A CLOSER LOOK

…at Lake Okeechobee Research

The sun sets over a littoral marsh community of Lake Okeechobee. Covering 650 square miles, this freshwater lake is the second largest in the nation.

The bottom of an ocean becomes a mammoth lake

Lake Okeechobee probably was formed about 6,000 years ago when ocean waters receded and exposed the land now known as the state of Florida. Most likely, the original lake was filled with salt water, which eventually 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 large littoral (wetland) region surrounding this lake extended from the Kissimmee River to the Florida Everglades.

In the early 1900s, portions of the Everglades immediately to the south of Lake Okeechobee were drained and developed into rich agricultural lands. Small towns arose in this region, some in very close proximity to the lake. In the 1920s, two major hurricanes struck south Florida, one of which churned the waters of Lake Okeechobee into waves that flooded hundreds of acres to the south and killed two thousand people. To prevent such devastation from happening again, the U.S. Army Corps of Engineers built the Herbert Hoover Dike, which still surrounds the lake's perimeter. This dike reduced Lake Okeechobee's original size to about 650 square miles, lowered its average water levels and produced a new lit-

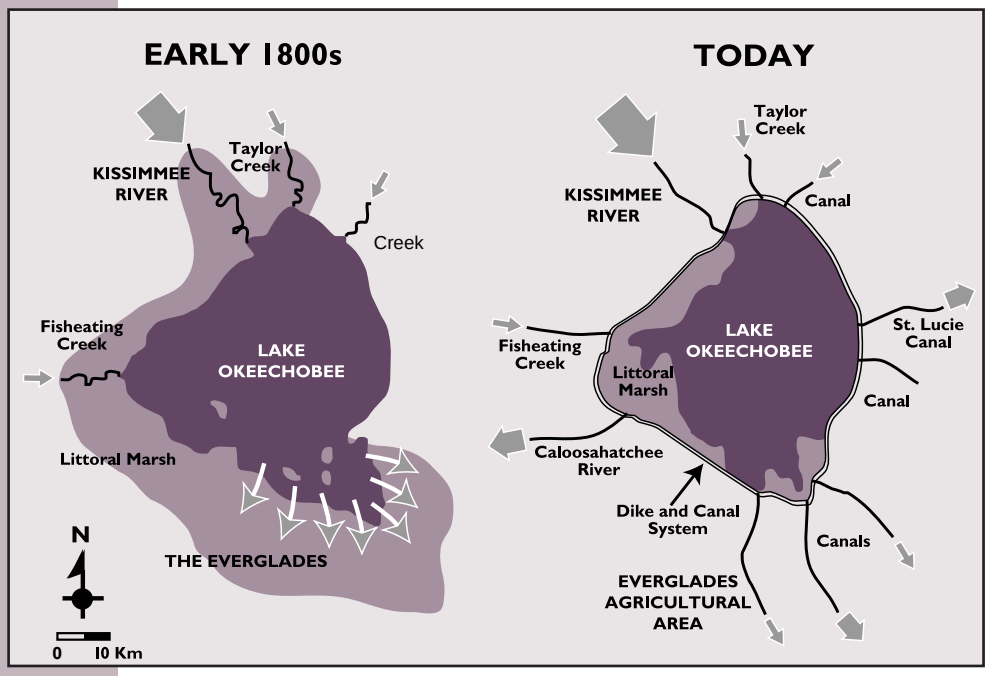
In review…

- The lake has been impacted by nutrients, exotic plants and unnatural water level fluctuations.
- Research considers how these impacts affect the lake's ecosystem.
- The District's goal is a predictive understanding of the lake and its downstream ecosystems to guide effective management actions.

toral zone inside the dike, where there once was deep, open water.

How the nature of the lake has changed

may be held inside Lake Okeechobee to ensure regional flood protection. In the late 1970s, the Corps of Engineers changed this schedule to allow



An artist's rendering depicts how Lake Okeechobee may have looked in the early 1800s, and how it looks today. Today's lake is smaller, surrounded by a dike and connected with other freshwater and estuarine ecosystems by way of man-made canals and water control structures. Arrows indicate directions and quantities of water flow.

Today, a Corps of Engineers regulation schedule determines the maximum water levels that

District researchers perform an experiment to determine the effects of nutrients on algal growth in the lake's open-water region.

for higher lake levels and increased water supplies for south Florida. Scientists, managers and members of the public have expressed concerns that high water levels during the rainy season now cause harm to the lake's natural plant and animal communities.

Another concern about high water levels is that at the extreme, they necessitate large discharges of freshwater through canals into Florida's east and west coast estuaries. Historically, these estuaries, a brackish mix of fresh and salt waters, were not connected directly to the lake. Now, large discharges from Lake Okeechobee carry freshwater far into the estuaries and have killed entire communities of brackish water plants and animals.

Extremely low water levels during the dry season also can threaten the lake's ecological health. This issue may be a future concern if water from the lake is used for regional restoration efforts or to supply water to growing metropolitan areas.

Lake Okeechobee also has been harmed by excessive nutrients entering its water from agricultural activities in surrounding areas. From 1975 to 1985, phosphorus levels in the lake's water doubled (to approximately 100 ppb total phosphorus), and high levels of phosphorus accumulated in the lake's sediments. There have been large algal blooms, changes in the composition of bottom-dwelling animals and high inputs of phosphorus from lake sediments to the water column.

The lake's littoral zone has been threatened by a variety of exotic (non-native) plants, most notably melaleuca and torpedo grass, which have expanded over large areas, displacing native plants and degrading the quality of habitat for fish and wildlife. In addition, certain nuisance plants such as cattail are expanding in the lake and crowding out less-invasive plants.

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Despite these human-induced impacts, Lake Okeechobee continues to be a vital, freshwater resource for south Florida, with

Beef cattle have been identified as a potentially large source of phosphorus to the lake.

irreplaceable natural and social values. The lake supplies water for urban, agricultural and environmental use as well as commercial and recreational fishing and critical wildlife habitat.

Researching ways to protect the "big water"

The District has a comprehensive research and modeling program that is designed to assist decision-makers in protecting Lake Okeechobee and downstream ecosystems, including the coastal estuaries and the Everglades. Progress toward this goal is the result of rigorous scientific research and modeling conducted by District scientists and engineers. Water samples and ecological data are regularly collected from the lake to develop a long-term record of overall ecosystem health.

District researchers collect samples in a large area of the lake that has been overtaken by torpedo grass, a harmful exotic plant.

Current research and modeling efforts focus on unnatural water level variations, excessive nutrients and exotic/nuisance plant expansion.

Water Level Research: Scientists and managers recognize that water level variations occurring under existing federal regulation schedules may not be beneficial to the lake's animal and plant communities. For this reason, there are ongoing efforts to evaluate environmental responses to alternative schedules, which might allow for lower lake levels. The same research will allow the District to predict how regional restoration efforts, such as the Corps' Central and South Florida Restudy Project, might impact the lake.

Research staff are quantifying the extent to which fish, birds and other animals use the different plant communities for nesting and feeding. This research will allow the District to predict how water-level-related changes in plant community structure will impact animal communities. Scientists also are conducting controlled experiments to quantify environmental responses to nutrient inputs. This effort will help predict how the littoral community responds to sustained high lake levels, where nutrient-rich water from the open-water region mixes into the nutrient-poor littoral zone.

Controlled laboratory studies are under way to evaluate how native and exotic plants are affected by different water levels. Such studies will allow scientists to predict how changes in lake level may affect the expansion of exotic plants. District researchers also are developing water quality models and conducting field research to predict how changes in lake level may affect nutrient concentrations, algal blooms and other key water quality indicators.

Watershed Nutrient Research:

A large portion of the phosphorus entering Lake Okeechobee comes from agricultural activities in the watershed, including dairy farming and beef cattle ranching. Therefore, District research pertaining to the lake also extends into the watershed. In the 1980s, dairy farms constructed waste-management systems that have greatly reduced phosphorus discharges. Scientists now are using landscape models to pinpoint remaining sources of phosphorus, which may be targeted for additional management actions.

Scientists also are conducting experimental research and modeling at a working cattle ranch north of the lake to develop best management practices for beef cattle operations, now identified as the largest remaining, human-related source of phosphorus to the lake. This is a collaborative effort that involves cattle ranchers and scientists from the University of Florida and its Institute of Food and Agricultural Sciences, and Archbold Biological Station.

Because the lake has received large doses of phosphorus for more than 50

PARTNERSHIPS IN RESEARCH

- Harbor Branch Oceanographic Institute
- Florida Atlantic University
- University of Florida (IFAS)
- U.S. Army Corps of Engineers Waterways Experiment Station
- St. Johns River Water Management District

years, it has accumulated more than 2,000 tons of phosphorus in its upper sediment layers. This enormous amount of phosphorus in the lake bottom could severely delay the lake's recovery from pollution, even when new phosphorus inputs from the watershed are greatly reduced.

Scientists are using water quality models to predict how the lake will respond to further reductions in phosphorus inputs from both the watershed and the lake sediments. In addition, it will soon be possible to use in-lake and landscape models in combination to predict how certain changes in land use may impact loads to the lake as well as in-lake water quality and the regional economy.

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The littoral marsh community is home to a diverse array of birds and other wildlife. A long-term goal of research on the lake is to protect this vital resource.

Exotic and Nuisance Plant Research: Exotic and nuisance plants threaten the lake's ecological values, because they take over areas once occupied by more desirable native plants and associated wildlife communities. Research staff are working with the District's Operations and Maintenance Department's Aquatic Plant Management Program to optimize the eradication of melaleuca. This is accomplished by producing detailed maps of melaleuca distribution, on a yearly basis, from which managers can evaluate program success and identify areas of most rapid expansion.

Researchers hope to develop an effective program for the eradication of torpedo grass. In large-scale experiments, replicated plots are treated with aerial herbicide applications to judge effectiveness in killing torpedo grass and opening up areas for native plants. Studies also are under way to consider whether controlled burns of torpedo grass communities may allow native plants to recolonize the areas.

Ecological Trend Studies: To determine the effectiveness of management programs that are focused on water levels, nutrients or exotic plants, long-term ecological data must be collected to evaluate ecosystem changes. District staff, in collaboration with scientists at the Florida Game and Fresh Water Fish Commission, are sampling several biological parameters for this purpose, including open-water algae, benthic algae, bottom-dwelling animals, littoral vegetation, lake sediment composition and fisheries.

Research leads to the lake's protection

Lake Okeechobee is a precious natural resource that has been harmed by human development in south Florida. Scientists at the District and other agencies are conducting research that will allow decision-makers to protect the lake's ecosystem. A healthy lake will provide critical needs to both human and wildlife inhabitants of south Florida for years to come.

What's ahead…

- Continue evaluating the relationship of lake levels to ecosystem health.
- Continue evaluating the relationship of plant communities to wildlife use.
- Refine and apply water quality, hydrodynamic and ecological models.
- Continue comprehensive long-term ecological monitoring.
- Continue evaluating agricultural best management practices.
- Continue evaluating methods for eradicating exotic plants.

For more information on Lake Okeechobee Research, please contact the SFWMD at (561) 686-8800.

For news on other SFWMD research projects, please see the following *Closer Look* publications:

- An Overview of Current SFWMD Research
- Estuary Research
- Everglades Research
- Kissimmee River Research
- Southern Everglades and Florida Bay Research
- Stormwater Treatment and Supplemental Technology Research