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## LAKE OKEECHOBEE: IN REVIEW

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### Introduction

Lake Okeechobee and its watershed are integral components of south Florida's Kissimmee-Okeechobee-Everglades ecosystem, which extends from the headwaters of the Kissimmee River in the north to Florida Bay in the south. Lake Okeechobee is the second largest freshwater body located wholly within the continental United States, and in Florida, it provides a number of ecological and societal values. It contains one of the nation's most prized bass and black crappie fisheries, an economically important commercial fishery, and it provides habitat for wading birds, migratory waterfowl, and the federally-endangered Everglades Snail Kite. The lake also is a source of drinking water for surrounding municipalities, a backup water supply for the lower east coast of Florida, supplies irrigation water to the large Everglades Agricultural Area, and is a critical supplemental water supply for the Everglades. Given these competing demands on the lake, management of the water resource is a major challenge.

### History

Geological survey data indicate that Lake Okeechobee was formed about 6,000 years ago, when ocean waters receded and water was left standing in a shallow depression in what today is known as the state of Florida. The original lake probably was saline, but over time the salt water was replaced by freshwater from rainfall. The expansive lake that resulted from this process was named Okeechobee, which means "big water" in the Seminole Tribe language. The lake had a large littoral (wetland) zone that extended from the Kissimmee River to the Florida Everglades, and a pelagic (open-water) zone much larger and deeper than that observed today. During periods of high rainfall, the littoral zone expanded far to the west, and the lake was a direct source of water to the Everglades, by way of numerous small tributaries passing out of the lake's southern end. Survey data indicate that sediments of the lake were primarily comprised of sand and anecdotal reports indicate that water transparency was good. The near-shore regions of the lake probably supported dense beds of submerged plants and nesting and feeding habitat for fish and wildlife. One interesting feature is that before the late 1800s, the lake was largely unknown and considered just a myth by European settlers.

### Human Impacts

#### *Excessive nutrient inputs*

During the 20th Century, much of the land around Lake Okeechobee was converted to agricultural use. To the north, dairy farms and beef cattle ranching

became the major land uses, while in the south, sugar cane and vegetable farming increased rapidly. Associated with the land use changes were large increases in the rate of nutrient (nitrogen and phosphorus) inputs to the lake, and detrimental changes occurred in the lake's water quality. Nitrogen inputs were particularly high from the south, and these were dramatically reduced after the late 1970s when an "interim action plan" prohibited pumping of agricultural water into the lake from the south except under situations where farmlands would otherwise be flooded. Phosphorus inputs were large from the north, and can be traced primarily to the animal agricultural activities in that watershed. Loads of total phosphorus to the open-water region of the lake nearly tripled between the early 1970s and mid-1980s, and coincident with this trend, the concentration of phosphorus in the lake itself increased from below 40 to over 100 ppb. Blooms of blue-green algae became more common, with particularly large blooms covering more than 40% of the lake surface in the 1980s. A number of programs have been implemented, and others are under development, to substantially reduce phosphorus loads to the Lake Okeechobee.

One of the greatest challenges in reversing harmful trends caused by excessive phosphorus loading may be in controlling sources internal to the lake. Because high phosphorus loads have occurred for over 60 years, over 30,000 tons of phosphorus accumulated at the bottom of the lake in the form of soft organic mud. Due to the lake's shallow depth (averaging just 2.3 meters or \_ 9 ft), this mud is mixed into the water column every time strong winds blow across the lake surface. This keeps water column phosphorus concentration high, and when the turbid water is transported to the near-shore region, it prevents submerged plant beds from getting the amount of light they need to grow. Phosphorus in the water also stimulates the growth of cattail along the edge of the littoral zone. Because of the large pool of sediment phosphorus, internal loads of phosphorus (from sediment to water) now equal external loads (from watershed to lake). When lakes display this situation, their recovery is severely delayed, even when external loads are dramatically reduced, because the sediments act as a phosphorus reservoir and keep releasing it to the water column of the lake. Some combination of sediment removal and external load reduction may be needed to achieve recovery of Lake Okeechobee in a relatively short (decades) time frame.

### *Hydrologic modifications*

Other developments in south Florida have had severe impacts on Lake Okeechobee. In the 1890's, Hamilton Disston constructed a canal connecting Lake Okeechobee with Lake Hicpochee, the headwaters of the Caloosahatchee River. This provided the lake's first outlet to tidewater via the Caloosahatchee River. In the early 1900's, Everglades Drainage District constructed several other canals that impacted Lake Okeechobee. The St Lucie, Hillsboro, North New River, West Palm Beach, and Miami Canals were constructed from the lake to tidewater. These canals provided a slow, continuous drainage from Lake

Okeechobee and the Everglades. The goal was to drain the northern Everglades for agriculture. Small towns arose in this region, some in close proximity to the lake. A small muck levee was constructed along the southern shore of the lake. In the 1920's two major hurricanes struck south Florida. One of them generated a storm surge in the lake that flooded hundreds of acres to the south and killed approximately two thousand people. To prevent such devastation from recurring, the United States Army Corps of Engineers (USACE) constructed Herbert Hoover Dike, an earthen levee which still surrounds the lake's perimeter. Today, all discharges into (except Fisheating Creek) and out of the lake are artificially controlled. One of the major impacts of the dike on Lake Okeechobee was to constrain the littoral zone to a much smaller region, along the western and southern shorelines. When water levels in the lake become very high, the littoral zone now has no opportunity to expand outward, but rather, it simply is flooded with deeper and deeper water.

Coincident with completion of the dike and water control structures, the USACE developed a "regulation schedule" that is cooperatively administered by the USACE and SFWMD. The Lake Okeechobee regulation schedule provides a balance between storage capacity during the wet season and water supply during the dry season. Under the present regulation schedule the lake has experienced frequent events with prolonged high water levels. These have been extremely damaging to both the lake and downstream ecosystems. High water levels have led to drastic declines in the lake's submerged plant beds, recently documented declines in important sport fisheries (largemouth bass), turbid water, and possibly have contributed to the rapid expansion of cattail in the lake's littoral zone. When lake levels are particularly high, large discharges of freshwater are sent through canals to the St. Lucie and Caloosahatchee estuaries, where there have been severe impacts on estuarine organisms. A new lake regulation schedule, which will attempt to reduce the occurrence of extreme high water events by using climate forecasting is scheduled to be implemented in March 2000.

Extremely low water levels during the dry season also can threaten the lake's ecological health by allowing certain exotic plants that have invaded the littoral zone to rapidly expand. Low water levels may become a greater concern in the future when a greater water supply is needed for both Everglades restoration and the growing human population of south Florida.

### *Exotic plants and animals*

When Lake Okeechobee was diked during the early to mid-1900s, the littoral zone was comprised of a diverse mosaic of native plants, including spikerush, beakrush, and willow. These plants provided important habitat for fish, birds, and other wildlife, as they continue to do so today. However, a large percentage of the native plant habitat in the lake's littoral zone (over 20,000 acres) has been lost to exotic plants, most notably melaleuca and torpedograss. Melaleuca is a native tree of Australia and torpedograss is a pasture grass native to Europe. Both were planted intentionally in the vicinity of the lake, and both rapidly

colonized the littoral zone. The SFWMD and other agencies are actively engaged in a program to eradicate melaleuca from south Florida, using herbicide and biological control agents. Control programs for torpedograss are under development. The spread of both plants, as indicated above, seems to be facilitated by extreme low water levels in the lake. The lake also contains exotic animals, including an asiatic clam and fish, but their negative impacts have not been as well documented.

### Major Issues for Management of the Resource

The following major issues have been identified as most critical for restoration of the Lake Okeechobee ecosystem.

1. External loads of phosphorus to the lake must be substantially reduced.
2. Internal loading of phosphorus from the lake sediments must also be reduced, if feasible, or responses to external load reduction will be considerably delayed.
3. Extreme high and low water levels must be dramatically reduced in their frequency and duration.
4. The rapid expansion of exotic plants in the lake's littoral zone must be stopped.

The SFWMD Okeechobee Division has established a comprehensive program of research, planning, regulation, and implementation to address these issues.

### Okeechobee Division Structure and Responsibilities

The Okeechobee Division is comprised of three core units that work closely together in order to carry out the most effective program for restoration of the water resource. These units and a brief description of their responsibilities are as follows.

#### *Watershed Source Control*

Staff in this unit identifies sources of phosphorus in the watershed and works with land owners and other state and federal agencies to ensure that water quality standards are met in a timely and economically practical manner. The unit contains a research component with a focus on spatial models that can be used to predict effects of land use and agricultural management practices on phosphorus exports to the lake. Large-scale experiments also are being conducted to identify management practices for beef cattle that will minimize phosphorus exports while still maintaining economic productivity.

In addition, the Works of the District (WOD) program, based at the Okeechobee Service Center, inventories and permits all non-dairy land uses in the priority basins of the Lake Okeechobee watershed. WOD staff perform compliance monitoring and synoptic water quality surveys to identify high phosphorus source areas, and require corrective actions from landowners when they are found to be out-of-compliance.

### *Program Planning and Implementation*

Staff in this unit develop planning documents (e.g., the Surface Water Improvement and Management Plan) and, coordinate the implementation of construction projects all related to the restoration of the lake and its watershed. Responsibilities for this unit include: (1) carrying out activities associated with the federally-funded “critical project” north of the lake, which include construction of stormwater treatment areas for removing phosphorus from tributaries and reflooding of isolated wetlands on dairy and pasture lands; (2) evaluating the feasibility of sediment traps as a means to capture phosphorus rich tributary sediments before they can enter the lake; (3) coordinating the design and construction of Comprehensive Everglades Restoration Plan (CERP)-related elements in the watershed; and (4) conducting a multi-year study to evaluate the economic, ecological, and engineering feasibility of removing the lake’s mud sediments.

### *Lake Research and Assessment*

Staff in this unit is responsible for developing the protocol to track long-term trends in the lake’s ecological health. This information is crucial to evaluating the magnitude of human impacts and the success of restoration programs. This unit also conducts experimental research and modeling, in order to establish causal relationships and provide information on which to base resource management decisions. Ongoing research dealing with submerged aquatic vegetation, for example, will allow identification of an optimal range of water levels, and this in turn can be used to maximize ecological benefits from regional hydrologic restoration programs (i.e., the Comprehensive Everglades Restoration Plan). Research dealing with the lake sediments will allow managers to predict the net benefits (in terms of reduced internal phosphorus loading) of complete or partial sediment removal. Research in the littoral zone is quantifying the effects of water level on rates of melaleuca and torpedograss expansion, and identifying the optimal combination of herbicide and fire to kill torpedograss.

This Web site provides an in-depth look at the issues facing Lake Okeechobee and its watershed, and the planned and implemented actions needed to restore the health of one of the most unique water bodies in the United States. The District will take the lead role in projects related to the Okeechobee Watershed during the next five years, but will continue to coordinate activities and conduct collaborative studies with universities, non-profit organizations as well as local, state, federal and tribal agencies including:

- \_\_\_ US Army Corps of Engineers - Jacksonville District (USACE)
- \_\_\_ US Army Corps of Engineers - Waterways Experiment Station (WES)
- \_\_\_ Florida Fish and Wildlife Conservation Commission (FFWCC)
- \_\_\_ Florida Department of Environmental Protection (FDEP)
- \_\_\_ Florida Department of Agriculture and Consumer Services (FDACS)
- \_\_\_ United States Environmental Protection Agency (USEPA)

- \_\_\_ The University of Florida (UF)
- \_\_\_ United States Geological Survey (USGS)
- \_\_\_ MacArthur Agro-Ecology Research Center (MAERC)
- \_\_\_ Florida Cattleman's Association
- \_\_\_ Okeechobee Economic Council
- \_\_\_ Florida Farm Bureau