor lake water chemistry to determine if changes are occurring in the Tsala Apopka Chain-of-Lakes.

1d) Control and eliminate sources of nutrient, bacterial and chemical contamination to the lakes from poorly functioning septic tanks, point sources, and stormwater runoff from roads.

1e) Understand how water softeners may increase salinity of water flowing into lakes and if this may impact Lake Ecology.

On September 1 and 2, 1998 a group of professionals also identified issues concerning the management of water quality in the Tsala Apopka Chain-of-Lakes (see Appendix II). The following is a list of those issues:

1f) Water quality in the Tsala Apopka Chain-of-Lakes appears to be good but there should be a monitoring program to ensure there is no future degradation with increasing population growth.

1g) The professionals agreed that septic tanks are a major issue for all groups who are concerned with the Tsala Apopka Chain-of-Lakes. However, there are two questions associated with this issue: 1) are septic tanks adding unwanted nutrients to the Tsala Apopka Chain-of-Lakes? and 2) are septic tank causing increased bacterial concentrations in the Tsala Apopka Chain-of-Lakes thereby causing potential health problems?

The objectives for this water quality management plan are to address each of the above issues and give options based on the pros and cons of each issue. The pros and cons of these issues were debated on December 9, 1999 by a panel of water quality experts from around the state. There were no major disagreements among the experts and the following discussions represent a consensus about the management of water quality in the Tsala Apopka Chain-of-Lakes.

Current Water Chemistry in the Tsala Apopka Chain-of-Lakes

The Tsala Apopka Chain-of-Lakes is actually a network of islands, lakes, wetlands, and canals that can be loosely divided into three “pools”: the Floral City Pool, the Inverness Pool, and the Hernando Pool. Lakes within each pool are hydrologically linked to each other by natural and artificial means and many of the interconnecting waterways are intermittent. Lakes are partially fed by the Withlacoochee River and during high water years, water generally flows north from the Floral City Pool, through the Inverness Pool and into the Hernando Pool.

Citizen volunteers working under the auspices of Florida LAKEWATCH recently (1991-1999) measured water clarity (Secchi Depth), algal biomass (chlorophyll concentrations), total phosphorus, and total nitrogen concentrations in four lakes from the Floral City Pool (Floral City, Tsala Apopka South, Hampton, and Tussock), four lakes from the Inverness Pool (Spivey, Henderson, Little Henderson, and Tsala Apopka) and six lakes from the Hernando Pool (Van Ness, Croft, Hernando, Todd, Bellamy, and Dodd). During this time period, organic color and aquatic plant communities were also measured by staff from Florida LAKEWATCH.

Data collected by volunteers and LAKEWATCH staff yield the following trends and averages:

Water Clarity — Water clarity as measured with a Secchi disc increased as one moved northward from the lakes of the Floral City Pool, through the Inverness Pool, and into the Hernando Pool. Secchi disc measurements averaged 3.5 ft in the Floral City Pool, 4.5 ft in the Inverness Pool, and 8.0 ft in the Hernando Pool.

Algal Biomass — Algal biomass as measured by chlorophyll concentrations decreased as one moved northward from the lakes of the Floral City Pool, through the Inverness Pool, and into the Hernando Pool. Chlorophyll concentrations averaged 17 µg/L in the Floral City Pool, 9 µg/L in the Inverness Pool, and 4 µg/L in the Hernando Pool.

Nutrient Concentrations — Total phosphorus concentrations generally declined as one moved northward from the lakes of the Floral City Pool, through the Inverness Pool, and into the Hernando Pool. Total phosphorus concentrations averaged 34 µg/L in the Floral City Pool, 20 µg/L in the Inverness Pool, and 10 µg/L in the Hernando Pool. Total nitrogen concentrations were lower in the Hernando Pool than they were in the Floral City or Inverness Pools. Total nitrogen concentrations averaged 980 µg/L in the Floral City Pool, 1,010 µg/L in the Inverness Pool, and 680 µg/L in the Hernando Pool.

Organic Color — Color concentrations gradually declined as one moved northward from the Floral City Pool, through the Inverness Pool, and into the

Hernando Pool. Color averaged 122 Pt-Co units in the Floral City Pool, 106 Pt-Co units in the Inverness Pool, and 35 Pt-Co units in the Hernando Pool.

Aquatic Plants — The abundance of aquatic plants was greater in the Hernando Pool relative to the Floral City and Inverness Pools. The percent area covered with aquatic plants increased from 11% in the Floral City and Inverness Pools to 90% in the Hernando Pool. The percent of the water column occupied by aquatic plants increased from less than 5% in the Floral City and Inverness Pools to 44% in the Hernando Pool.

Submersed plant biomass averaged less than 0.5 kg wet weight per square meter in the Floral City and Inverness Pools, but averaged over 7 kg wet weight per square meter in the Hernando Pool. Emergent plant biomass was higher in the Inverness Pool and floating-leaved plant biomass was higher in the Hernando Pool.

Trophic Status — The trophic state of a lake is determined by the lake's level of biological productivity, which is often estimated from algae and aquatic plant biomass. Lakes range along the trophic state continuum from oligotrophic (very low in biological productivity) to hypereutrophic (very high in biological productivity). Lakes that have moderate and high levels of biological productivity are termed mesotrophic and eutrophic, respectively. Eutrophication is the process that some lakes undergo in which they become more biologically productive. For example, progressing from an oligotrophic lake to a mesotrophic state is considered eutrophication.

Based on the algal biomass (as measured by chlorophyll concentrations) and aquatic plant data, the lakes of the Tsala Apopka Chain-of-Lakes are currently eutrophic, or biologically productive. The available LAKEWATCH data suggest the lakes have been eutrophic since their entry into the program.

Some Florida lakes are naturally eutrophic by virtue of their underlying soils and bedrock composition, others are pushed toward eutrophy by human activities. Many lakes that occur in low-lying, organic soils are naturally eutrophic, whereas lakes that occur in high sand hills tend to be less eutrophic. Without long-term monitoring data, it is not possible to determine whether the lakes are naturally biologically productive or if they have undergone eutrophication in the recent past. With continued monitoring, however, in the future it will be possible to evaluate whether the productivity of the Tsala Apopka Chain of Lakes is gradually changing.

Discussion of Issues Identified by Citizens

Issue 1a) Clearly define the term water quality and how it relates to the use of the Tsala Apopka Chain-of-Lakes.

The water quality experts brought together to debate the pros and cons of each water quality issue, agreed that defining water quality is difficult. Unfortunately, many citizens and professionals equate lake trophic status with good or bad water quality. It was agreed, however, that this view is flawed for two reasons; 1) Lakes of low trophic state or of high trophic state can be good or bad depending on the defined use, and 2) a lake can be naturally oligotrophic or eutrophic depending on many factors, but primarily the physiographic region in which it exists. Therefore, water quality can not be defined using simple lake trophic state variables.

Lakes in "pristine or natural" condition are commonly considered by citizens and professionals to have good water quality. Again this is a difficult concept and probably not the best to use when defining water quality because of the difficulty in defining "natural" conditions. Did natural conditions exist 10, 100, 1,000, or 10,000 years ago? This is especially difficult considering that lakes age naturally and change through time. Additionally, if we define "natural" as the conditions existing 1,000 years ago, how can the water chemistry conditions at that time be determined?

Perception is another complicating factor when defining water quality. For example, individuals who are used to recreation on productive lakes in Iowa would consider that a lake with an 8-ft Secchi depth has good water clarity and therefore good water quality. A person from Maine, however, who is used to looking at lakes with Secchi visibility in excess of 20 feet would consider a lake with a Secchi visibility of 8 feet as degraded and therefore of bad water quality.

For the reasons listed above it will be difficult to satisfactorily define the term water quality as it applies to the Tsala Apopka Chain-of-Lakes. Many people currently use the Tsala Apopka Chain-of-Lakes for a multitude of activities and there are few complaints about water quality negatively impacting these activities. Therefore, current water quality in the Tsala Apopka Chain-of-Lakes, without a clear definition, is apparently acceptable to the majority of the user groups. Thus, the important issue is maintaining current water quality for the system.

Issue 1b) Maintain and control current trophic status of the lakes.

Personnel from the South West Florida Water Management District have assembled all available historical water chemistry data for the Tsala Apopka Chain-of-Lakes (see Appendix III). These water chemistry data, illustrate that the major trophic state variables (total phosphorus, chlorophyll, and total nitrogen) in the Tsala Apopka Chain-of-Lakes have not changed significantly over the last 10 to 30 years. This suggests that while the population around the lake system has increased over the last thirty years, population increases have not led to increases in lake trophic state. In fact, with the removal of a sewage treatment plant in the Inverness Pool, total phosphorus concentrations have actually declined.

The lack of significant changes in the trophic status of the Tsala Apopka Chain-of-Lakes suggests that maintaining the current trophic status is an important goal. Maintaining the current trophic status through time requires careful management of activities that would significantly increase nutrient loading to the Tsala Apopka Chain-of-Lakes. It also requires the continued monitoring of the lake to evaluate whether significant increases in trophic state variables are occurring.

Issue 1c) Monitor lake water chemistry to determine if changes are occurring to the Tsala Apopka Chain-of-Lakes.

As mentioned in the discussion of issue 1b, maintaining lake trophic status requires the implementation of a water chemistry monitoring system. Fortunately, for the Tsala Apopka Chain-of-Lakes, 15 lakes in the chain are currently monitored by citizen volunteers in the Florida LAKEWATCH program. Keeping these lakes in the Florida LAKEWATCH program will insure that any changes in water chemistry are measured and fully documented.

Issue 1d) Control and eliminate nutrient, bacterial and chemical contamination inputs to the lakes from poorly functioning septic tanks, point sources, and storm water runoff from roads.

The concern over nutrient, bacterial, and chemical contamination of the Tsala Apopka Chain-of-Lakes from septic tanks, point sources, and stormwater runoff is well founded. Especially, considering the population in Citrus County has dramatically increased from 9,268 in 1960 to 93,515 in 1990. Population increases are often accompanied by increases in septic tanks, watershed development, and stormwater runoff.

The impact of septic systems on the Tsala Apopka Chain-of-Lakes dominated the concerns of many citizens in the Citizens' Issue Forum (Appendix I). These concerns were focused on two separate issues: 1) nutrient additions may cause eutrophication of the Tsala Apopka Chain-of-Lakes, and 2) bacterial or viral additions that may cause health problems for people using the Tsala Apopka Chain-of-Lakes.

Conventional onsite wastewater treatment systems typically consist of a septic tank and a subsurface wastewater infiltration system. Wastewater flows from a home, through a septic tank and into an infiltration system where it infiltrates the soil and percolates downward to groundwater. The septic tank provides primary wastewater treatment that removes the majority of settleable solids, grease, and other floatable solids that could clog the infiltrative surface and cause hydraulic failure of the system. Anaerobic breakdown and digestion of the retained solids also occur in septic tanks. Soils below the infiltration system provide physical, chemical, and biological treatment of septic tank effluent as it percolates to groundwater.

The infiltration system is the most critical component of a septic system. It provides most of the treatment and ultimate disposal of the wastewater. The effectiveness of an infiltration system is limited by the characteristics of the treatment site, primarily the soil type and the vertical distance between the output of wastewater and the groundwater surface. Thus, successful performance of septic tank systems is achieved only if the soil below the wastewater output accepts all wastewater it receives and provides sufficient final treatment before reaching groundwater.

The following summarizes the performance of conventional septic systems that was published by the State of Florida Department of Health and Rehabilitative Services in 1993:

Summary of Documented Conventional Onsite Sewage Disposal Systems (Section 4.5.2 of the report entitled "An Evaluation of Current OSDS Practices in Florida")

> Septic tank systems are designed to provide wastewater treatment and disposal through soil percolation and groundwater recharge. Satisfactory performance is dependent on the properties of the soil underlying the infiltrative surface. The soil must have adequate pore characteristics, size distribution and continuity to accept the daily volume of wastewater that is applied and to provide sufficient soil/water contact and retention for achievement of acceptable treatment before percolating wastewater enters groundwater.
>
> Important soil properties include:
>
> Texture (particle size)
> Structure (arrangement/aggregation)
> Pore size distribution and continuity
> Bulk density
> Mineralogy
> Organic content
> Cation exchange capacity
> pH
> Moisture content
> Redox potential
>
> Satisfactory performance based on monitoring of traditional wastewater variables (BOD_5, suspended solids, fecal coliforms) has been shown to occur where an aerobic, unsaturated zone of medium to fine textured soils, 2 to 5 ft

in thickness, is maintained below the infiltrative surface during operation. Soils with excessive permeability (coarse textured soil or soil with large and continuous pores), low organic matter contents, low pH, low cation exchange capacities and redox potentials, high moisture contents and low temperatures have been shown to reduce treatment efficiencies.

Groundwater monitoring below properly sited, designed, constructed, and operated subsurface infiltration systems shows BOD_5, suspended solids, fecal indicators, and surfactants are effectively removed within 2 to 5 ft in unsaturated, aerobic soil. Phosphorus and metals can be removed through adsorption, ion exchange, and precipitation reactions, but the capacity of soils to retain these ions is finite and varies with soil mineralogy, organic content, pH, redox potential, and cation exchange capacity. The fate and transport of viruses are largely unknown, but there is growing evidence that some types of viruses leach with wastewater from subsurface infiltration systems to groundwater. Fine textured soil, low hydraulic loadings, aerobic subsoils, and high temperatures favor virus destruction. Toxic organics appear to be removed in aerobic subsoils, but further study of the fate and transport of these compounds is needed. Public health and environmental risks from properly sited, designed, constructed, and operated septic tank systems are apparently low. However, use of conventional septic tank system technology in high density developments or environmentally sensitive areas could increase these risks to unacceptable levels.

Septic tank systems do impact groundwater quality and, therefore, have the potential to impact surface water quality. Studies show that after the treated percolate enters groundwater, it remains as a distinct plume for as much as several hundred feet. Solute concentrations can remain above ambient groundwater concentrations within the plume. Attenuation of solute concentrations is dependent on the quality of the natural recharge and travel distance from the source. Organic bottom sediments of surface waters appear to provide some retention or removal of wastewater contaminants. Groundwater must seep through bottom sediments to enter surface waters. Bottom sediments can effectively remove trace organics, endotoxins, nitrate, and pathogenic agents through biochemical activity. However, few data regarding the effectiveness and significance of removal by bottom sediments are available.

This summary suggests that properly constructed, located and maintained septic tanks are efficient at treating both nutrients and infectious agents in wastewater. However, poorly constructed and improperly located septic tanks have the potential to impact surface waters by both increasing nutrient concentrations and causing health related problems.

It is difficult to determine exactly how many septic tanks in the Tsala Apopka Chain-of-Lakes area are functioning properly. Historical information on in-lake nutrient concentrations (see Appendix III), however, shows no significant nutrient increases in Lakes Hernando (1987 to 1996), Little Henderson (1987 to 1996), Henderson (1973 to 1996), or Floral City (1984 to 1996). These data suggest that even with increases in population and associated septic tanks, stormwater runoff and development, there appears to have been no significant increase in nutrient concentrations of the lakes in the Tsala Apopka Chain-of-Lakes.

The impact that septic tanks, point sources, and stormwater runoff have had on bacterial and chemical contamination is difficult to assess because current and historical information on bacterial and other chemical concentrations in Tsala Apopka Chain-of-Lakes is unavailable.

Issue 1e) Understand how water softeners may increase salinity of water flowing into lakes and if this may impact the ecology of the lakes.

Many homes surrounding the Tsala Apopka Chain-of-Lakes have private wells for water supply. The water from these wells is considered "hard", with dissolved minerals mostly in excess of 1 grain per gallon or 17 mg/L. The most common of these minerals are calcium and magnesium. An unknown number of homes in this area use some type of water softener to eliminate difficulties caused by hard water.

Most water softeners use a synthetic resin to remove minerals. The resin beads contain sites that hold sodium ions. As hard water passes through the resin, calcium and magnesium ions are attracted to the resin beads and exchange with the sodium ions. This process is called ion exchange and it continues until most of the sodium on the resin beads is replaced with hardness ions. The resin beads are considered exhausted when they are covered with hardness ions because they can no longer exchange sodium ions with hardness ions. The resin beads must now be recharged. During this process, a sodium chloride salt solution is rinsed through the resin beads exchanging new sodium ions for the calcium and magnesium ions, which are flushed down the drain. If the home is not connected to a sewer system then the wastewater from the water softening process, including many ions of calcium, magnesium and chloride, enters the watershed directly or through a septic tank.

The exact number of homes that utilize water softeners in the Tsala Apopka Chain-of-Lakes' watershed is unknown. This number is required to calculate accurately how much extra salt is being added to the system. However, if there were enough water softeners being used to change the water chemistry in the Tsala Apopka Chain-of-Lakes, it should be evident in the long-term water chemistry data available in Appendix III. Chloride concentrations and specific conductance measurements (a general measure of all ions in water) showed no significant increase in Lakes Hernando (1965 to 1996), Little Henderson (1987 to 1996), Henderson (1965 to 1996), or Floral City (1965 to 1996) over approximately the last 30 years. This suggests that water softeners are probably not altering salinity in the Tsala Apopka Chain-of-Lakes.

Summary of Options to be considered for the Management of Water Quality in the Tsala Apopka Chain-of-Lakes

The following options for water quality management of the Tsala Apopka Chain-of-Lakes are listed for consideration by the citizens who originally identified issues of concern for the Tsala Apopka Chain-of-Lakes (see Appendix I). These options are not presented as recommendations by the water quality experts who were brought together to discuss the pros and cons of identified issues, but rather as possible approaches to water quality management in the Tsala Apopka Chain-of-Lakes. A section on economics is included because it is an important factor to consider with respect to the management of water quality in the Tsala Apopka Chain-of-Lakes.

Option 1. Maintain Current Status

Doing nothing to manage water quality in the Tsala Apopka Chain-of-Lakes is a viable and inexpensive option. This option may be appropriate for the Tsala Apopka Chain-of-Lakes because there appear to be no long-term changes in water chemistry variables used to estimate lake trophic status (total phosphorus, total nitrogen, chlorophyll), and there are few complaints from user groups concerning water quality. There may, however, be changes in other water quality variables that are not currently being measured.

Option 2. Continue Monitoring

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 in four lakes from the Floral City Pool (Floral City, Tsala Apopka South, Hampton, and Tussock), four lakes from the Inverness Pool (Spivey, Henderson, Little Henderson, and Tsala Apopka) and six lakes from the Hernando Pool (Van Ness, Croft, Hernando, Todd, Bellamy, and Dodd). With the continued support of the citizens this monitoring effort should be sufficient to detect any significant changes that may be occurring to the trophic status of lakes in the Tsala Apopka Chain-of-Lakes. The Florida LAKEWATCH program, however, is not set up to monitor contamination of the Tsala Apopka Chain-of-Lakes from other chemicals or bacteria.

Option 3. Expand Lake Monitoring to Include Potential Chemical or Biological contaminants

Research for this report has not detected any cases in which chemical or biological contamination of the Tsala Apopka Chain-of-Lakes caused environmental degradation or human health problems. However, if these issues are of concern to citizens using the Tsala Apopka Chain-of-Lakes, additional funding would have to be appropriated to measure other chemicals or bacteria that may be entering the Tsala Apopka Chain-of-Lakes from poorly functioning septic tank systems, point sources, or stormwater runoff.

Option 4. Organize Program for Septic System Inspections.

Properly constructed, located and maintained septic tanks are efficient at treating both nutrients and infectious agents in wastewater. However, poorly constructed, improperly located septic tanks can impact surface waters by both increasing nutrient concentrations and causing health related problems. Thus, septic tank inspections could be instituted to assure that all septic tanks in the area of the Tsala Apopka Chain-of-Lakes are functioning properly.

Economics

The cost of monitoring the Tsala Apopka Chain-of-Lakes through the Florida LAKEWATCH program is minimal, as long as volunteers continue to donate their time. Therefore, no additional funds are needed to continue this monitoring program. However, this program only addresses lake trophic state variables.

Another program would have to be started in order to monitor other chemical and bacterial parameters. This would require the appropriation of new funds. Some commonly measured constituents found in storm water runoff and wastewater that potentially could occur in surface waters include; bacteria (total coliforms and fecal coliforms), surfactants (alkylbenzenesulfonate), toxic organic compounds (1,4-dichlorobenzene, toluene, xylenes, 1,1-dichloroethane, 1,1,1-trichloroethane, and acetone) and metals (antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver and zinc). The cost of analyzing these constituents varies considerably among laboratories. The costs of analyzing bacteria are around \$15 to \$20 per sample, surfactants about \$35 to \$65 per sample, toxic organic compounds around \$90 to \$125 per compound, and metals about \$15 to \$25 per sample. These figure do not account for the time and personnel used to collect the samples.

The sampling design (location and frequency) in Tsala Apopka Chain-of-Lakes would have to be considered carefully before starting such a program. Currently, Florida LAKEWATCH samples three stations monthly in each of 14 lakes in the Tsala Apopka Chain-of-Lakes. Assuming the same number of samples (504) would be collected for bacterial and additional chemical analysis, it would cost approximately \$400,000 dollars to analyze each of the above variables for one year. Additional money would be needed for sample collection and data analysis.

Inspection all septic tank systems around the Tsala Apopka Chain-of-Lakes would require the appropriation of new monies for the development of an inspection program. The Citrus County Department of Environmental Health inspects septic systems for proper location and height above ground water at a cost of approximately $50. Private businesses would be required to inspect the tanks and pump out solids, at a cost of about $150. This inspection would not be a one-time event and the Citrus County Department of Environmental Health suggests inspections would have to be done about every three years to insure proper septic system functioning.

Section 2 - Management of Aquatic Plants in the Tsala Apopka Chain-of-Lakes

Currently, Florida Department of Environmental Protection and Citrus County have the responsibility to manage aquatic plants in the Tsala Apopka Chain-of-Lakes. Aquatic plant management by any means often causes controversy between and among user-groups, scientists, and management /regulatory agencies over whether there is a "weed problem" and whether the problem needs to be managed. If all parties agree that management is necessary, quarrels then tend to erupt over how much aquatic vegetation should be controlled. If consensus develops about the level of aquatic vegetation, additional concerns then develop over how to achieve desirable levels. Should nutrient control be instituted? Should aquatic herbicides be used or should mechanical harvesting be used? Should biological control like grass carp be used?

Aquatic plant management is an important aspect of Lake Management. As with other Lake Management issues, controversies come with the territory. Quarreling amongst ourselves, however, cannot solve problems nor improve the chances that a serious aquatic weed problem will improve if left alone. A well-evaluated and carefully designed management plan must be developed for each waterbody. With reasonable care in the decision making process, aquatic plants can be managed successfully without destroying the desirable attributes of the Tsala Apopka Chain-of-Lakes.

The first step in developing a management plan for aquatic macrophytes is to define the uses of the Tsala Apopka Chain-of-Lakes and the major issues regarding aquatic macrophytes. Thus, on May 9, 1998 a group of citizens (see Appendix I) identified the following issues as major concerns regarding the management of aquatic plants in the Tsala Apopka Chain-of-Lakes:

2a) Aquatic plants should be managed for fish and wildlife concerns, recreational access, and other navigational concerns.

2b) Aquatic plants should be managed to reduce future accumulations of muck.

2c) Where possible, manage systems for native aquatic plants.

2d) Harvested material should be used to create wildlife islands where possible.

2e) Biological control and plant harvesting should be considered before chemical control.

On September 1 and 2, 1998 a group of professionals (see Appendix II) also identified issues concerning the management of aquatic plants in the Tsala Apopka Chain-of-Lakes. The following is a list of their issues:

2f) The management of aquatic macrophytes and tussocks are major issues facing the overall management of the Tsala Apopka Chain-of-Lakes.

2g) The management of aquatic macrophytes and tussocks should only be conducted after first considering impacts to fish and wildlife.

2h) Other management efforts in the Tsala Apopka Chain-of-Lakes, including water level manipulations should be conducted after first determining impacts to aquatic macrophytes and tussock formation.

The objectives for this aquatic plant management section are to address each of these issues and give options based on discussions of the pros and cons of each issue. The pros and cons of these issues were debated on November 4, 1998 by a panel of aquatic plant management experts from around the state of Florida. There were no major disagreements among the experts and the following discussions represent a consensus about the management of aquatic plants in the Tsala Apopka Chain-of-Lakes.

Historical and Current Aquatic Plant Management in the Tsala Apopka Chain-of-Lakes

Citrus County Aquatic Services has managed aquatic plants on Tsala Apopka Chain-of-Lakes since 1977. Citrus county has received funds through Department of Environmental Protection's (DEP) Cooperative Aquatic Plant Control Program (Chapter 62C-54 FAC) since the early 1980's. Pursuant to the Florida Aquatic Weed Control Act (FS 369.20) and Chapter 62C-54 F.A.C., Citrus County develops annual aquatic plant management workplans to apply for funds to control aquatic plants in the Tsala Apopka Chain-of-Lakes, through DEP's Cooperative Program. The workplans are reviewed by Florida Game and Fresh Water Fish Commission, DEP, and other concerned citizens or environmental agencies, and are designed to address the following issues:

- maintain navigation through designated trails and keeping boat ramps free of obstructions,
- gaining and sustaining maintenance control of highly invasive non-native aquatic plants such as hydrilla, water hyacinth, and water lettuce thereby improving and encouraging native fish and wildlife habitat,
- minimizing impacts to fish and wildlife, including endangered species,
- integrating management techniques, including the use of biological control agents and mechanical control devises,
- evaluating new techniques for aquatic plant management,
- managing and preventing floating tussocks through the use of cost-efficient methods such as in-lake disposal.

The Tsala Apopka Chain-of-Lakes poses a unique challenge in that so much of the system is shallow and vegetated. Due to the absence of sufficient recurring funds to manage all of Florida's public waters, there are some years when statewide requests for aquatic plant management cannot be fully realized. The Tsala Apopka Chain-of-Lakes is only one of Florida's 450 public waters that are eligible to receive aquatic plant management funds. Because of recurring budget shortfalls, and to help disburse funds equitably across the state, the following priorities have been developed for DEP’s Cooperative Aquatic Plant Management Program:

1. Floating vegetation (water hyacinth and water lettuce) including plants in canals that could contaminate adjacent public lakes and rivers.

2. New hydrilla infestations, usually at boat ramps. Also hydrilla in canals connected to lakes that contain little to no hydrilla.

3. All aquatic plants to keep public boat ramps accessible and navigation trails open that benefit the public. Navigation trails should not exceed 50 feet wide.

4. Create open areas in extensive hydrilla stands:
    - flood control and navigation structures,
    - recreation.

5. Large scale hydrilla control considerations:
    - **water uses**
        - navigation
            - commercial
            - public
        - flood control
        - drinking and irrigation
        - recreation potential
            - boating
            - fishing / hunting (commercial / recreational)
            - water sports (swimming, skiing, etc.)
            - wildlife observation
        - wildlife management
        - habitat
            - endangered species concerns
    - **control feasibility**
        - potential for control
            - available methods
            - environmental conditions (especially water movement)
        - history of control success

•potential for native / invasive plant regrowth
•cost
•public support level
•**other considerations**
•trophic state of the water body
•water body classification and S.W.I.M. potential
•pollution problems
•alternative water body proximity

6.Other plants (except in boat trails)

7.Residential or dead end canals or boat trails servicing private homes or clubs except for:
•water hyacinth or water lettuce,
•hydrilla, if a connecting public water has little to no hydrilla.

The Tsala Apopka Chain-of-Lakes falls into several of these priorities and has received $2.9 million of aquatic plant management over the last five years (approximately $2.0 million from DEP, and $900,00 from Citrus County, Appendix IV). These monies were spent controlling floating plants (water hyacinth *Eichornia crassipes* and water lettuce *Pistia stratiotes*), *hydrilla verticillata*, non native and native nuisance plants, and tussocks. The control was conducted at access points and in lakes throughout the Tsala Apopka Chain-of-Lakes and in a large trail system connecting many of the lakes.

Levels of Aquatic Plant Control

The Tsala Apopka Chain-of-Lakes is actually a network of islands, lakes, wetlands, and canals that can be loosely divided into three “pools”: the Floral City Pool, the Inverness Pool, and the Hernando Pool. The lakes within each pool are hydrologically linked to each other by natural and artificial means and many of the interconnecting waterways are intermittent. Each lake, wetland and canal has it's own potential to produce aquatic plants based on several environmental factors. In general, aquatic plants become more abundant moving from Floral City Pool north through the Inverness Pool and into the Hernando Pool. Some concerns listed by the citizens centered on uses (e.g., access, navigation, fish and wildlife). When aquatic macrophytes interfere with a defined lake use then some level of aquatic plant control becomes necessary.

Levels of control that need to be considered are:

a) No Control: It may be best to leave special habitat areas untouched if they do not support significant infestations of exotic plants, such as shoreline wildlife conservancy areas that serve as nesting and forage sites for waterfowl and other animals. Sometimes these sanctuary areas are islands within the water body system. Native plant beds that function as fish spawning sites might best be left alone or subjected to minimal treatment. In some cases, the presence of native plants may have aesthetic value to the surrounding community.

b) Moderate level of control: Moderate levels of control might be all that is needed to attain your management goals. This usually involves a partial removal of vegetation or removal in select areas. For instance, in lakes where a warm-water fishery is important, using mechanical means to develop fish lanes through vegetation can be quite valuable. Moderate intensity control efforts are also important in shoreline treatments where emergent vegetation is to be protected.

c) High level of control: Certain situations may require aggressive control. For safety reasons, it may be necessary to clear all vegetation from swimming or wading areas. Other areas requiring intensive removal may include areas around docks or boat ramps. The presence of invasive non-native plants may justify aggressive lake-wide measures to remove plants. Some user groups do often not consider lake-wide control efforts to control 100% of invasive exotic aquatic macrophytes appropriate, but it might be the best.

The level of aquatic plant control in the Tsala Apopka Chain-of-Lakes can range from doing nothing to controlling the maximum amount of plants with available money or the maximum amount that would be permitted by the Florida Department of Environmental Regulation. These levels of aquatic plant control can be implemented on the whole chain-of-lakes or individual areas within the chain depending on the management objectives.

Examination of Issues with Different Levels of Aquatic Plant Control

Issue 2a) Aquatic plants should be managed for fish and wildlife concerns, recreational access, and other navigational concerns. *With no aquatic plant control*

The do nothing level of control is an option but it does not meet all of the demands of this issue. Access for recreation and navigational activities, which are major concerns of citizens, would be impaired by selecting a do nothing option. Without aquatic plant control in the Tsala Apopka Chain-of-Lakes both native and exotic aquatic plants, especially hydrilla and water hyacinth, would increase in lakes, block boat ramps and trails making movement within and between lakes difficult if not impossible.

The do nothing level of control would not be harmful to all fish because some small fish species (e.g., bluespotted sunfish *Enneacanthus gloriosus* and golden topminnow *Fundulus chrysotus*) thrive on abundant, even matted aquatic vegetation. In areas where vegetation became abundant and matted, however, the well being of many sportfish would be decreased. One primary reason for the decrease in well being would be caused by the sportfishes inability to capture prey items in the high structural complexity of matted aquatic vegetation. The decrease in available access and navigation would also significantly decrease the ability of anglers to fish for sportfish.

The do nothing level of control would also not be harmful to all species of aquatic birds because similar to the fish populations some bird species (e.g., ring-necked duck *Athya collaris*) thrive in abundant, even matted aquatic vegetation. However, some bird species (e.g., double-crested cormorant *Phalacrocorax auritus*) that forage in the water column tend to leave matted vegetation for open water habitats. Thus, for both fish and aquatic bird populations as aquatic macrophytes increase in a lake total abundances remain relatively stable. The species composition, however, changes from open water oriented species to aquatic macrophyte oriented species. Therefore, the do nothing level of plant control would benefit some species while harming others.

Issue 2a) Aquatic plants should be managed for fish and wildlife concerns, recreational access, and other navigational concerns. <u>*With moderate levels of aquatic plant control*</u>

The moderate level of aquatic plant control is an option that meets most of the demands of this issue. A moderate level of control will keep the majority of boat ramps and channels open allowing access and travel within and between most lakes of the Tsala Apopka Chain-of-Lakes. A moderate level of control would also allow for maintenance control of water hyacinth keeping this plant from expanding and decreasing access and navigation. In some areas of the Tsala Apopka Chain-of-Lakes, however, where hydrilla has the potential to completely cover lakes (primarily lakes in the Hernando and Inverness Pools), a moderate level of aquatic plant control may not be enough to keep lakes open to navigation and fishing.

Maintenance control (or management) refers to controlling plants at low levels and before they 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 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 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. 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 hyacinth can double every 7 - 10 days. Ten plants 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.

A moderate level of aquatic plant control would allow some open water habitats and some vegetated habitats for both fish and birds. This would yield a mixture of open-water oriented species and aquatic plant oriented species. The probability of negatively impacting sportfish populations would also be decreased.

Issue 2a) Aquatic plants should be managed for fish and wildlife concerns, recreational access, and other navigational concerns. *<u>With a high level of aquatic plant control</u>*

The high level of control is an option that meets some of the demands of this issue. At high levels of aquatic plant control, access to all boat ramps, trails and lakes for navigation would be good. When large levels of aquatic plants are controlled, fish and bird populations will generally switch from aquatic macrophyte oriented species to open-water oriented species, some of which are sportfish. When managing aquatic plants at extremely low levels reproduction and recruitment of some sportfish species can be negatively impacted. Also, if abundant aquatic macrophytes are killed rapidly sever oxygen depletions can occur causing significant fish kills.

Issue 2b) Aquatic plants should be managed to reduce future accumulations of muck. With no aquatic plant control.

The do nothing level of control is an option that does not meet the demands of this issue. Accumulation of muck or organic sedimentation is a complex physical problem resulting in the filling of Lake Bottoms with decomposing terrestrial and aquatic plants (both algae and rooted aquatic plants). This problem may be more significant in warmer latitudes, where aquatic plant productivity is enhanced by warm weather. While little is known about organic sedimentation in most water bodies, some studies have measured a significant contribution made by aquatic plants (e.g., giant reed *Phragmites* spp., cattail *Typha* spp., and water hyacinth) to the accumulation of materials in a lake bottom. Thus, allowing aquatic plant populations, especially exotic ones, to thrive unchecked with no aquatic plant control could significantly increase accumulation of muck.

Whether this particular example is an ecological or user problem, or both, depends on several things. For instance, accumulation of aquatic vegetation in ponds, lakes, and bogs is an integral part of the natural succession of shallow open water bodies to vegetation-covered wetlands, or even terrestrial vegetation. Active management would be necessary to stop, reverse or slow succession. Invasive, non-indigenous plants now dominate many of the water bodies that are rapidly filling in. Biomass production by these species can be many times that of the native species that are reduced or eliminated from the sites because of competition. Again, depending on the stated uses for an aquatic system, managers may want to reduce the added accumulation of decaying biomass by reducing non-native species and being less concerned about the consequences of native plant growth.

Issue 2b) Aquatic plants should be managed to reduce future accumulations of muck. With moderate or high levels of aquatic plant control.

Moderate and high levels of aquatic plant control would both act to decrease aquatic macrophyte abundance and potentially future accumulations of muck. Even the complete elimination of aquatic plants, however, would not stop the build up of muck. Other plants like algae and terrestrial plants will still contribute to the additions of muck in the Tsala Apopka Chain-of-Lakes. Terrestrial erosion can also contribute to the accumulations of muck. Therefore, many other management activities should be examined when considering muck accumulation in the Tsala Apopka Chain-of-Lakes.

Issue 2c) Where possible, manage systems for native aquatic plants. <u>With no aquatic plant control.</u>

Controlling no aquatic plants in the Tsala Apopka Chain-of-Lakes is an option that does not meet the goal of managing for native aquatic plant species. Hydrilla and water hyacinth, the two major exotic species in the Tsala Apopka Chain-of-Lakes, would quickly expand and dominate aquatic plant communities in many lakes and trails if all aquatic plant control was stopped.

Issue 2c) Where possible, manage systems for native aquatic plants. <u>With moderate aquatic plant control.</u>

Controlling a moderate amount of aquatic plants can sometimes be an effective way of managing for native aquatic plants. The use of maintenance control (defined earlier) of water hyacinth can maintain this exotic plant at low levels allowing native aquatic plants space to grow. Some chemicals can selectively treat exotic plants while allowing native ones to flourish. In lakes and trails where hydrilla can grow to matted conditions, a low level of control may not be enough to allow other native species to grow. In these cases, high levels of aquatic plant control will be necessary to allow native aquatic plants an opportunity to grow.

Issue 2c) Where possible, manage systems for native aquatic plants. <u>With high levels of aquatic plant control.</u>

Controlling a high amount of aquatic plants can sometimes be an effective way of managing for native aquatic plant. In some situations where hydrilla has matted an entire lake, continually treating the whole lake with herbicides has allowed native aquatic vegetation to increase in abundance. However, whole lake treatment using grass carp can sometimes eliminate all native aquatic plants with the exotic ones.

Issue 2d) Harvested material should be used to create wildlife islands where possible.

The creation of wildlife islands is a new way to dispose of harvested aquatic plants, tussocks or organic sediments (muck), while providing benefits for fish and wildlife. The creation of these islands is simply the collection of unwanted aquatic plants, tussocks, or muck and piling them in one location within a lake allowing for compaction to eventually create a hard surface for plant colonization. The Florida Game and Freshwater Fish Commission has recently evaluated this technique and concluded: "Where upland disposal of organic material is not possible, wildlife islands offer a cost-effective alternative that allows for muck removal projects essential to maintaining sportfish and aquatic-oriented bird habitat in our lakes. At the same time, in-lake disposal islands do not present water quality or turbidity problems, vegetate quickly, are utilized by wildlife and even serve as reproductive habitat for some species." This review suggests that this form of aquatic plant management is a viable, worthwhile technique for the Tsala Apopka Chain-of-Lakes.

Issue 2e) Biological control and plant harvesting should be considered before chemical control.

Insects and pathogens

Biological control is the purposeful introduction of organisms, such as insects and pathogens to keep the growth of problem plants in check. Biocontrol agents have to be released into the problem plant's range to help suppress its growth. Small numbers of biocontrol agents are released so that they can increase to a point where they control the problem plant and are in balance with the target plant, so a self-perpetuating population is established. The most attractive aspect of this type of biological control is that it can be permanent and self-perpetuating. Once established, additional releases are usually unnecessary so additional expenses are avoided. The initial expense of biocontrol is high, but if they are successful, biocontrol agents are among the least expensive control options.

A foreign insect species or pathogen must be extensively tested and proven to be host-specific (can not reproduce in the absence of the host) before it can be released in the United States. These tests are designed to demonstrate that the bioagent will not feed appreciably or reproduce on any plant other than the target weed. This ensures that it will not harm crop plants or other desirable species.

The first aquatic weed target for biocontrol was alligator-weed (*Alternanthera philoxeroides*). Three host-specific South American insects were found and eventually released. These include the alligator-weed flea beetle (*Agasicles hygrophila*), which was released in 1964; the alligator-weed thrips (*Amynothrips andersoni*), which was released in 1967; and the alligator-weed stem borer (*Vogtia malloi*), a moth, which was released in 1971. These insects are very effective and usually suppress the growth of alligator-weed below problem levels. However, their effectiveness is diminished toward the northern limits of the plant's range in North Carolina. These insects are established throughout the southeastern United States, but populations sometimes are diminished following harsh winters. When this happens control can be enhanced on a localized level by importation of insects from more southerly regions.

Three species of insects have been released for control of water hyacinth. The first is the mottled water hyacinth weevil (*Neochetina eichhorniae*), which was released in Florida in 1972. The second is the chevroned water hyacinth weevil (*Neochetina bruchi*), which is quite similar to the first. It was released in Florida in 1974. The third insect is a moth, the water hyacinth borer (*Sameodes albiguttalis*), which was released in 1977. These three insects are established throughout the Southeast. A good indication of the presence of water hyacinth weevils is the occurrence of distinctive adult feeding scars on the leaves. Mature larvae can often be found in the petiole bases or in the stem. It has been difficult to quantify the impact of these insects on water hyacinth populations, but suppression has not been sufficient to diminish the need for aggressive maintenance management of water hyacinth with herbicides.

Several insect biological controls are in various stages of research, quarantine, and early release for control of water lettuce, hydrilla, and Eurasian watermilfoil.

The introduction approach would seem ideal for the use of pathogens (fungus, diseases, etc.). However, restrictions regarding the importation of plant pathogens from abroad tend to prohibit this approach and limit the scope to native pathogens.

Pathogens also tend to be environmentally sensitive and populations do not remain high enough for sustained suppression of weed populations. Therefore, the use of pathogens for biological control of aquatic weeds has more promise as an augmentation approach. Suspensions of fungal spores can be formulated and applied to weed populations. One fungal pathogen (*Cercospora rodmanni*) has been formulated as a mycoherbicide for water hyacinth. However, it has not been very effective and research in this area is continuing. Research is also currently being conducted to develop methods for biological control of hydrilla and Eurasian watermilfoil with pathogens. Insects, especially stem borers and piercing-sucking types often provide points of entry for native plant pathogens. While neither the insect nor the pathogen has a substantial impact on the nuisance plant population, in combination they may help control nuisance situations.

While all of these biological controls sound attractive, there has been only one true success story (control of alligator-weed) using insects or pathogens to control aquatic plants. Thus, the use of insects or pathogens for the control of aquatic plants in the Tsala Apopka Chain-of-Lakes is not currently a viable option.

Triploid Grass Carp

Grass carp (*Ctenopharyngodon idella*) is the most commonly used and effective biological control currently available. The success of grass carp is also the primary reason this biocontrol agent is so controversial. When grass carp are stocked at high enough densities they can remove virtually all aquatic vegetation for a decade or longer. Because of the fear that grass carp would escape and reproduce in United States waters, sterile triploid grass carp are now required by most states that allow grass carp for aquatic plant control.

Triploid grass carp are specially produced in hatcheries and possess three sets of chromosomes instead of the normal two. This abnormal condition causes sterility, so these are the only non-indigenous fish that can be legally used for aquatic weed control in most states. A permit is required for possession and use of triploid grass carp. Because they cannot reproduce, the number of fish will not increase beyond the initial stocking. However, they cannot be effectively removed from large bodies of water and they are often hard to contain.

Triploid grass carp prefer to consume submersed plants, so they are effective controls of this type of vegetation. Grass carp also browse tips of young, tender emergent plants and often provide control of emergent species, which may be nontarget species. Although young grass carp feed on filamentous algae such as *Cladophora* and *Spirogyra*, they are not effective for control of most filamentous algal species unless all other aquatic plants are gone and they are stocked at high rates (>50 per acre). Grass carp do not control phytoplankton.

Stocking rates of 20 - 25 grass carp per acre of lake effectively controls all aquatic plants in southern latitudes but rates as high as 150 grass carp per acre are required before control is achieved in northern lakes. At any latitude, if enough grass carp are stocked where the consumption rate of the grass carp exceeds the growth rate of the aquatic plants, grass carp are an effective method of controlling aquatic vegetation (except for a few nonsusceptible species, such as spatterdock, *Nuphar luteum* and *Bacopa spp*). Because of their nonselective feeding behavior and lack of predictability, grass carp should only be used in lakes where complete control of aquatic plants is an acceptable part of a management plan.

If the complete elimination of submersed aquatic vegetation in the Tsala Apopka Chain-of-Lakes is desired, then using grass carp is an option. The difficulty, however, is maintaining sufficient triploid grass carp for their consumption rate to exceed the growth rate of aquatic plants. This would be difficult because the Tsala Apopka Chain-of-Lakes is an open system, especially during high water, and triploid grass carp would tend to leave the system into the Withlacoochee River. Thus, the use of triploid grass carp as a form of biological control of aquatic plants in the Tsala Apopka Chain-of-Lakes is not a viable option.

Mechanical Control

Aquatic plants can be harvested by hand, specialized machines, and in extreme cases, dredging. These types of plant harvesting are important methods of aquatic plant management in certain circumstances because of several advantages they have over other methods. Immediate control can be achieved in small areas. Water can be used immediately, as compared to water-use restrictions associated with some herbicides. Objectionable dead and dying vegetation that may be associated with other methods is minimized.

Physical harvesting of aquatic plants is limited in many regions because of several disadvantages. It is usually higher in cost, slower, and less efficient than other methods and there are high maintenance and repair costs. Some water bodies are not suitable for mechanical removal because of water depth and presence of obstructions. Plant fragments drift to infest new areas. Temporary increases in turbidity may result from disturbance of sediments while harvesting aquatic plants or tussocks. A suitable area for disposal of harvested plants must be available. Wildlife (e.g., small fish, snakes, turtles) and desirable vegetation is also removed with harvested plants.

The physical removal of aquatic plants is a viable option that can be used in the Tsala Apopka Chain-of-Lakes. The cost of physical removal, however, is much higher then most other aquatic plant control techniques. The cost can be lessened, however, with the ability to create in-lake wildlife islands but physical removal of aquatic plants is still expensive. The special equipment needed and high maintenance required to keep the equipment running also limit the amount of area that can be cleared with physical removal methods.

Chemical control

The issue suggesting the use of biological control or plant harvesting over the use of herbicides is based primarily on the fear of herbicides, which are loosely defined as chemicals. This fear of chemicals is probably linked to the many stories in newspapers, magazines and television where chemicals have invaded the environment causing damage and even health related problems. The vast majority of these problems are related to accidental spills or misuse of chemicals that were never intended to be put into the environment. Herbicides on the other hand are chemicals that are regulated by the United States Environmental Protection Agency (EPA) for the sole purpose of being applied in the environment to control plants.

The Environmental Protection Agency (EPA) requires extensive data on safety before a herbicide can be marketed. Toxicology studies are conducted on animals to evaluate safety to humans. These are single dose studies on rats, mice, rabbits, and chickens and long term feeding studies on rodents and non-rodents.

Environmental site data are required to determine degradation in water and soil, movement in soil, groundwater contamination, and accumulation in irrigated crops, fish and other aquatic organisms. Wildlife and aquatic organisms are tested to determine acute and long term effects. The nature and duration of residues in plants, livestock, potable water, fish, meat, milk, poultry and eggs must be determined. Waiting periods must be established following treatment for swimming, use of treated water for irrigation and for drinking. Spray drift data and effect on nontarget insects and plants are required.

Problems in any area of data submitted may result in preventing registration of a candidate herbicide. EPA is highly sensitive to problems with long residual, bioaccumulations, ground water contamination, reproduction, carcinogenicity, teratogenicity and mutagenicity. Prior to registration no effect levels for toxicology must be established. Maximum food residues are set at 100 to 1000 times less than the no effect level of the most sensitive test. The tolerance level for drinking water is set at 20% of that for food.

An article entitled "Aquatic Herbicide Safety" written by Dr. Paul L. Thayer and published in the Proceedings of the Florida Lake Management Society's 1996 Annual Meeting describes the whole creation, testing and use of aquatic herbicides. This article is added to this management plan in Appendix V to help citizens understand more about herbicides, hopefully giving them information to use for management decisions.

Labels on herbicide containers provide mixing and application instructions, describe environmental hazards, safety measures for the applicator, and instructions for container disposal. When used according to label instructions, aquatic herbicides are safe and effective. Therefore the use of herbicides to control aquatic plants in the Tsala Apopka Chain-of-Lakes is a viable option.

Summary of Options to be considered for the Management of Aquatic Plants in the Tsala Apopka Chain-of-Lakes

The following options for the aquatic plant management of the Tsala Apopka Chain-of-Lakes are listed for consideration by the citizens who originally identified issues of concern for the Tsala Apopka Chain-of-Lakes (see Appendix

I). These options are not listed as recommendations by the aquatic plant experts that were brought together to discuses the pros and cons of all identified issues, but as possible approaches to the management of aquatic plants in the Tsala Apopka Chain-of-Lakes. A section on economics is also added because it is one of the most important factors to consider in the management of aquatic plants and other lake management activities.

Option 1. Decrease the Current Level of Aquatic Plant and Tussock Management

During the last five years the Department of Environmental Protection and Citrus County spent approximately $588,000 annually to control aquatic plants and tussocks. If this level of control exceeds the demand of the users of the Tsala Apopka Chain-of-Lakes, then aquatic plant management should be reduced or eliminated.

Eliminating all forms of aquatic plant and tussock control and allowing nature to take its course is always an option. If this option is taken, however, native and exotic aquatic plant species will proliferate and impede recreational access to the Tsala Apopka Chain-of-Lakes. The increase in aquatic plants will also probably increase the formation of muck, and accelerate the aging process for the lakes in the system. Following this option will not eliminate fish and wildlife but there is the potential to decrease fish species considered sportfish.

Option 2. Maintain the Current Level of Aquatic Plant and Tussock Management

The current level of aquatic plant and tussock management is at level desired by the users of the Tsala Apopka Chain-of-Lakes. Thus, the Department of Environmental Protection and Citrus County should continue their current level of funding (Approximately $588,000 per year) to support this desired amount of aquatic plant and tussock management.

Option 3. Increase the Current Level of Aquatic Plant and Tussock Management

The current level of aquatic plant and tussock management is deemed insufficient by the users of the Tsala Apopka Chain-of-Lakes. Thus, additional needs exist which are not being addressed by the current level of funding. These needs should be identified as management objectives and additional funds requested.

Choice of Methods Needed to Meet Desired Level of Control

Method 1. Manage Aquatic Plants with Biological Control Agents

With the exception of triploid grass carp all available biological controls for aquatic plants have been released in the state of Florida and have access to the Tsala Apopka Chain-of-Lakes. The biological control agents have had little if any success at controlling problem aquatic plants in the Tsala Apopka Chain-of-Lakes. If triploid grass carp were released into the Tsala Apopka Chain-of-Lakes in sufficient numbers for the grass carp consumption rate to exceed the growth rate of the aquatic plants they could control all aquatic plants in the system, with the exception of a few species that grass carp can not consume (e.g., spatterdock). The Tsala Apopka Chain-of-Lakes, however, is an open system and any grass carp put into it would soon find their way out and into the Withlacoochee River defeating the purpose of biological aquatic plant control. Thus, the use of biological control in the Tsala Apopka Chain-of-Lakes is not a viable option.

Method 2. Manage Aquatic Plants and Tussocks with Mechanical Means

The control of aquatic plants and tussocks in the Tsala Apopka Chain-of-Lakes using mechanical means is a viable option with several advantages over other methods. Immediate control can be achieved in small areas. Water can be used immediately, as compared to water-use restrictions that may be associated with herbicide use. Objectionable dead and dying vegetation that may be associated with other methods is minimized. Currently all tussock removal and a significant portion of aquatic plant control in the Tsala Apopka Chain-of-Lakes are accomplished with mechanical means.

Use of mechanical removal for aquatic weed control may be limited in the Tsala Apopka Chain-of-Lakes because of several disadvantages. It is usually higher in cost (approximately $400 per acre for aquatic plants and up to $4,000 per acre for tussocks), slower, and less efficient than other methods and there are high maintenance and repair costs. The cost of plant harvesting, however, can be decreased somewhat by allowing in-lake disposal of harvested aquatic plant material. Some areas in the Tsala Apopka Chain-of-Lakes also are not suitable for mechanical removal because of water depth and presence of obstructions.

An average of approximately 900 acres of aquatic plants has been controlled every year for the last five years in the Tsala Apopka Chain-of-Lakes (see Appendix III). Considering the disadvantages listed above it is unlikely that this level of aquatic plant control in the Tsala Apopka Chain-of-Lakes could be accomplished with only mechanical means.

Method 3. Manage Aquatic Plants with Herbicides

Aquatic herbicides are chemicals designed to be put into the environment to control aquatic plants. They are tested intensively by the US Environmental Protection Agency and when used properly according to label instructions, are safe and effective (see Appendix IV). There are several herbicides that can be used to control different species of aquatic plants in unique habitat types. Aquatic herbicides are generally less expensive than other forms of aquatic plant control. These attributes make aquatic herbicides a viable option for the control of aquatic plants in the Tsala Apopka Chain-of-Lakes.

Method 4. Manage Aquatic Plants with Integrated Methods

An integrated aquatic plant management program consists of controlling aquatic plants with a variety of methods, and using the most appropriate method for the location and unique attributes of the plant problem. This is currently the approach that is being used to manage the aquatic plants in the Tsala Apopka Chain-of-Lakes and is a viable option for future control of aquatic plants in the system.

Economics

The amount of aquatic plant management that can be conducted on the Tsala Apopka Chain-of-Lakes, as with all lakes in the state, is often limited by money.

There is also a limit to the amount of aquatic vegetation that the Department of Environment Regulation would allow controlled. In the last five years approximately $2.9 million (approximately $2.0 million from DEP, and $900,000 from Citrus County), with an average of approximately $588,000 every year (see Appendix I), has been spent controlling aquatic plants in the Tsala Apopka Chain-of-Lakes. Approximately 25% of these funds are spent on the control of floating plants (water lettuce and water hyacinth) and hydrilla. These are plants that DEP has put on a priority list to be controlled and funding used in the Tsala Apopka Chain-of-Lakes to control these plants will likely continue. Almost 75% of the total funds, however, are used to manage tussocks and control native and non-native plants to keep trails open. Because the Tsala Apopka Chain-of-Lakes is only one of 450 public lakes eligible to receive a limited supply of funds from DEP's Cooperative Aquatic Plant Management Program, funds used to control tussock and trails may decrease depending on the statewide allocation of these funds.

The availability of funds for aquatic plant management or any other type of Lake Management activity should always be considered when developing a management plan. The level of management and often the management techniques will be determined by the amount of money available. If available money is not sufficient to carry out the management plan, then more money must be appropriated, the management activities must stop or the management plan must be adjusted to fit the available budget.

Section 3 - Management of Fish and Wildlife in the Tsala Apopka Chain-of-Lakes

The Tsala Apopka Chain-of-Lakes is a 20,000 acre (8,900 ha) network of islands, lakes, and wetlands with diverse habitats for fish and wildlife. People that recreate in the Tsala Apopka Chain-of-Lakes enjoy the fish and wildlife for a variety of reasons. Many people enjoy consumptive uses for fish and wildlife that angling or duck hunting provide. Some people enjoy nonconsumptive aspects of fish and wildlife that catch and release fishing or bird watching provide. Finally, some people simply benefit from the knowledge that fish and wildlife live in the Tsala Apopka Chain-of-Lakes and are doing fine. Thus, most people using the Tsala

Apopka Chain-of-Lakes are concerned for the fish and wildlife in the area and want them managed properly so future generations will also be able to enjoy them.

Many Lake Management activities have the potential to impact fish and wildlife directly and indirectly. For example, it was mentioned in the aquatic macrophyte section of this document that controlling all plants in a given lake would tend to change the species composition of fish and bird population toward open-water oriented species. Allowing aquatic plants to dominate a lake tends to shift the species composition of fish and birds populations toward aquatic plant oriented species. Following this example, should the Tsala Apopka Chain-of-Lakes be managed for open-water oriented or macrophyte oriented fish and aquatic bird species? These and other similar lake management questions are hard to answer without knowing the needs and desires of the lake user groups. Thus, the first step in developing a management plan for fish and wildlife in the Tsala Apopka Chain-of-Lakes is to define the issues associated with fish and wildlife.

On May 9, 1998, a representative group of citizens (see Appendix I) identified the following issues as major concerns with respect to the management of fish and wildlife in the Tsala Apopka Chain-of-Lakes:

3a) Fisheries habitat should be created with artificial substrates and improved with drawdowns and muck removal.

3b) Fish populations should be managed aggressively with stocking programs, closed seasons, length limits, and catch and release programs.

3c) Fish stocking efforts should center on native fish.

3d) Manage all aspects of Tsala Apopka for healthy fish and wildlife.

On September 1 and 2, 1998 a group of professionals (see Appendix II) also identified issues concerning the management of fish and wildlife in the Tsala Apopka Chain-of-Lakes. The following is a list of those issues:

3e) There is a real lack of information on the fish populations in the Tsala Apopka Chain-of-Lakes. This information needs to be collected prior to any management activities.

3f) All management activities (e.g., water level changes, aquatic plant control etc.) in the Tsala Apopka Chain-of-Lakes should be conducted after first determining impacts to fish and wildlife.

We tried to evaluate these issues by examining the available historical data on fish and wildlife in the Tsala Apopka Chain-of-Lakes. The following sections describe the available information that was found.

Historical Fish Data

There is only a little historical information on the fish populations in the Tsala Apopka Chain-of-Lakes. The Florida Fish and Wildlife Conservation Commission occasionally sampled fish populations in the Floral City Pool, Inverness Pool, and Hernando Pool using blocknets and electrofishing (see below for description of blocknets and electrofishing methods). The fish populations in the Floral City Pool were sampled using blocknets in 1979 and 1988 and using electrofishing in 1988. The fish populations in the Inverness and Hernando Pools were sampled using blocknets in 1975 and 1988 and using electrofishing in 1988. This information is listed and summarized in a report entitled "Lake Tsala Apopka Environmental Assessment" published by the Southwest Florida Water Management District (Appendix VI).

Blocknet sampling is conducted by placing a fine mesh net around a measured area (often one acre or one-fifth acre) of water enclosing all of the fish inside the net. The fish are killed by applying a fish toxicant (rotenone) to the water. The fish are collected for three consecutive days. This method yields an estimate of fish number and biomass per unit area (number of fish/acre of lake and pounds of fish/acre of lake). Electrofishing is conducted by creating an electrical charge in the water that temporarily stuns the fish, allowing them to be netted, measured and returned to the lake. This method yields fish number and biomass per unit of time (number of fish/hour of electrofishing and pounds of fish/hour of electrofishing). Blocknet data and electrofishing data are also used to examine the size distribution of individual fish species. This can yield information needed to manage sportfish populations.

Examination of all of the Florida Fish and Wildlife Conservation Commission blocknet data found that: 1) estimates of total fish biomass in the Floral City Pool in 1979 and 1988 were 91 and 54 lbs/acre, respectively, 2) estimates of total fish biomass in the Inverness Pool in 1975 and 1988 were 163 and 219 lbs/acre, respectively, and 3) estimates of total fish biomass in the Hernando Pool in 1975 and 1988 were 55 and 68 lbs/acre, respectively. These total fish biomass estimates are similar to Florida Fish and Wildlife Conservation Commission estimates for Lake Panasoffkee (109 lbs/acre) and Lake Rousseau (92 lbs/acre) in 1988 and 1979, respectively. This is a good comparison because Lakes Panasoffkee and Lake Rousseau lie in the Withlacoochee River basin, as does the Tsala Apopka Chain-of-Lakes. All of these total fish biomass estimates are also well within or above the range of 32 to 212 lbs/acre estimated for 25 eutrophic lakes by the University of Florida (Aquatic Macrophytes and Their Relation to Limnology of Florida Lakes. University of Florida, SP115, Gainesville, Florida). Thus, it seems that in the 1970s and 1980s the Tsala Apopka Chain-of-Lakes was producing fish similar to other lakes in the Withlacoochee River basin and other eutrophic lakes in Florida.

Examining all of the 1988 electrofishing data, the total fish biomass caught per hour of electrofishing in the Floral City Pool, Inverness Pool, and Hernando Pool were 85, 122, and 71 lbs/hour of electrofishing, respectively. These data are generally above the range of 2 to 74 lbs/hour of electrofishing estimated for 25 eutrophic lakes by the University of Florida. Thus, it seems that in 1988, the Tsala Apopka Chain-of-Lakes was producing fish similar to other eutrophic lakes in Florida.

A major concern in the management of fish populations is the number of anglers and the amount of effort these anglers put into a body of water. Historical or current estimates of the number of anglers fishing or the number of fish caught per hour of fishing in the Tsala Apopka Chain-of-Lakes are not known. However, it is probable that fishing pressure has increased considerably over the last 30 years because the population of Citrus County increased from 9,268 in 1960 to 93,515 in

1990. How probable increases in fishing pressure since 1960 may have changed sportfish populations is unknown.

Historical Aquatic Bird Data

There is little information on the historical abundance of aquatic birds using the Tsala Apopka Chain-of-Lakes. However, the Florida Fish and Wildlife Conservation Commission has flown annual winter transects (1993-1998) over the Tsala Apopka Chain-of-Lakes to count ducks but not wading birds (Appendix VII). Florida Game and Fresh Water Fish Commission personnel counted an average of 697 birds (primarily ring-necked duck and American coot) ranging from 101 to 1,328 birds between 1993 and 1998. Similar flights over Lake Panasoffkee yielded a higher annual average of 7,401 birds (primarily ring-necked duck and American coot) with a range of 1,898 to 15,375 birds. These data suggest that Lake Panasoffkee held more ring-neck ducks and American coots than the Tsala Apopka Chain-of-Lakes did between 1993 and 1998.

The Gazetteer of Florida Lakes lists the surface area of the Tsala Apopka Chain-of-Lakes as 19,111 acres (77 km^2). The actual amount of open water in this total area is extremely variable and dependent on rainfall and the amount of water in the Withlacoochee River. Using 77 km^2 as a liberal estimate of open water, the number of American coots and ring-necked ducks per unit area averaged 6.1 and 2.9 birds/km^2, respectively. An aquatic bird survey conducted by the University of Florida (Aquatic Macrophytes and Their Relation to Limnology of Florida Lakes. University of Florida, SP115, Gainesville, Florida) on 46 Florida Lakes shows that American coots occurred on 19 of the 46 lakes surveyed and on these lakes their abundance ranged from about 1 to 292 birds/km^2. The same survey indicated that ring-necked ducks occurred on 11 of the 46 lakes and their abundance on these lakes ranged from about 1 to 221 birds/km^2. These data suggest that the abundance of birds on Lake Panasoffkee is greater than the abundance found on the Tsala Apopka Chain-of-Lakes but the abundances (density, birds per square kilometer) of ring-necked ducks and American coots on the Tsala Apopka Chain-of-Lakes fall within the range of other Florida lakes.

Discussion of Issues Identified by Citizens

Issue 3a). Fisheries habitat should be created with artificial substrates and improved with drawdowns and muck removal.

After the citizen's issue forum held May 9, 1998, the Florida Game and Fresh Water Fish Commission examined the fish populations (using electrofishing methods) in all three pool of the Tsala Apopka Chain-of-Lakes. The electrofishing transects taken in October 1998 revealed that sportfish populations are reproducing and recruiting into harvestable size. Thus, the fisheries experts brought together to debate the pros and cons of each fish and wildlife issue agree that there is sufficient habitat in the Tsala Apopka Chain-of-Lakes for the reproduction of most fish species.

There are areas with abundant muck and tussocks that could be removed to increase the abundance of fish habitat and angler access in the Tsala Apopka Chain-of-Lakes. The amount of muck and tussocks that could be removed, however, would be very small in comparison to the 20,000 acres of habitat that encompasses the whole Tsala Apopka Chain-of-Lakes.

Issue 3b). Fish populations should be managed aggressively with stocking programs, closed seasons, length limits, and catch and release programs.

In July 1969, Chapter 69-939 (F.S.) was enacted, authorizing Citrus County to impose and collect an additional $1.00 fishing license fee to improve sportfish life. The first five years of this funding went solely toward efforts to seine "trash fish" from the Tsala Apopka Chain-of-Lakes. The increase in abundance of hydrilla in the system made this type of effort impossible.

In approximately 1975, a hatchery to raise largemouth bass fingerlings was started with funds collected from the $1.00 fishing license fee. Phil Phillips, a former hatchery operator estimated that approximately 45,000 largemouth bass fingerlings were raised each year, and because the Tsala Apopka Chain-of-Lakes was the largest system in Citrus County, 60% of these fish were stocked in that chain annually. The hatchery is currently out of operation but for about 20 years almost 27,000 largemouth bass fingerlings were released annually into the Tsala Apopka Chain-of-Lakes.

The largemouth bass stocking effort was ongoing during the time periods that the Florida Fish and Wildlife Conservation Commission sampled fish populations in the Tsala Apopka Chain-of-Lakes. The fisheries experts assembled to debate the pros and cons of fishery issues examined these data and concluded that the stocked fish were not enhancing the number of largemouth bass recruiting into adult size classes. Thus, it does not appear that a hatchery for largemouth bass is warranted at this time because it is unlikely that past largemouth bass stocking efforts resulted in an increase catch rate of largemouth bass to the anglers of Tsala Apopka Chain-of-Lakes.

Developing special fishing regulations like closed seasons, length limits, and catch and release programs are a difficult task requiring approximately two years for a new regulation to work its way through the Florida Fish and Wildlife Conservation Commission process. These types of regulations are set to limit some form of angling pressure to improve an aspect of fishing or fish populations that have been impaired by angling pressure. The fisheries experts agreed that the amount of angling pressure and its impact on the fish populations in the Tsala Apopka Chain-of-Lakes is completely unknown. Therefore, they concluded that it would be difficult to attempt to regulate unknown amounts of fishing pressure to improve unknown impairments to fishing or fish populations. The fisheries experts strongly felt that a creel (angler) survey was needed before any new regulation was attempted to manage fish populations in the Tsala Apopka Chain-of-Lakes.

Issue 3c). Fish stocking efforts should center on native fish.

For approximately 20 years (1975-1995), largemouth bass fingerlings were stocked into the Tsala Apopka Chain-of-Lakes with little impact on the largemouth bass population or angling success. Periodically from the late 1970s through the early 1990s, the Florida Fish and Wildlife Conservation Commission also stocked sunshine bass (hybrid cross between white bass female and striped bass male) into all three pools of the Tsala Apopka Chain-of-Lakes. The sunshine bass is a non-reproducing fish that must be stocked repeatedly.

From limited gillnet sampling, the Florida Fish and Wildlife Conservation Commission has determined that the survival of sunshine bass stocked into the Floral City Pool and Inverness Pool was good. Survival of sunshine bass stocked into the Hernando Pool was not good. These fish were stocked to take advantage of excess forage fish and to yield additional angling opportunities. However, the Florida Fish and Wildlife Conservation Commission's current policy is to stock sunshine bass into productive lakes with excess forage fish like the threadfin shad. The Tsala Apopka Chain-of-Lakes does not have abundant open-water forage fish like the threadfin shad. Therefore, sunshine bass stocked into the Tsala Apopka Chain-of-Lakes could potentially compete with resident sportfish for food.

The Florida Game and Fresh Water Fish Commission currently requires documentation that sunshine bass stocking yields increased angling success before additional stockings are conducted. Due to the lack of documentation, it is unknown if the last stockings of the sunshine bass into the Tsala Apopka Chain-of-Lakes were successful. Therefore, given the current policy of the Florida Game and Fresh Water Fish Commission, without documentation like a creel survey it will be difficult to justify future stockings of sunshine bass into the Tsala Apopka Chain-of-Lakes.

Issue 3d). Manage all aspects of Tsala Apopka for healthy fish and wildlife.

The general statement "manage all aspects of the Tsala Apopka Chain-of-Lakes for healthy fish and wildlife" would be a difficult management objective to accomplish. The difficulty comes in defining what "healthy" fish and wildlife means. Some individuals believe that as long as there are sufficient largemouth bass in a lake then the lake has a healthy fish population, while others may require a whole native fish species assemblage to believe the Tsala Apopka Chain-of-Lakes has healthy fish. Similar arguments can be made for the wildlife inhabiting the Tsala Apopka Chain-of-Lakes. Thus, without defining the term "healthy" fish and wildlife, management activities can not be directed properly. This is also important because as mentioned earlier in this document a lake can not be all things to all people.

Summary of options to be considered for the Management of Fish and Wildlife in the Tsala Apopka Chain-of-Lakes

The following options for fish and wildlife management of the Tsala Apopka Chain-of-Lakes are listed for consideration by the citizens who originally identified issues of concern for the Tsala Apopka Chain-of-Lakes (see Appendix I). These options are not presented as recommendations by the fish and wildlife experts who were brought together to discuss the pros and cons of identified issues, but rather as possible approaches to the management of fish and wildlife in the Tsala Apopka Chain-of-Lakes. A section on economics is presented at the end of the options because it is an important factor to consider with respect to the management of fish and wildlife in the Tsala Apopka Chain-of-Lakes.

Option 1. Maintain Current Status

Maintaining the current management activities for the fish and wildlife in the Tsala Apopka Chain-of-Lakes is a viable and inexpensive option. This option may be appropriate for the current fish populations in the Tsala Apopka Chain-of-Lakes because the available fish data suggest that the system is producing fish at a level that would be predicted from its trophic status. The majority of the fish data, however, is old and may not represent the conditions that exist today. There is much less information available on the wildlife including aquatic birds that may be using the Tsala Apopka Chain-of-Lakes. Doing nothing to manage these organisms will most likely not harm the current abundances but the experts believe some work needs to be done in order manage the Tsala Apopka Chain-of-Lakes properly.

Option 2. Collect Wildlife and Fish Population Data

It is generally agreed that the Florida Fish and Wildlife Conservation Commission should continue their annual aerial duck surveys. Additional counts to survey all aquatic birds may be needed if problems with local bird populations are suspected. Without knowing current information on the fish populations living in the Tsala Apopka Chain-of-Lakes it would be difficult to manage environmental or angling aspects that may be impacting fish populations. Thus, an option that would help define future management of fish populations in the Tsala Apopka Chain-of-Lakes would be to sample the fish populations in all three pools of the Tsala Apopka Chain-of-Lakes. At a minimum, fish sampling with blocknets should be conducted to estimate total fish abundance and species composition. Electrofishing should also be conducted to further define aspects of sportfish populations. Finally, Gillnets or trawls should be conducted to examine the open-water fish populations.

Option 3. Collect Angler and Other User Information

The management of fish populations using angling regulations is difficult without information on the fish population and angling pressure. Therefore, to manage the fish populations in the Tsala Apopka Chain-of-Lakes with closed seasons, length limits, or catch and release programs, data needs to be collected on angling pressure and certain fish population parameters. This information on angler preferences and amount of angling conducted for individual sportfish species can best be acquired using a randomized creel survey. Creel surveys can be conducted relatively quickly and inexpensively.

Creel information with fish population statistics can help determine if an angling regulation will have the desired effects on future fish populations. An additional benefit to creel surveys is the ability to collect information on other user groups without spending much additional money. This extra information can be extremely useful when considering management options and goals.

Option 4. Special Angling Regulations

Establishment of any special angling regulation on the Tsala Apopka Chain-of-Lakes different from current statewide regulations would take a minimum of two years. Successful creation of angling regulations will also require substantial fish population information. However, some lakes such as Orange Lake in Alachua/Marion Counties have established special regulations like slot limits. Orange Lake has a slot limit for largemouth bass where anglers can keep three largemouth bass either below 15 inches or above 24 inches per day. The goal of this regulation is to increase the number of larger sized largemouth bass in Orange Lakes thereby increasing the angling success for these fish. Therefore, creating some form of a special regulation for the Tsala Apopka Chain-of-Lakes is not impossible.

The available fisheries data for the Tsala Apopka Chain-of-Lakes does not currently suggest the need for special angling regulations. However, if the size and abundance of large largemouth bass are a concern to the anglers using the Tsala Apopka Chain-of-Lakes, these anglers might voluntarily adopt a slot limit similar to the one currently used on Orange Lake. There is no guarantee that such a voluntary regulation will work and success needs to be well documented before the Florida Fish and Wildlife Conservation Commission is requested to approve this type of regulation for the Tsala Apopka Chain-of-Lakes.

Option 5. Collect Largemouth Bass Information

Largemouth bass are likely the most important fish for angling in the Tsala Apopka Chain-of-Lakes. Based on the importance of largemouth bass populations in each pool, potential benefits of harvest restrictions could be evaluated. Estimates of age, growth, and mortality for adult largemouth bass from each pool should be obtained. Once growth and mortality rates are known, potential benefits of various harvest restrictions (i.e., minimum size limits or slot limits) could be investigated with a computer model. The model would predict changes in angler catch rates of quality, preferred, and memorable-sized largemouth bass due to various simulated harvest restrictions. For example, if populations exhibit slow growth, benefits of a harvest restriction would likely be nil, whereas harvest restrictions can substantially improve the abundance of large fish in populations exhibiting rapid growth.

Economics

Doing nothing to manage fish and wildlife in the Tsala Apopka Chain-of-Lakes is indeed the least expensive (no cost option). This option with the lack of information that currently exists on the fish and wildlife populations in the Tsala Apopka Chain-of-Lakes would hamper any management activities that may be deemed necessary now or in the future. A creel survey with a recreational-use survey could be accomplished for about $20,000 to $40,000. This amount of money would give good information on the current fishery and actual types and amount of uses in the Tsala Apopka Chain-of-Lakes, yielding information for potential management activities.

The cost of sampling fish populations or wildlife populations in the Tsala Apopka Chain-of-Lakes is variable depending upon the intensity of the sampling and who does the sampling. In the Tsala Apopka Chain-of-Lakes, it would cost approximately $65,000 to $100,000 to estimate the fish abundance, biomass and general species composition with blocknet sampling procedures. These procedures would include setting approximately six blocknets in each pool yielding a total of 18 net sets. Sampling sportfish populations (e.g., largemouth bass, bluegill, and redear sunfish) in more detail using electrofishing would cost approximately an additional $30,000 to $50,000. Sampling open-water fish populations (e.g., sunshine bass and black crappie) in all three pools of the Tsala Apopka Chain-of-Lakes using gill nets would cost an additional $10,000 to $20,000. Currently, there is no information regarding the growth and mortality rates of largemouth bass from the Tsala Apopka Chain-of-Lakes. It would cost $40,000 to $60,000 to collect fish, process the age-and-growth samples, and run the simulations to determine if largemouth bass harvest restriction could be used to improve angling.

As mentioned earlier these costs are only estimates and the real costs depend on the number of samples taken and the detail in the information collected. The important point is that some information on the fish populations is needed before management activities in the form of habitat work or angler regulations are started. Some data also needs to be collected after any management activities to evaluate the success or failure of each management activity. The cost of fish sampling to provide the least and the greatest amount of information needed to manage the fish populations in the Tsala Apopka Chain of Lakes probably ranges from approximately $20,000 to $210,000.

Section 4 - Water Level Management in the Tsala Apopka Chain-of-Lakes

Managing water level is and will continue to be one of the most challenging aspects in the management of the Tsala Apopka Chain-of-Lakes. The importance of water level to the Tsala Apopka Chain-of-Lakes cannot be overstated because water level is related to almost every aspect of the system including but not limited to: aquatic plant abundance and species composition, tussock abundance and possible formation, water chemistry, fish and wildlife populations, water conservation for access and travel within and among lakes, flooding and property damage, aquifer recharge, and abundance of wetland areas. The difficulty in management occurs when trying to maximize the benefits of one aspect listed above which may be completely negative to another aspect. For example, managing the Tsala Apopka Chain-of-Lakes at a high water level all the time would benefit access issues but when large rain events occur it may cause flooding. This is a continuing reminder that a lake can not be all things to all people.

The first step in developing a management plan for water levels in the Tsala Apopka Chain-of-Lakes is to define desired uses and issues associated with water level. Thus, on May 9, 1998 a representative group of citizens identified the following issues as major concerns with respect to management of water level in the Tsala Apopka Chain-of-Lakes (See Appendix I):

4a) Lake level management objectives need to be clearly defined.

4b) Water levels should be managed for maximum navigation among basins and minimum flooding of residential properties.

4c) Water should be available for agricultural and residential irrigation.

4d) Minimal water control structures should be used for the stated management objectives.

4e) Slow water flow in the Withlacoochee for more water during drought times (consider dam or some other method).

4f) Manage water level after considering impacts to aquifer recharge.

4g) Manage water level using historical levels as a template.

On September 1 and 2, 1998 a group of professionals also identified issues concerning the management of water levels in the Tsala Apopka Chain-of-Lakes (See Appendix II). The following is a list of those issues:

4h) A primary issue to the professionals was the management of Lake Levels and these management objectives need to be clearly defined.

4i) A complete water budget needs to be developed for the whole Tsala Apopka Chain-of-Lakes to determine the range and the limitations that the lake levels can be manipulated. The water budget can not be separate from the Withlacoochee River and ground water influences.

4j) A good user survey needs to be conducted to determine a weighted use for each individual user group. The exact process of weighting is unknown but some form of economic assessment needs to be a part of the user survey. The environment itself should also be considered a user. The user survey should consider future user demands on the Tsala Apopka Chain-of-Lakes because of the rapid growth occurring in Citrus County. This and the water budget information can then be used to determine a lake level schedule for the Tsala Apopka Chain-of-Lakes.

4k) Any changes in the water level schedule, however, need to consider property rights and potential damage/compensation to habitat and property owners.

The objectives of this water level discussion are to address each of the above issues and give options based on the pros and cons of each issue. The pros and cons of these issues were debated on February 24, 1999 by a panel of water level experts from around the state. There were no major disagreements among the experts and the following discussions represent a consensus about the management of water level in the Tsala Apopka Chain-of-Lakes.

History of Water Level Manipulations in Tsala Apopka Chain-of-Lakes

A short account describing the historical development of the Tsala Apopka Chain-of-Lakes was written by Vincent Attardi in 1983 and published in a report entitled "An Environmental Description of Lake Tsala Apopka" by the Southwest Florida Water Management District. This account describes the pertinent cultural factors in the development of the Tsala Apopka Chain-of-Lakes, dating from about 10,000 years ago to present times. Many of these cultural changes over time were the driving forces causing the manipulation of water levels in the Tsala Apopka Chain-of-Lakes.

Generally, Americans of European decent began settling small farms around Brooksville, Homosassa and Crystal River in the mid to late 1800's. By 1870 a small farming settlement developed along the western margin of The Tsala Apopka Chain-of-Lakes. The demand for citrus fruits that were being produced in the region began to escalate after the Civil War and during the 1880's-1890's. In 1884, the Orange state canal was built connecting the Tsala Apopka Chain-of-Lakes to the Withlacoochee River, the Outlet River, and Lake Panasoffkee. The canal allowed boats to haul produce from the farms to the nearest railroad terminus by Panasoffkee Town, at the southern tip of Lake Panasoffkee. Thus, the first manipulation done to the Tsala Apopka Chain-of-Lakes that could impact water levels, was done for commerce and navigation not to manipulate water levels.

From 1884 to the early 1950s the area surrounding the Tsala Apopka Chain-of-Lakes experienced three waves of commerce (Citrus production, phosphate mining, and a real-estate boom), with the population expanding and crashing through each wave of commerce. During that time private individuals build roads throughout areas of the Tsala Apopka Chain-of-Lakes. At times these roads restricted water flow into the lake system from the Withlacoochee River and water flow out of the lake system into the Withlacoochee River. These roads were built primarily for access to dry areas and transportation throughout the Tsala Apopka Chain-of-Lakes. However, some roads or levies were built in conjunction with canals attempting to dry land for agricultural practices.

From the 1950s to the present time the region around the Tsala Apopka Chain-of-Lakes experienced a tremendous increase in population, residential areas and businesses associated with residential life. For example, the population of Citrus County increased from approximately 9,000 people in 1960 to almost 100,000 people in 1990. Many people moved to the area to experience lakeside living, which requires access to lakefront property and water.

In the mid 1950s, Florida experienced severe drought conditions which concerned residents because of low lake levels. This pushed people living around the Tsala Apopka Chain-of-Lakes into a water conservation mode. In 1959, the Tsala

Apopka Basin Recreation and Water Conservation and Control Authority built the Orange State Canal control structure. The structure was built to keep water in the Floral City Pool when the Withlacoochee River water level is less than the Floral City Pool.

Concerns about low water were temporarily removed when 10 inches of rain fell between March 15 to 18, 1960, after a period of above normal rainfall. This rainfall caused flooding to urban and agricultural areas with flood conditions lasting from approximately one week to two months. During floods of this magnitude it is hard to think about conserving water for access and navigation.

An interesting aspect of the 1960 flood situation is the difference between the amount of water flowing in the Withlacoochee River upstream and downstream of the Tsala Apopka Chain-of-Lakes. Gage information from March 1960 showed a maximum stream flow at Croom gage (located upstream of the Tsala Apopka Chain-of-Lakes) of approximately 8,600 cubic feet per second (cfs) and a maximum stream flow at Holder gage (located downstream of the Tsala Apopka Chain-of-Lakes) of approximately 8,300 cfs. A report prepared by the staff of the Southwest Florida Water Management District entitled "Rating curves for the Structures on the Tsala Apopka Chain-of-Lakes," examined a similar storm event that occurred in 1950. The report shows gage information from the 1950 flood indicated a maximum stream flow at Croom gage of 8,400 cfs and a maximum stream flow at Holder gage of only 5,000 cfs. The report concluded that a significant portion of the drop in stream flow (approximately 3,400 cfs) was attributed to flow, which was naturally diverted into the Tsala Apopka Chain-of-Lakes by way of a swampy area between Jumper Creek and Outlet River. Therefore, some manipulation between 1950 and 1960 changed the ability of water, during flood events, to flow into the Tsala Apopka Chain-of-Lakes.

After 1960, with the fear of both drought and floods fresh in the minds of Lake Residents, additional canals and water control structures were constructed. These structures were multipurpose with the idea of conserving water during drought situations and moving water during floods.

On the north side of Hernando Pool the Tsala Apopka Basin Recreation and Water Conservation Construction Authority built the Van Ness Structure. The Southwest

Florida Water Management District assumed control of the structure in 1962. The structure is used only under extreme flood condition and shunts water north through Two-Mile Prairie. Operational guidelines also include operation for conservation and flood protection.

Bryant Slough and structure were built in 1963. The Southwest Florida Water Management District added a control structure on the upstream side of the culverts that connect to the Bryant Slough. The structure was built to regulate flow from Inverness Pool through Bryant Slough to the Withlacoochee River and to regulate the water level in the Inverness Pool. The structure was replaced in 1968 and 1977.

In 1959 the Leslie Heifner Canal was planned by the Tsala Apopka Basin Recreation and Water Conservation and Control Authority. The original intent of the canal was to convey water between the Inverness Pool and the Withlacoochee River. Construction of the Leslie Heifner Canal began in 1962 but it was eventually connected to the Floral City Pool instead of the Inverness Pool.

The Golf Course Structure and Canal were constructed by the Southwest Florida Water Management District in 1965 for Citrus County. The District was asked to take control of the structure in 1966, while Citrus County maintained responsibility for the canal. Modifications were made to the structure in 1975 and 1992. The purpose of the structure was to control flows between Floral City Pool and Inverness Pool.

The Robinson Fill structure was built by the Tsala Apopka Basin Recreation and Water Conservation and Control Authority in 1962 to control water leaving the Hernando pool. This structure was modified by the US Army Corps of Engineers and is now called Structure 353. Both, Canal 331 and Structure 353 were constructed by the US Army Corps of Engineers with Southwest Florida Water Management District as a local sponsor. Canal 331 extends northeast and north from Hernando Pool to the vicinity of Stokes Ferry where State Road 200 crosses the Withlacoochee River. Structure 353 is on the alignment of Canal 331 and about 2.5 miles south of Stokes Ferry. It is a concrete spillway with four lift gates. The purpose of the control structure is to permit releases from Hernando Pool as needed to maintain desired water levels according to set water level schedules in the Tsala Apopka Chain-of-Lakes.

The water level schedules for the Tsala Apopka Chain-of-Lakes were set in 1966 by the Southwest Florida Water Management District and accepted by the U.S. Army Corps of Engineers. There is a water level schedule set for each of the three individual pools (Figure 1 Floral City Pool, Figure 2 Inverness Pool, and Figure 3 Hernando Pool) The water level schedules for each pool are set to provide flood protection from rain events up to a 10 year flood event.

Brogdon Bridge structure and culverts were completed in 1972 after the original structure was destroyed by vandalism. The purpose of the structure and culverts was to control water flow between Inverness Pool and Hernando Pool thus regulating water level.

Moccasin Slough Structure was completed in 1996. This structure was constructed to provide extra control of water flowing from Floral City Pool into the Inverness Pool.

Discussion of Issues Identified by Citizens

Issue 4a) Lake level management objectives need to be clearly defined.

The scientist gathered to discuss the water level issues, understand this concern of the citizens, but point out that there is a water level management plan with clearly defined water level objectives. These objectives are part of the Four Rivers Basin Project Water Control Plan for Tsala Apopka Area (Appendix VIII), as stated by the U.S. Army Corps of Engineers, Jacksonville District. The Four Rivers Basin Project was authorized by the Flood Control Act of October 23, 1962, (House Document No. 585/87/2) Public Law 87-874. The water level management plan attempts to maximize navigation and minimize flooding, within a 10-year flood event. This leads to the discussion of issue 4b.

Issue 4b) Water levels should be managed for maximum navigation among basins and minimum flooding of residential properties.

Issues 4a and 4b are two major concerns that were regularly identified throughout the discussions of issues in the Citizens Workshop (Appendix I).
The water level management plan for the Tsala Apopka Chain-of-Lakes attempts to minimize flood damage during the wet season by providing flood storage space early in the wet season to handle the runoff from large storms. The minimum water levels are set to provide sufficient flood control storage while maintaining sufficient depth for navigation. As the wet season progresses, July to December, water levels are increased conserving water for use throughout the dry season.

Natural barriers and water control structures (see above section called "History of Water Level in Tsala Apopka Chain-of-Lakes") divide the Tsala Apopka Chain-of-Lakes into three distinct pools; Floral City Pool, Inverness Pool, and Hernando Pool. The water levels of each pool are regulated by the Southwest Florida Water Management District according to the regulation schedules set for each pool (Figure 1-3 and Appendix VIII). The water level schedules were set in 1966 by the Southwest Florida Water Management District and approved by the U.S. Army Corps of Engineers. The actual water level of the three pools often deviates from the set water level schedules because of extreme droughts and floods. During droughts all lakes in the Tsala Apopka Chain-of-Lakes will be low due to evaporation and recharge to the Floridan Aquifer. During extreme floods (greater than a 10-year event) the chain-of-lakes is strongly connected to the Withlacoochee River and water levels will be high with no way of controlling them. Thus, the water level experts agree that *there is only a narrow window of opportunity in which to manage the water levels in the Tsala Apopka Chain-of-Lakes*.

The water level schedules for the Tsala Apopka Chain-of-Lakes were set using information on water levels and water movement that were collected after most of the structures, canals and roads, that have potential to impact water levels, were already built. The scientists that were gathered to debate the water level issues agreed that with the current structures, canals and roads the water level schedules are set correctly to meet the objective of flood control and navigation within the confines of a 10 year flood event. Should some form of management remove or add any structures, canals, or roads that do impact water levels in the Tsala Apopka Chain-of-Lakes, then the water level schedules would need to be reexamined and changed depending on the set objectives for water levels in the system.

Throughout discussions of water level issues conducted by the water level experts, one important aspect continued to be expressed by the water level experts. *There is only a narrow window of opportunity to manage water levels in the Tsala Apopka Chain-of-Lakes*. During extreme drought, the Withlacoochee River and the lakes in the Tsala Apopka Chain-of-Lakes will be low because of the close connection both systems have with ground water and each other. On the other extreme, when water is abundant, the Withlacoochee River and the Tsala Apopka Chain-of-Lakes are connected and there is little or no way to control water levels in either system. This is an important concept that citizens and professionals need to keep in mind when attempting to discuss the management of water levels in the Tsala Apopka Chain-of-Lakes.

Issue 4c) Water should be available for agricultural and residential irrigation.

Water for agricultural and residential irrigation is available to consumers living in the area of the Tsala Apopka Chain-of-Lakes. There are certain volumes of water that can be pulled from wells or surface water before requiring a permit from the Southwest Florida Water Management District. In the area of the Tsala Apopka Chain-of-Lakes, unless expressly exempt by law or District rule, a water use permit is required prior to withdrawal of water if any of the following thresholds are exceeded:

• Annual average withdrawal from any source or combined sources is greater than or equal to 100,000 gallons per day (gpd).

• Withdrawal is from a well having an outside diameter of 6 inches or more at the surface.

• Withdrawal is from a surface water body and the outside diameter of the withdrawal pipe or the sum of the outside diameters of the withdrawal pipes is 4 inches or greater.

• Total <u>capacity</u> to withdraw water from any source or combined sources is greater than or equal to 1,000,000 gpd.

If these withdrawal levels are exceeded then there is still an ability to use that level of water but it requires a permit from the Southwest Florida Water Management District.

Issue 4d) Minimal water control structures should be used for the stated management objectives.

Structures, canals and roads that have the ability to impact water levels in the Tsala Apopka Chain-of-Lakes were built for several reasons. As was mentioned above in the "History of Water Level in Tsala Apopka Chain-of-Lakes", some manipulations were done for navigation and transportation, some were done to remove water from certain areas for flood control and others were constructed for conservation of water. The water level experts agree that using the fewest number of water control structures makes for the easiest working of a water level plan. However, because there are several different goals and reasons for each structure, it would be difficult to decrease the number of structures without significantly changing the objectives that currently exist for managing water levels in the Tsala Apopka Chain-of-Lakes.

Conceivably, if people were willing to accept the droughts and flooding conditions that Mother Nature provides, then all structures could be removed and water levels could be left to fluctuate according to historical levels. The water level experts, however, explain that many homes are now built in areas that would suffer flood damage without any structures. Other homes are built in areas where access to the water would be significantly impaired without any structures. Thus, managing water levels with no structures and according to historical levels would be a hardship on some individuals either from flooding or loss of access to the waterfront property that was the reason for buying a home at the Tsala Apopka Chain-of-Lakes.

Issue 4e) Slow water flow in the Withlacoochee for more water during drought times (consider dam or some other method).

This issue is related to discussions about the Wysong Dam and arguments about whether the dam significantly impacted water levels in the Tsala Apopka Chain -of-Lakes. There have been conflicting reports on the impact the Wysong Dam had on the water levels while it was in place on the Withlacoochee River. Claims the Wysong Dam increased the water level in the Tsala Apopka Chain-of-Lakes range from less than a few inches to more than several inches. The water level experts agree the Wysong Dam did increase the water levels in Tsala Apopka Chain-of-Lakes but that the exact amount is unknown. Current water budgets that are available are insufficient to determine exact impacts of some form of dam in the Withlacoochee River on water levels in the Tsala Apopka Chain-of-Lakes.

This issue is important because it was raised several times by citizens in the Workshop on Citizens Concerns (Appendix I). The rational for putting a dam in the Withlacoochee River is to direct more water into the Tsala Apopka Chain-of-Lakes during drought situations, which would tend to improve navigation and access to the lakes. One difficulty with this management scenario is that, as mentioned earlier, *there is only a narrow window of opportunity to manage the water level in the Tsala Apopka Chain-of-Lakes*. The water in the Tsala Apopka Chain-of-Lakes, Withlacoochee River and the groundwater are so closely connected that when there is a drought, water levels in the river and the lakes will be low. During this type of situations using a dam to manipulate water levels is now even more difficult because of the passage of laws that establish minimum flows and levels in Florida rivers, lakes and aquifers. Therefore, during drought situation, which is when water is needed in the Tsala Apopka Chain-of-Lakes, diverting water from the Withlacoochee River may violate law.

Issue 4f) Manage water level after considering impacts to aquifer recharge.

There have been several studies examining the relations between the water in the Tsala Apopka Chain-of-lakes, the Withlacoochee River and the Florida aquifer. The water level experts generally agree with these studies and suggest that the whole chain of lakes has the potential to recharge the Florida aquifer because of the geologic attributes of the whole area. The amount of recharge that the aquifer will accept, however, is limited because the potentiometric surface of the Florida aquifer is so close to the land surface that during periods of moderate to heavy rainfall the aquifer becomes full and excess rainfall runs off to the river.

Therefore, managing the Tsala Apopka Chain-of-Lakes for aquifer recharge is dependent on the amount of rainfall occurring to the whole area.

Summary of Options to be considered for the Management of Water Quality in the Tsala Apopka Chain-of-Lakes

Option 1. Maintain current water level management conditions.

Making no changes and living with the current water level plan listed in Appendix VIII is a viable option. This plan has been in place since 1966 and has successfully provided flood protection for up to a 10-year flood event and adequate navigation except during extreme drought or flood conditions. However, the water level schedules in the current water level plan are regulatory guidelines that cannot be maintained under all hydrologic conditions. It is important to remember that *there is only a narrow window of opportunity for the manipulation of water levels* because the Tsala Apopka Chain-of-Lakes, Withlacoochee River and ground water are closely linked. Therefore, during drought conditions all water levels will be low and during extreme flood periods the river and lakes are connected with no ability control water levels.

Option 2. Change one or all of the water level schedules for Floral City Pool, Inverness Pool, and Hernando Pool for additional management benefits.

The current water level schedules are shown in Appendix VIII. The water level experts agree that these schedules are set opposite to the natural water cycle because they bring water levels down during wet months of June, July, August and September and then bring water levels up in the typically dry months of November through May. These schedules are set with the objectives of flood protection during wet periods and increased access and navigation during dry seasons. Thus, the actual water levels in all three pools do not track the water levels set by these schedules. However, within *the narrow window of opportunity to manage water levels in the Tsala Apopka Chain-of-Lakes*, there are several ways to change these water level schedules.

At times the water level in individual pools could be left higher than the schedule indicates to allow for better aquatic plant management. Higher water levels would allow greater access for mechanical harvesters, allowing them to more effectively control problem plants in shallow areas of the Tsala Apopka Chain-of-Lakes. Some cattail problems could also be minimized with higher water because cattails do not survive well in deep water.

Changes to the water level schedules that are going to be considered, need to be examined carefully because of the potential impact each change may have on different user groups. For example, the water level schedules could be flatted out maintaining higher water levels during summer months, aiding access and navigation. However, stabilizing the water level schedules in the wet months would decrease water storage for storm events lessening the ability to protect against floodwaters. This points out the need to carefully examine all ramifications before changing water level schedules.

Option 3. Remove select water control structures, roads, or canals and reset water level schedules for the Tsala Apopka Chain-of-Lakes.

Removing select (one or more) structures, roads, or canals will require a good water budget to determine impacts of removing any structures to the whole Tsala Apopka Chain-of-Lakes. Currently, the Southwest Florida Water Management District is collecting more data to improve their ability to predict water movements and storage capacities in the whole chain-of-lakes. After examining the water budget and potential impacts to the whole chain-of-lakes it will probably be necessary to establish new water level schedules to fit the new water budget and maintain flood protection up to a 10-year flood event. The cost of removing one or more structures and the impacts to the whole Tsala Apopka Chain-of-Lakes has to be acceptable before this type of option is implemented.

Within this option, is the ability to set and maintain a water level for select structures that would approximate prestructural levels or some other stated objective, but not permanently remove the structure itself. This would significantly decrease the cost of this option while maintaining the ability to use the structure if future information or emergency conditions dictate the need.

Option 4. Remove all water control structures, roads, and canals that impact water levels in the Tsala Apopka Chain-of-Lakes and allow water levels to fluctuate according to historical levels.

The removal of all water control structures, roads and filling in of canals that impact water levels in the Tsala Apopka Chain-of-Lakes is an option that would be very expensive. The cost would not only be for the engineering to restore historical water levels but the loss of property values when water levels eliminated access or caused flooding to a number of homes that have been built in the Tsala Apopka area. This is, however, an option to consider if people are willing to accept these costs and impacts.

Another difficulty in removing all of the water control structures, roads, and canals that impact water levels in the Tsala Apopka Chain-of-Lakes, is trying to determine what the exact height of the original land was before the modifications occurred. Without good historical data it would be difficult to recreate original levels throughout the system.

Option 5. Remove muck from canal and access points to allow for better navigation and lake access without changing current water level management conditions.

Throughout the citizen's discussion of water level issues (Appendix I) a major complaint was decreased access and navigation caused by accumulations of muck. This muck also gives substrate for increased growth of aquatic and terrestrial plants causing more access and navigation problems. The increased vegetative growth also tends to increase the formation of tussocks. To alleviate these problems many people suggested increasing water levels to allow for better access and navigation. However, increasing water levels during the wet part of the year may yield better access and navigation but at the cost of a higher chance of flooding because of decrease water storage.

An alternative to increasing water levels is to remove muck in canals and waterfront areas where accumulation of muck is excessive. The removal of muck is currently a lake management tool used by Florida Fish and Wildlife Conservation Commission. The removal of muck yields several benefits including;

improved access and navigation, decrease in substrate for growth of aquatic macrophytes, increase in abundance of fish habitat and decreased potential for tussock formation. Another beneficial aspect to muck removal is that many muck removal programs have been implemented in the State of Florida with no long term environmental problems.

Economics

Maintaining the current water level management condition would also keep the amount of money spent on managing the water levels in the Tsala Apopka Chain-of-Lakes the same. The current amount of money spent on personnel and operational costs to manage water levels is covered by the Southwest Florida Water Management District.

Changing one or all of the water level schedules would probably cost the same as maintaining the current water level management conditions, with the exception of money needed to study the impacts of any changes in water level schedules to different user groups. With the current structures, roads and canals in place, the data needed to evaluate impacts to the different user groups from any water level schedule change probably already exists. If any structures, roads, or canals that impact water levels in the Tsala Apopka Chain-of-Lakes are changed or removed then additional information in the form of water budget data would be needed.

Removing select water control structures, roads, and canals would range in cost depending on the number of structures being removed. Removal of all water control structures, roads, and canals that impact water levels in the Tsala Apopka Chain-of-Lakes and allow water levels to fluctuate according to historical levels would be by far the most expensive option listed in this report. There would be huge direct costs of planning, engineering and implementing the removal of structures and there would be huge indirect costs to different user groups who would potentially be negatively impacted by such a management approach. The cost of both options (option 3 and 4), however, could be decreased considerably by setting structures, canals and roads at levels that would allow water to move in historic levels and volumes but not completely remove structures. This would also allow for the future use of structure if needed.

The primary cost of removing accumulated muck in canals and lake front sites that historically were devoid of muck will vary depending on the amount of muck that needs to be removed. Additional costs for muck removal depend on access to muck disposal sites and type of equipment needed to remove muck. Lake Tohopekaliga is an example where the Florida Fish and Wildlife Conservation Commission removed approximately 300 acres of muck for about $500,000. This project was conducted in the late 1980s and was deemed a successful lake management program by the Florida Fish and Wildlife Conservation Commission.