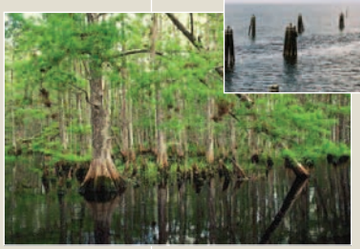
The Journey of Wayne Drop to Lake Okeechobee

US Army Corps of Engineers
Jacksonville District

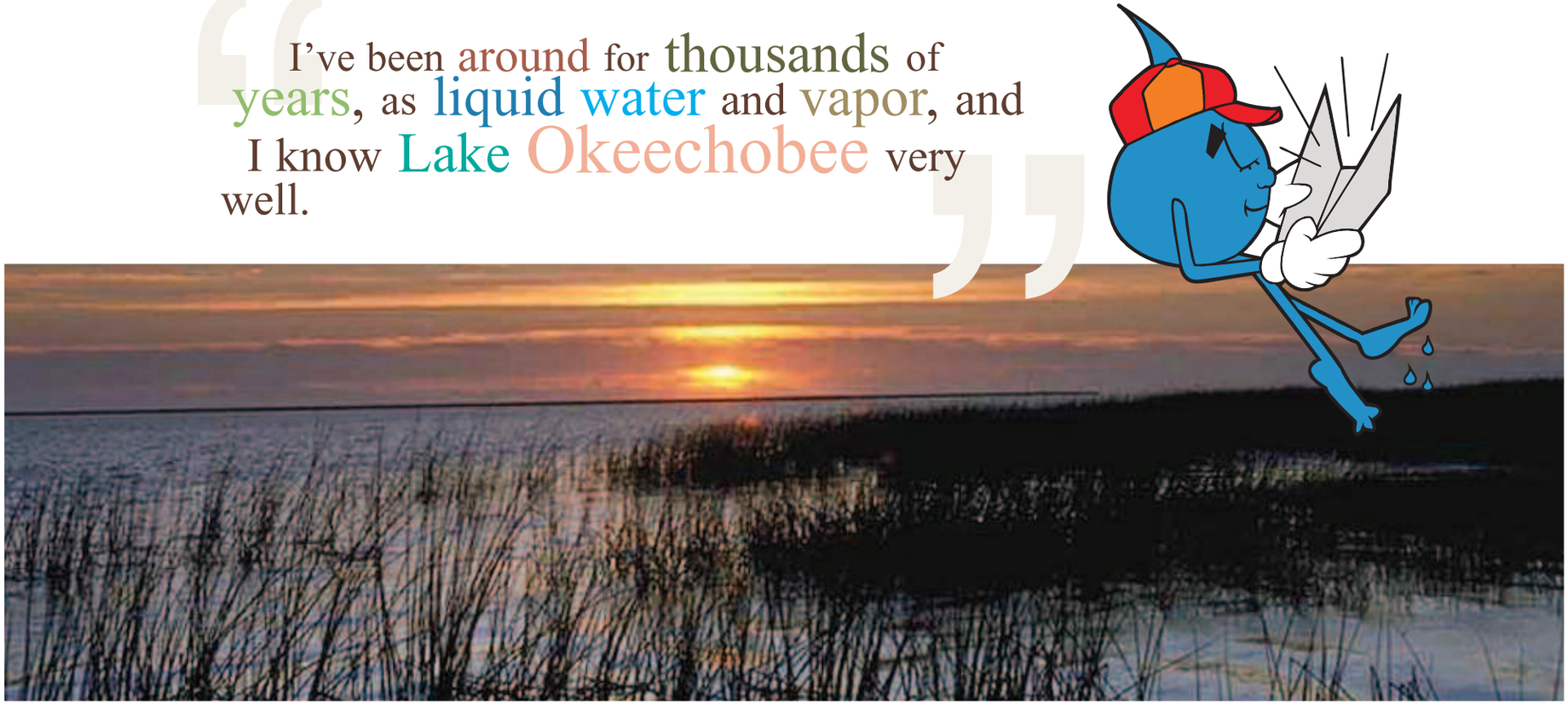


VERY EARLY HISTORY

Hi friends. My name is Wayne Drop. I know, you may think it's Rain Drop, but no, it's Wayne. I happen to be a water drop who likes to tell stories, particularly about my favorite topic: south Florida's fascinating natural environment.

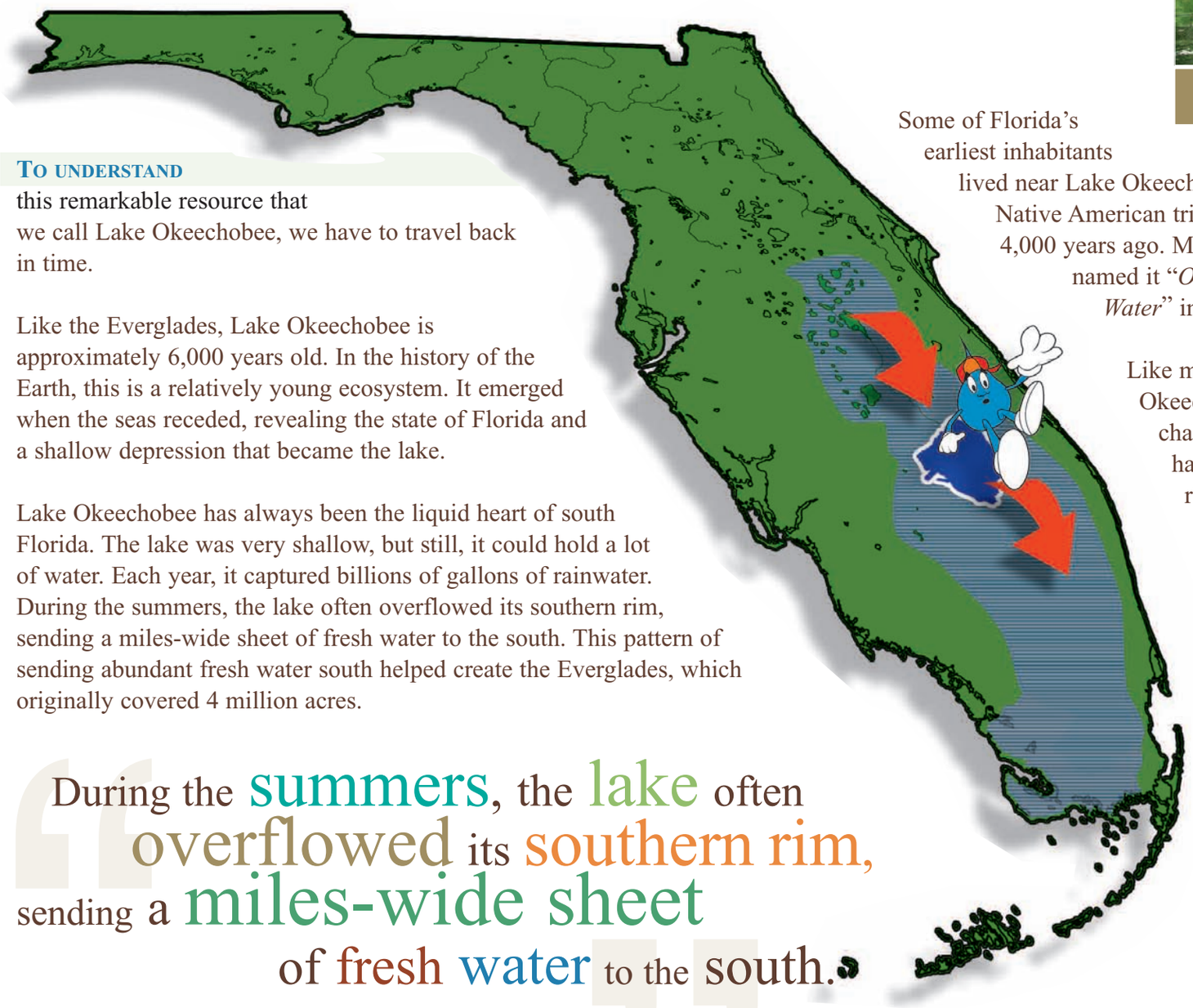
I have been asked by the **U.S. Army Corps of Engineers** to tell you about **Lake Okeechobee**. Why me? Simple! I've been around for thousands of years, as liquid water and vapor, and I know Lake Okeechobee very well. Through my unique abilities to travel through time and transform myself, I see things from different perspectives. You could say I view life from a birds-eye point of view. I may be able to show you some things about the lake and **Herbert Hoover Dike** that you may not learn about otherwise. Of course, it requires a little imagination to pay attention to a water drop, but believe me, the story is pretty interesting!

> "I've been around for thousands of years, as liquid water and vapor, and I know Lake Okeechobee very well."



LAKE OKEECHOBEE has a **RICH** and **INTERESTING PAST**

Dense vegetation once surrounded the lake.



To understand this remarkable resource that we call Lake Okeechobee, we have to travel back in time.

Like the Everglades, Lake Okeechobee is approximately 6,000 years old. In the history of the Earth, this is a relatively young ecosystem. It emerged when the seas receded, revealing the state of Florida and a shallow depression that became the lake.

Lake Okeechobee has always been the liquid heart of south Florida. The lake was very shallow, but still, it could hold a lot of water. Each year, it captured billions of gallons of rainwater. During the summers, the lake often overflowed its southern rim, sending a miles-wide sheet of fresh water to the south. This pattern of sending abundant fresh water south helped create the Everglades, which originally covered 4 million acres.

> "During the summers, the lake often overflowed its southern rim, sending a miles-wide sheet of fresh water to the south."

Some of Florida's earliest inhabitants lived near Lake Okeechobee. There is evidence that Native American tribes settled close to the lake 4,000 years ago. More recently, the Seminoles named it "*Okeechobee*," which means "*Big Water*" in their native language.

Like much of south Florida, Lake Okeechobee presented a difficult and challenging environment. The lake had no natural outlets such as rivers or streams and was surrounded by dense vegetation that kept people from getting to it. Some early explorers never saw it so they refused to believe it even existed. The lake first appeared on maps in 1837, but remained largely unknown to European-descendent settlers until the late 1800s.

THE LAKE has Changed DRAMATICALLY

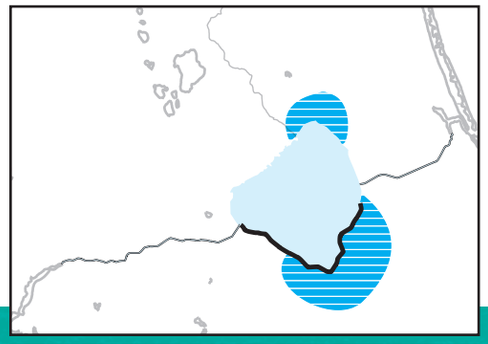
The first canal draining water from Lake Okeechobee was built in the 1880s. These canals later allowed successful steamboat travel on the lake and associated rivers.

Lake Okeechobee has changed dramatically in the past 120 years, as has most of Florida.

The historic lake was 25 percent larger than it is today, was deeper – averaging 20 to 21 feet – and had a wide vegetation area that covered the place where the shore and the water met. A vegetated area that circles a lake's shoreline is called a littoral zone. Lake Okeechobee's original littoral zone is now completely gone. The lake had a sandy bottom and its waters were probably very clear and clean.

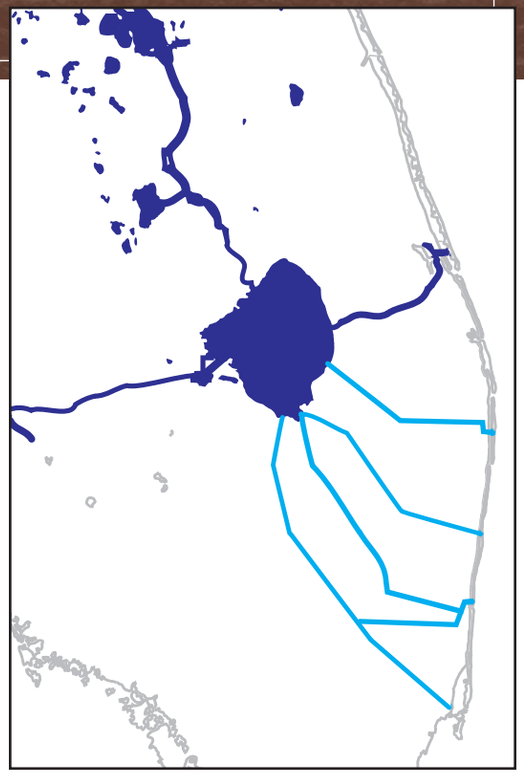
The lake has changed over time for many reasons, most of which were caused by people. Early settlers wanted to make Florida a nice place to live. However, Florida is low, it has many wetlands, and it floods frequently. Early pioneers wanted to drain floodwaters from Florida as quickly as possible. All eyes looked to frequently flooded Lake Okeechobee as the biggest problem to tackle.

Hamilton Disston, a wealthy Philadelphia industrialist, felt the best way to drain floodwaters north of the lake was to create outlets in the lake. Like removing the stopper from a basin, outlets would allow water from north of the lake to flow through the lake and out to sea. This would open up thousands of acres for cattle ranching, farming and urban development north of the lake.



Flooded areas in 1928.

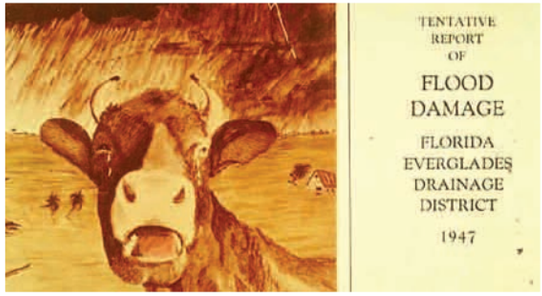
Disston made the first attempt to drain floodwaters by connecting the Caloosahatchee River to Lake Okeechobee. By 1882, steamboats were sailing from Fort Myers to Orlando!



In all, 440 miles of drainage canals were built by 1927.

Continuing with these early efforts, from 1907 to 1927 the state's Everglades Drainage District dredged four large canals south of the lake to the Atlantic Ocean and one east to the St. Lucie estuary – all in an effort to drain water to sea. In all, 440 miles of canals and levees had been built by 1927 in an attempt to make this difficult state easier to live and grow crops in.

However, these early drainage efforts were no match against Mother Nature. In 1926 and 1928, two hurricanes swept through south Florida, killing an estimated 3,000 people and leaving another 40,000 homeless. Hurricane force winds pushed water to the north part of the lake and then the water sloshed back to the south. The hurricane waters destroyed 21 miles of a small earthen dam that had been built on the south side of the lake. The floodwaters destroyed almost everything in its path and killed many people. Moore Haven, Belle Glade, South Bay and Okeechobee were among the cities that flooded.



Early flood control efforts were no match against two hurricanes in 1947.

Following the storm of 1928, residents were terrified by the thought that the lake could overflow again. The federal government was asked to increase efforts to drain south Florida and make sure Lake Okeechobee never overflowed again. The U.S. Army Corps of Engineers built a huge earthen dike around Lake Okeechobee. The dike was constructed from sand, muck and other earthen materials piled up from the lake basin.

The dike, at its base, was as wide as a football field. It was about three stories tall and shielded the most vulnerable areas along the southern rim of the lake. The dike was considered an impressive flood control structure.

As most people who have lived in Florida for any length of time can tell you, the state is a land of weather extremes. In the 1930s and 1940s, Florida then experienced a very severe drought, lasting about 15 years. During this time, wildfires raged out of control in the Everglades, made worse by the four large drainage canals which had artificially lowered groundwater levels. Early residents were having a difficult time living in this land of extremes.

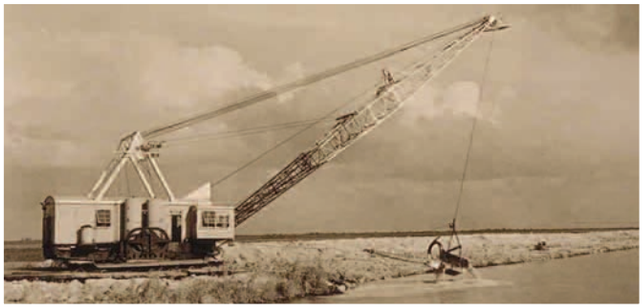
Hurricanes presented many challenges to early settlers.

Then, in 1947, an event happened that changed the course of history in Florida. Two back-to-back hurricanes hit, causing widespread flooding from Orlando to Miami. Though floodwaters did not recede for months, there was little loss of life associated with the storms. Economic losses were huge, however. Agricultural crops and beef and dairy cattle industries suffered millions of dollars of damage. Life came to a standstill for many. Northern visitors were reluctant to spend winters in this unpredictable state.

Residents of Florida had enough! In 1948, the state asked Congress for help. The Florida Legislature asked for a flood control project that would tame the wild swings of nature and allow the state to grow and prosper. Congress authorized the **Central & Southern Florida Flood Control Project**.

Over the next 20 years, the U.S. Army Corps of Engineers designed and built an engineering marvel. The **C&SF Project** consisted of 1,000 miles of canals and 720 miles of levees. The dike around Lake Okeechobee was strengthened, completed and was renamed the Herbert Hoover Dike in 1961. The C&SF Project safely routed water throughout central and south Florida, allowing the region to grow to more than 7 million people today and support one of the nation's most productive agricultural areas.

However, water management efforts took a toll on the natural environment.



A world class flood control project was started in the early 1950s to effectively drain floodwaters from Florida and protect its residents. This dragline is shown in 1955. Construction of the project continued into the 1970s.

Managed for **MULTIPLE** and **CONFLICTING PURPOSES**

Now, Lake Okeechobee is very different from the historic lake. The lake has been reduced to 730 square miles – still great enough to be the largest lake in the southeastern United States and second-largest freshwater lake fully in the continental United States (far behind those of the Great Lakes, though). It also is much shallower today, averaging 9 feet deep.

Today, Lake Okeechobee is a completely managed water body. About 60 percent of its water comes from five rivers and tributaries north of the lake and the remaining 40 percent comes from rainfall directly over the lake. Trillions of gallons of water are stored in the lake. All outflows are controlled by federal and state water managers through an intricate series of canals, locks and pump stations.

Perhaps one of the biggest challenges is the fact that the lake now has "*multiple purposes*." No longer does it function as a natural lake, but it must serve many often-conflicting goals.

• FLOOD CONTROL

Water that was historically stored in wetlands in Florida – many of which now are gone – is stored in the lake. This has allowed the growth of cities and farms in its basin. The Herbert Hoover Dike allows for the storage of large amounts of water in the lake and prevents flooding from the lake.

• WATER SUPPLY

The lake serves as a water supply source for farms in the Everglades Agricultural Area to the south of the lake and as a back-up water supply source for east coast urban areas.

• NATURAL ENVIRONMENT

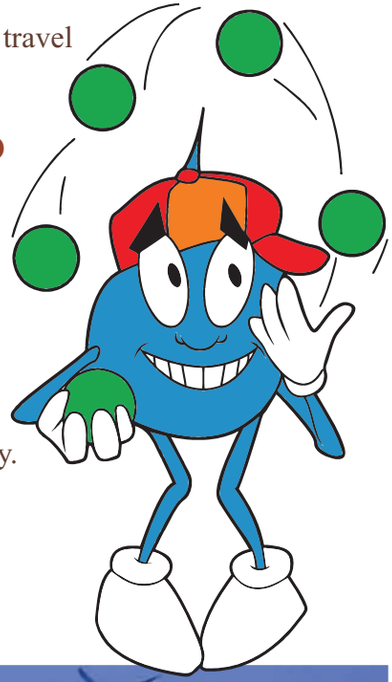
The lake provides habitat for plants, fish, waterfowl and other wildlife. Endangered and threatened species live in its watershed area. Impacts to its ecology can have significant effects many miles away.

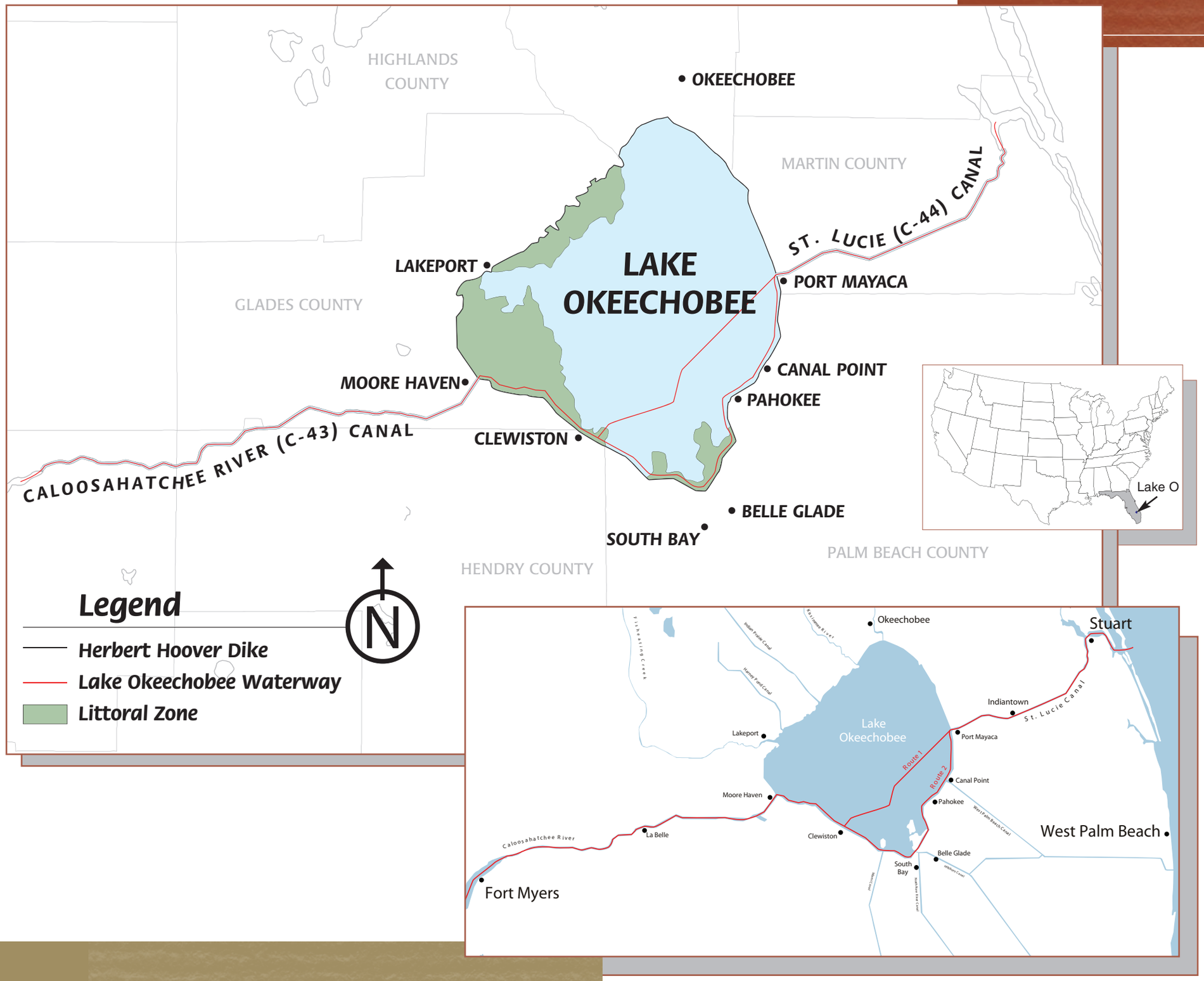
• NAVIGATION

The **Okeechobee Waterway** allows boat travel from Fort Myers to the St. Lucie River.

• FISHING, RECREATION AND TOURISM

Lake Okeechobee offers some of the best sport fishing for largemouth bass and black crappie in the world, and is visited by anglers from around the nation. Other recreation in the lake and its basin includes bicycling, bird-watching, boating, camping, hiking and photography.




HIGHLANDS COUNTY
OKEECHOBEE
MARTIN COUNTY
ST. LUCIE (C-44) CANAL
LAKE OKEECHOBEE
LAKEPORT
PORT MAYACA
GLADES COUNTY
CANAL POINT
MOORE HAVEN
PAHOKEE
CLEWISTON
CALOOSAHATCHEE RIVER (C-43) CANAL
BELLE GLADE
SOUTH BAY
PALM BEACH COUNTY
HENDRY COUNTY
Lake O
Legend
Herbert Hoover Dike
Lake Okeechobee Waterway
Littoral Zone
N
Okeechobee
Stuart
Indiantown
St. Lucie Canal
Lake Okeechobee
Lakeport
Port Mayaca
Route 1
Route 2
Canal Point
Moore Haven
Pahokee
West Palm Beach Canal
West Palm Beach
Caloosahatchee River
La Belle
Clewiston
Belle Glade
South Bay
Fort Myers

Huge **DIKE** Provides Safety

It is impossible to write about Lake Okeechobee without addressing the Herbert Hoover Dike. The dike has a profound impact on the lake, its health, and water management activities miles away.

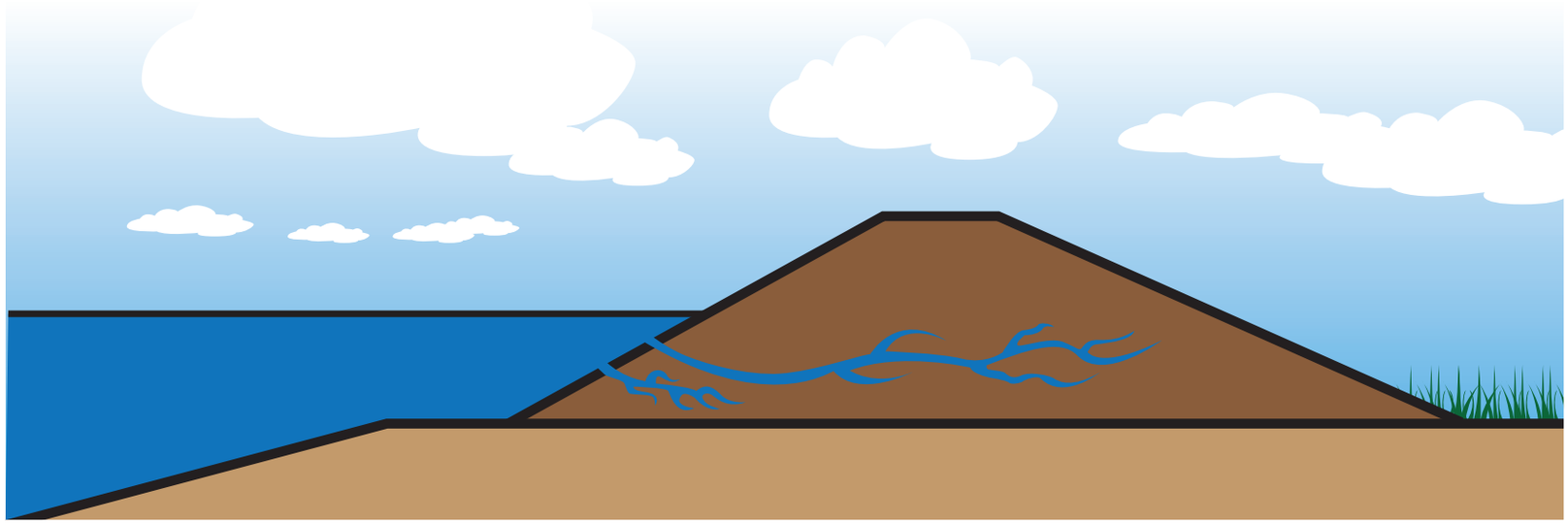
The U.S. Army Corps of Engineers designed and built the dike and is responsible for its maintenance today. The dike was originally built in the 1930s. It is constructed of earthen materials found on site: limestone, gravel, sand, rock and shell. This design was good at the time. Today, it would not be built this way. The dike was largely constructed from 1932 to 1937. It was strengthened and completed by 1961.

> "The dike has not failed in its 70 years."

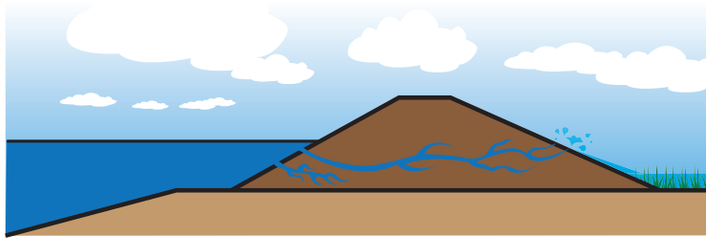
The dike has not failed in its 70 years. It is 144 miles around and completely encircles the lake. However, because the dike is built of earthen materials, it is subject to internal erosion. Water can seep through the dike in a process called piping, in which small tunnels or pipes are formed which carry water and materials. The dike leaks during times of high water levels. It is very doubtful water would ever overtop the dike; the concern is leaking at its base.

These issues have been well-known for years. In 2000, the Corps of Engineers completed a study of the conditions and decided to do a major repair to strengthen the dike. That same year, Congress approved a dike-strengthening program. Construction began on the strengthening project. However, after Hurricane Katrina in New Orleans in 2005, an Independent Technical Panel of experts reviewed the current construction plans and recommended more measures to strengthen the dike.

The dike protects 60,000 people who live near the lake.



The dike can leak during times of high water levels. The Corps of Engineers is strengthening the dike in sections to prevent this.



The Corps agrees with the findings and is implementing the panel's advice as quickly as possible. The plan cost an estimated $856 million in 2007. The new plan involves land acquisition, an expensive step not taken in the first plan. The South Florida Water Management District is assisting with the purchase of these lands. In addition, the Corps and state of Florida carefully regulate water levels in the lake, keeping the level lower, when possible, to maintain the safety of the dike and health of the lake.

While the dike has never failed, it is always a prudent idea for people living near the lake to have a plan to prepare for and respond to hurricanes, as should all residents of Florida and other coastal areas of the United States.

Are **VERY** Carefully Managed **TODAY**

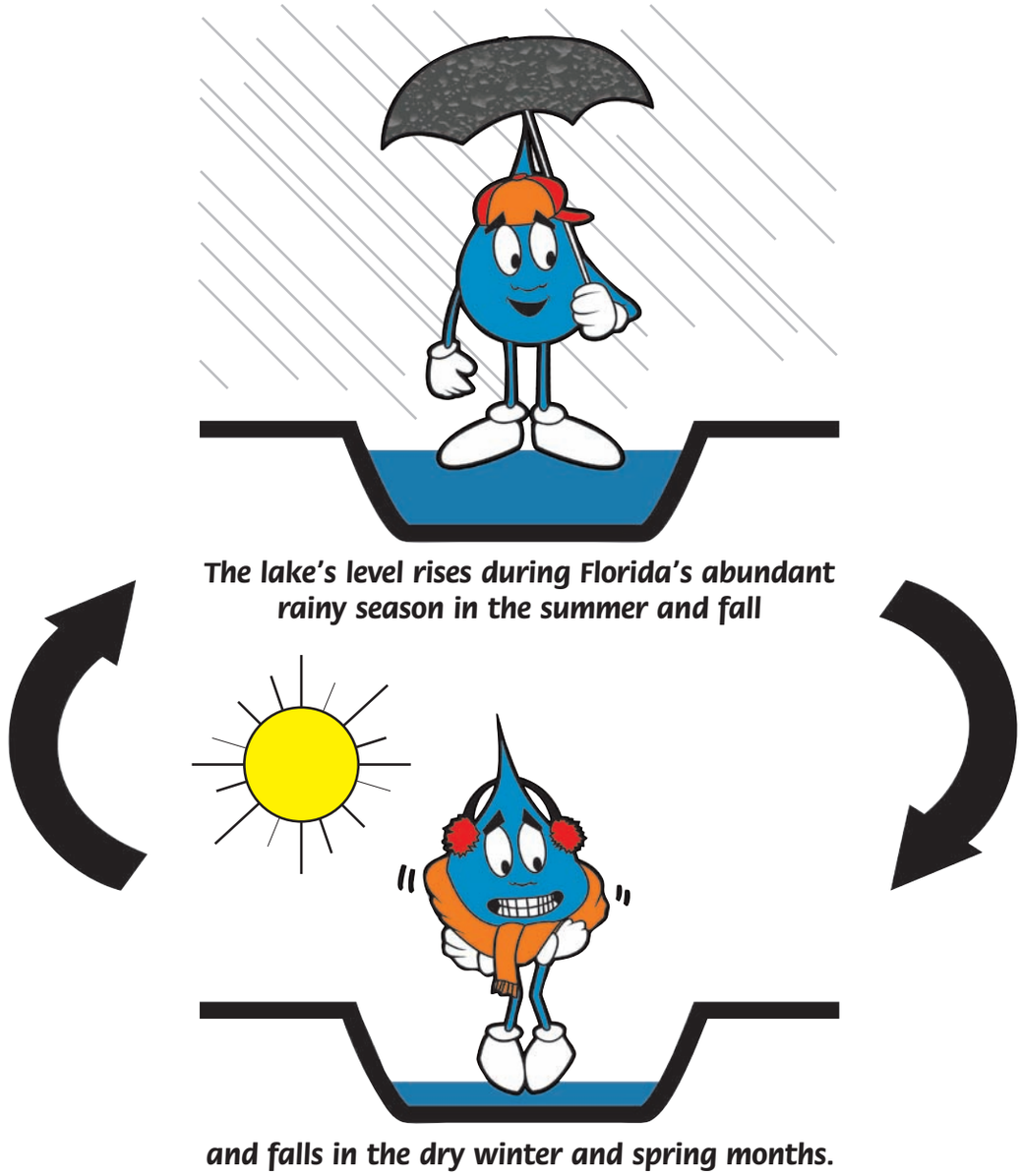
WATER LEVELS IN LAKE OKEECHOBEE ARE MANAGED by the Corps of Engineers and its state partner, the South Florida Water Management District. The Corps sets the water level based on the **Lake Okeechobee Regulation Schedule**, which takes many factors into consideration including the current level, rainfall, climate conditions and time of year.

Each spring, the water level is lowered in anticipation of the summer rainy season. From June to November, the lake level is expected to rise as it captures rain falling directly on the lake and in the Kissimmee basin to its north. In the winter, during Florida's dry season, water from the lake is often used to augment water flows to the historic Everglades and to the Caloosahatchee and St. Lucie estuaries. It can also serve as the back-up water supply for cities east of the Everglades. The lake level tends to peak in the late summer and fall, and decline to a low point in the late spring. This level is carefully controlled by water managers, when possible.

Lake Okeechobee's water level is the subject of a great deal of discussion as it has a huge impact on the health of the lake, water supplies for south Florida cities and farms, coastal estuaries, navigation and the safety of the dike. There is rarely one level that pleases all groups. The final level is balanced to take many factors into consideration.

The Corps of Engineers revises the lake regulation schedule periodically based on new conditions and information.

Lake Okeechobee Water Level Cycle



Are **INFLUENCED** by Flood and **DROUGHT**

Mother Nature has a huge effect on Lake Okeechobee.

Despite the best efforts of people to manage the water levels (and health) of the lake, nature has most of the influence.

Too much water – **a flood** – causes water managers to send excess water to tide, harming the estuaries. The lake level can rise very quickly – up to 4 feet in several weeks – but then it takes months to release this amount of water. High lake levels harm wildlife and put added pressure on the dike.

The other extreme – **a drought** – provides its own set of worries. As the lake level falls and miles of lake bed are exposed, recreation, boating and the local economy are affected. Water supplies are a very large concern, as south Florida depends on the lake as a back-up water supply source.

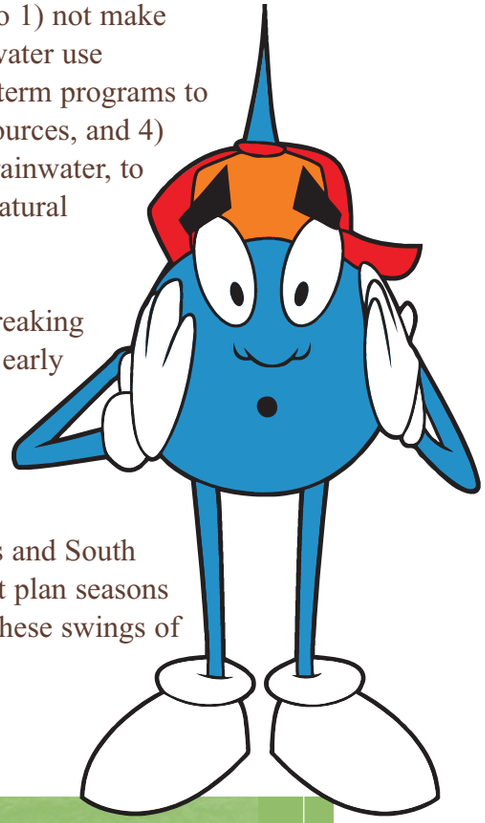
Excess water from Lake Okeechobee is sent to sea -- in this case through the C-24 canal to the east coast.

Florida's historic 2007 drought wreaked havoc on natural ecosystems, including Lake Okeechobee.

The only remedy for a drought is to 1) not make releases from the lake, 2) impose water use restrictions, 3) develop more long-term programs to conserve south Florida's water resources, and 4) develop additional places to store rainwater, to send it later to the lake and other natural systems as needed.

In 2007, the lake fell to a record-breaking low of 8.82 feet above sea level in early July, as a drought affected the southeast United States. The drought continued into early 2008.

The U.S. Army Corps of Engineers and South Florida Water Management District plan seasons and years in advance to deal with these swings of nature in south Florida.



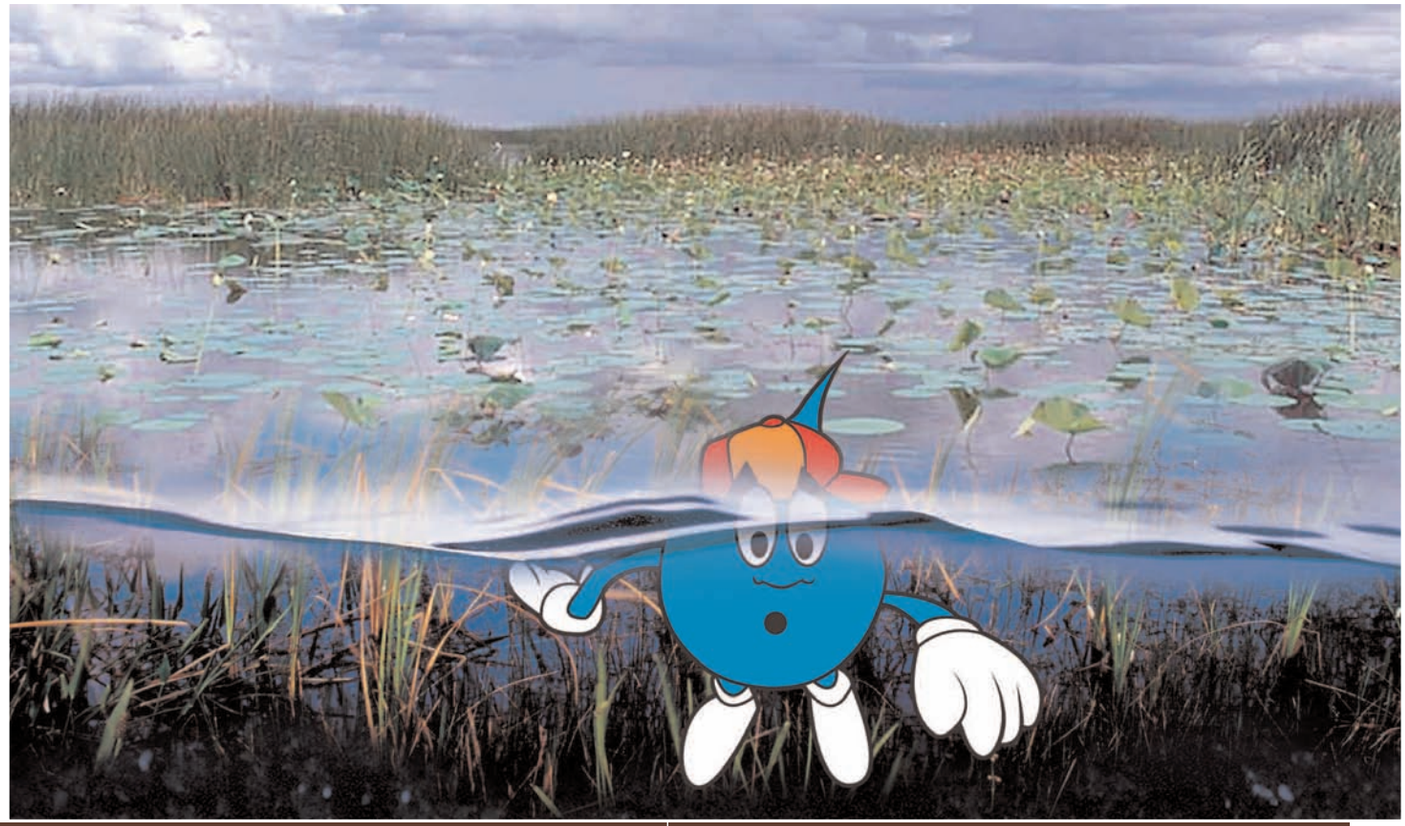
Faces Many **CHALLENGES**

THE MANY CHALLENGES FACED BY LAKE OKEECHOBEE INCLUDE OVER-enrichment from phosphorus, spread of non-native plants and unnaturally high water levels.

PHOSPHORUS. A byproduct of agricultural and urban activities, phosphorus has been flowing into the lake for more than 60 years. Today, it comes from agricultural operations largely north of the lake as well as urban fertilizer runoff. Phosphorus is embedded in the soil, is picked up in water, and then flows into the lake with water. The hurricanes of 2004 and 2005 worsened the situation, by sending additional phosphorus-enriched water into the lake and stirring up phosphorus on the lake bottom. Over-enrichment causes many problems, including upsetting the native plant balance, causing blue-green algal blooms and clouding water. It can affect fish and wildlife populations. Lastly, the polluted water then flows out to the estuaries, harming them too.

NON-NATIVE PLANTS. Thousands of acres of Melaleuca, torpedo grass, cattail, and other invasive plant species have infested the lake. Federal and state governments have been successful in removing a great deal of the Melaleuca. Other non-natives are being tackled through aquatic spraying and biological measures. It is an ongoing battle, though, to remove these nuisance plants that crowd out natural vegetation and wildlife and interfere with navigation.

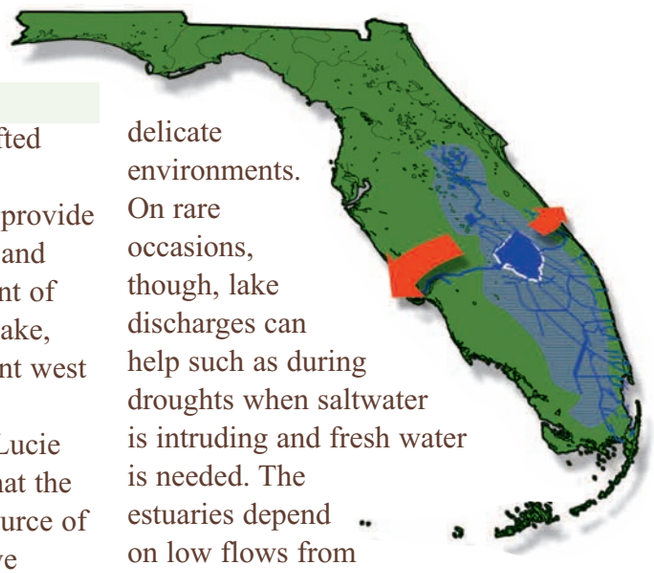
HIGH WATER LEVELS. Unnaturally high water levels are harmful to the lake and dike. The Herbert Hoover Dike allows for the storage of vast amounts of water – more than is healthy for the lake. Until recently, federal and state policy allowed for higher lake levels and more storage of water. However, high water levels drown the natural plant area that is essential to the health of the lake called the littoral zone. The littoral zone occupies up to 25 percent of the lake area, under certain circumstances. It provides habitat, oxygen, and a food source for aquatic life. In addition, shallow water levels encourage more light penetration into the lake, also beneficial. Lastly, high water levels put added pressure on the dike itself, which is not desirable.



Managing the lake is a very complex undertaking.

LAKE OKEECHOBEE Water can Help or Hurt Coastal Estuaries

Coastal estuaries can be greatly affected by changes in water flow. Pictured is the Indian River Lagoon.



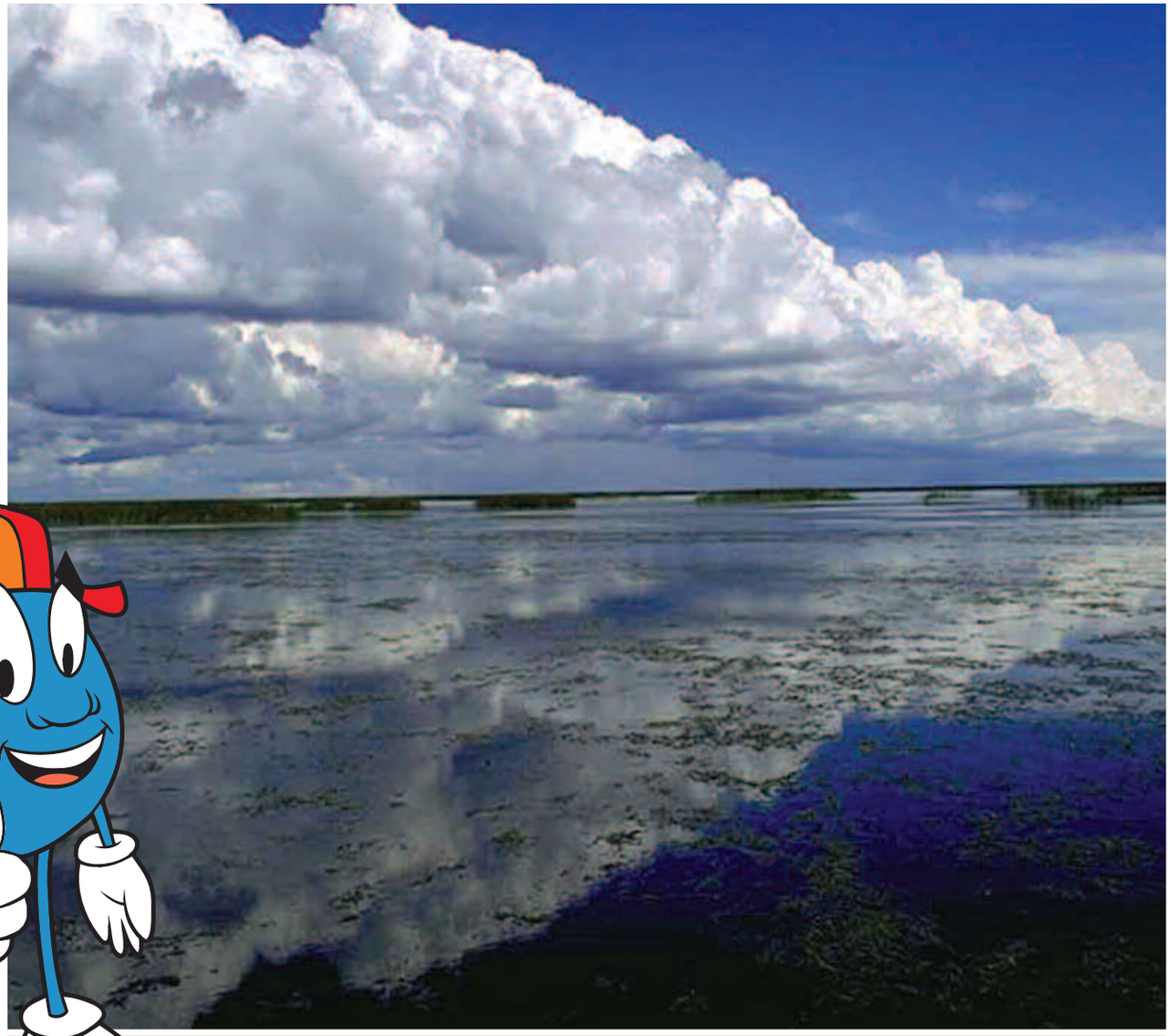
HISTORICALLY, water from the lake slowly drifted south to the Everglades. However, in an effort to provide flood control in Florida, and allow for the development of agriculture south of the lake, these discharges were sent west and east through the Caloosahatchee and St. Lucie estuaries. The result is that the estuaries are getting a source of water they did not receive historically.

Estuaries are accustomed to brackish conditions, which is a mixture of fresh and saltwater – less salty than sea water. Too much fresh or saltwater can be harmful. Estuaries provide many important functions, including serving as nurseries for juvenile marine life, so their good health is essential. Today, water discharges from Lake Okeechobee can be very harmful to the estuaries. Huge amounts of fresh water, often polluted, wreak havoc on these delicate environments. On rare occasions, though, lake discharges can help such as during droughts when saltwater is intruding and fresh water is needed. The estuaries depend on low flows from the lake in drought to keep saltwater from moving to them and into associated St. Lucie and Caloosahatchee rivers.

Programs are Under Way to Help Both the **LAKE** and its **ASSOCIATED DIKE**

THE U.S. ARMY CORPS OF Engineers and the South Florida Water Management District have important programs under way to protect Lake Okeechobee, the coastal estuaries, and the dike.

The South Florida Water Management District and other state partners are working to improve the health of the lake and associated coastal estuaries through the **Lake Okeechobee and Estuary Recovery (LOER) Program**. This includes setting aside land for additional water storage, constructing Stormwater Treatment Areas to clean water prior to discharge to the lake (and later estuaries), identifying additional water storage areas, and identifying improved land use practices north of the lake to reduce fertilizer and urban runoff. In 2007, the Florida Legislature passed the **Northern Everglades Protection Act**, providing additional benefits to the lake and estuaries.



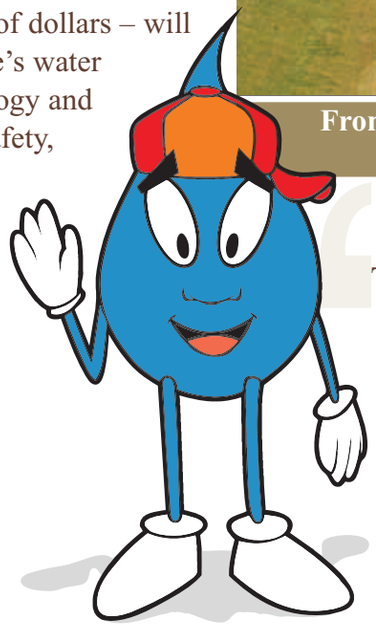
In all seasons, the lake is beautiful.

The **Comprehensive Everglades Restoration Plan (CERP)** and other ecosystem restoration projects will help improve the health of Lake Okeechobee. CERP is a long-term $10.5 billion program to restore the greater Everglades ecosystem that includes Lake Okeechobee. CERP will benefit Lake Okeechobee directly by building many new water storage areas north of and around the lake to capture billions of gallons of water that would normally flow into the lake. This will keep the lake level 1 foot lower than it is today. This will improve the lake's ecology, prevent tons of phosphorus from entering the lake, and benefit the coastal estuaries by reducing unwanted discharges. CERP is a project of the U.S. Army Corps of Engineers in partnership with the state of Florida.

Other efforts to benefit the lake include ongoing programs to remove and control non-native weeds, periodic updates of the Lake Okeechobee Regulation Schedule, and the U.S. Army Corps of Engineers **Herbert Hoover Dike Rehabilitation Project**. The goal of these programs is to keep the lake's water level lower, improve water quality, and properly maintain the dike.

Lake Okeechobee is a critical resource to the state of Florida. It provides water supply, recreation, environmental and economic benefits and is truly the liquid heart of south Florida. While it has changed tremendously in the past century, these federal and state efforts – costing billions of dollars – will improve the lake's water quality and ecology and protect public safety, allowing future generations to enjoy and benefit from it.

From left: Lake Okeechobee, the Herbert Hoover Dike, the rim canal, and the shoreline.



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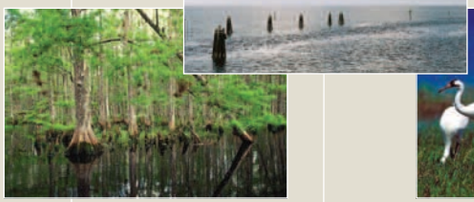

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US Army Corps of Engineers
Jacksonville District

the journey to restore
America's Everglades

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