Special Okeechobee Issue
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How to Clean Up the Weeds Without Losing the Lake

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EDITORIAL

In 1986, the water hyacinth management program on the Big O ceased as fears of excessive nutrient pollution and accelerated eutrophication peaked. Concerned individuals looked for an immediate cure to the problem, and, as always, the aquatic weed program was the most visible and thus became the scapegoat. It was thought that if water hyacinths could be mechanically harvested, then phosphorous could be physically removed and this might buy precious time while the Lake Okeechobee Technical Advisory Committee (LOTAC) formulated long term recommendations for improving water quality.

Sound good? Well, to the layman it sounds like a dandy idea. But as professionals, we all recognize the potential problems associated with a maintenance program on a system of this magnitude utilizing only mechanical control. Did the weed problems on the lake get out of hand you ask? Between August and November water hyacinth coverage increased almost 100%, according to DNR aerial surveys. Without the maintenance control program the lake was in crisis condition. In the recent past, water hyacinth populations were being maintained at a level of between 300 and 500 acres. When the spray program was finally restored, there were almost 10,000 acres of water hyacinths to contend with. The results of this lesson on water hyacinth mismanagement will be increased cost, increased organic loading to the lake bottom, increased herbicide usage, increased damage to native plant populations, and decreased public image for the spray program.

The utilization pressure on Lake Okeechobee is tremendous. It is nationally recognized as a fishing and hunting resource, it supplies drinking water and flood prevention for 4.5 million people and provides irrigation water for the Everglades Agricultural Area. Due to the recent publicity the lake has received and the multiple user groups involved, this and the next issue of Aquatics will review Lake Okeechobee's history, resources, management and problems.

ABOUT THE COVER

Map of Okeechobee. Courtesy of Okeechobee County Chamber of Commerce. Reproduced by permission from Gibraltar Marketing Corporation.
Lake Okeechobee’s History

by
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Okeechobee, Florida

For three centuries, the lady was a mystery surrounded by myth and legend. First mention was made of her in the mid-1500’s, but she was not discovered by the white man until the mid-1800’s.

Escalonte de Fontaneda was a Spaniard captured by the Calusa Indians and held as a slave for 17 years. When he was released, he told the story that the Indians had related about many towns of Indians containing 30 to 40 people on the shores of a great lake called Mayaimi. During the next three centuries, the mysterious undiscovered body of water was referred to as Lake Mayacoo, Lake Macoco and Laguna del Esperitu Santo (Lagoon of the Holy Spirit.)

Charles Vignoles, an English engineer, explored the interior of Florida during 1823, but he was unable to discover any large body of water. When he wrote a report on the St. Lucie River, he alluded to its possible existence.

The St. Lucie River “…gives the idea of having traveled a long region from the west, perhaps in the much-talked-of-Lake-Mayacoo, which like the Fountain of Youth, has never been found.”

The “Big Water” remained shrouded in legend until the 1830’s when the U.S. Army pursued Indians to its shores. It was subsequently given the name of Lake Okeechobee.

Following the Indian Wars of 1856, Army Lieutenant Ives drew a military map of south Florida which contained relatively accurate drawings of Lake Okeechobee, the Everglades and the Big Cypress swamp in detail.

It is difficult to envision what the lake looked like before the advent of civilization, but authors have reached back into history books, and their imaginations, to give us a glimpse of what it was like over 100 years ago.

Author Lawrence Will in his Cracker History of Okeechobee, published in 1964, gave his description of the undiscovered lake. “…was lonely, silent and mysterious, as well. It was beautiful, and sort of inspiring, too.”

Patrick D. Smith, a Pulitzer nominated author, probably gave the best description of the lake in his 1894 novel, A Land Remembered. Smith had researched over 60 books before writing this exciting description of what his fictional characters saw when they traveled the south bank of the Caloosahatchee River from the west Coast of Florida and discovered the lake for the first time.

Smith described a shimmering expanse of water which seemed to be endless. When you realize the lake stretches 32 miles from east to west and 37 miles from north to south, then it is easy to realize why the sight of the lake for the first time gives the viewer the impression it goes on forever, like an ocean.

Smith’s description tells about the blues of the blooming pickerel weed, and the white creamy hue of the clumps of buttonbush.

He describes an array of birds; great blue and white herons, egrets, whooping cranes, anhingas, wood ibises, cormorants, ducks, coots, and roseate spoonbills.

Many of the birds and plant growth mentioned in the novel are no longer in existence, a fact which is most regretful for anyone who loves nature as the Creator made it.

The 730-square mile lake is the second largest fresh water lake within the boundaries of the United States. The lake covers a half a million acres and offers 135 miles of shoreline.

One hundred years ago, the lake stood high and clear, its waters broken only by Kreamer, Torry, Ritta and Observation Islands in its southern half. It is a shallow lake, the deepest portions near the center of the lake, are no lower than sea level. In the 1800’s it was never more than 20 feet deep at its deepest part. The bottom of the lake was hard muck, sand and shell.

There was an invisible dividing line marking the differences in the growth of plant life on the shores of the lake.

The northern shoreline was crowded with dense stands of water oak, cypress, popash, rubber and palmetto trees. For a distance of some 30 miles north of the lake, there were prairie lands and pine forests. This prairie land contained some scattered patches of pitchy pines, 15 inches in diameter, and 75 to 100 feet tall.

There were numerous small pools on these prairies which were named according to the type of growth found in them. For example, there were sawgrass ponds, flag ponds, and maiden cane ponds.

Meandering through this prairie scene for a distance of more than 100 miles was the Kissimmee River.

During the annual 55 to 60 inches of rainfall each year around the lake, these prairies had water to a depth of several inches standing on them. Today, this area is known more familiarly as the Kissimmee River floodplain.

Along the eastern shore of the lake, East Beach stretched for a distance of some 18 miles. Across the lake, Big Bare Beach extended...
its sandy arms for a distance of six
miles, and Little Bare Beach had a
wide sandy strand.

At the southwestern arc of the
lake shore, the vegetation was
more sparse, consisting of great
stretches of willows and elder
bushes. It was this area that
Patrick D. Smith was describing
in his novel. The bottom of the lake
was flat, and grown over with the
flags, bonnets, and high grass.
When the lake rose during heavy
periods of rains, the lake shore
could move back as much as six
miles or so.

From the south shore, and half-
way along the eastern shoreline
running north was a solid belt of
tropical trees called Custard Apple
trees. These trees were blanketed
with a moonvine cover. The
woods covered 32,000 acres, two
miles wide in some places, with no
break or opening. They ran from
Clewiston's Sand Point to Port
Mayaca. The shores, for the most
part, were black muck, with the
previously mentioned patches Of
sandy beaches.

The lake’s main outlet along its
southern and eastern shores, was
the overflow, trickling and spilling
over its entire south side, across
the custard apple ridge, and into
dead rivers there. Water stood all
over the land from knee deep to
waist deep year round, except in
the driest years.

As the water continued its
southward journey, it entered
sawgrass standing in continual
water and this “sea of grass”
reached unbroken to nearly the
state’s southern tip.

In May, 1881, Hamilton Disston,
a Philadelphia entrepreneur,
signed a contract with Governor
William D. Bloxham in which he
purchased four million acres of
Florida for 25 cents per acre. One
of the stipulations of the contract
was that Disston was to drain the
swampy land and re-claim it so it
could he settled and developed.

Much of the interior of the state
was still unexplored, and little did
they know that some of the state’s
highest and driest lands were in-
cluded in the area. That acreage
included most of the state’s in-
terior from just west of Tampa and
south of Orlando, excluding the

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continued on page 8
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**Hydrothol 191**
*Aquatic Algaecide and Herbicide*

**Hydrothol 191**
*Granular Aquatic Algaecide and Herbicide*
of being a killer. Its shallowness belies its dangers during sudden squalls and storms. Even today, she still claims three or four lives in an average year, most of them long-time residents who lost their fear of the deceptive lady.

During the hurricane of 1926, which leveled parts of Dade County and Miami, the storm passed over the lake and literally destroyed the town of Moore Haven on the west shore of the lake.

Mother Nature again sent a killer storm directly over the lake in September, 1928, which resulted in the deaths of an estimated 2,000 or more from the southern tip of the lake all the way up the eastern shoreline to the northern tip.

As the storm began to pass over the lake, the winds first pushed the water southward and then spilt out of the lake, much like water would slosh out of a shallow pan when it was suddenly tipped. Then the winds shifted (like the pan being tilted in the opposite direction) and the waters rushed northward, crashing like a tidal wave over the eastern, northeastern, and northern parts of the shoreline.

After this devastating storm, the Army Corps of Engineers began work on the construction of the Hoover Dike, which today surrounds the lake. A flood control district was formed in 1929, and work began on the dike in 1930. A combination of federal and state financing gave work to many during the darkest days of the depression until the task was completed in 1937.

The dike was tested in September, 1947, when a hurricane followed by two lesser storms passed over the lake. The dike held. But the Kissimmee River Valley flooded with a large loss of property and livestock.

With the sudden flow of the excess waters from the interior of the state through the lake, the Gold Coast sustained severe flooding, particularly in parts of Palm Beach and Broward counties.

In October of that year, a committee was formed to attempt to get a flood control program passed through Congress. It did and funds were authorized in 1948.

In 1950, the Army Corps of Engineers were once more on the scene to implement the most extensive water control program which would encompass the Kissimmee River Valley, the 730-square-mile lake and surrounding areas, as well as the Gold Coast counties to the southeast.

The Corps' engineers decided to make the Kissimmee River flood-proof by converting the hundred plus miles of meandering river into a 58 mile channel.

In 1957, the work began which would convert the river to a depth of 30 feet, and stretch the width of the channel to 325 feet in some areas to as much as 700 feet in others. By the time the channelization was completed in the early 1970's, the "C-38" canal was embroiled in controversy.

Floodplain marshes along the Kissimmee River were destroyed. These marshes had formerly served as "sponges" to absorb much of the nutrients from the waters as they meandered through the main oxbows on the river. Now those nutrients flowed unimpeded straight down the channel into the lake.

During the late 1950's, many dairy farmers were being forced out of Dade and Broward counties by the rapid development along the Gold Coast. Okeechobee County welcomed them to the northern edge of the lake, and by the late 1970's and early 1980's, 40 dairies were located within the boundaries of the county. While many of them were located within drainage areas to the Kissimmee River, the majority were located where the high intensity dairy runoff went into the Taylor Creek/Nubbin Slough waterways.

As the years passed, the controversy heated up. In 1976, the Florida Legislature created the Coordinating Council on Restoration of the Kissimmee River Valley and Taylor Creek/Nubbin Slough Basins. The committee was instructed to study the problem and report back with a plan to restore the water quality of the valley.

The Corps of Engineers also began a study to evaluate the effects of the channelization of the Kissimmee River, and what the consequences would be of restoration of same.

At this point, no one was paying much attention to what was happening on and in, the "Big Lake." Other committees were formed, and studies completed.

Former Governor Bob Graham began a campaign in the early 1980's to see that the Kissimmee River was restored to its former meandering path. The South Florida Water Management District was instructed to construct a demonstration project on a 12 mile stretch of the river. Three weirs were built across the canal which would force the waters to begin flowing back through the old oxbows on the river.

In the summer of 1986, algae blooms on the lake itself suddenly directed the attention of the national media, conservation groups, governmental agencies, and the general public to the fact that there was a crisis developing in Lake Okeechobee.

Nutrients from the Kissimmee River on the north, Fisheating Creek on the northwest, and Taylor Creek/Nubbin Slough on the east have contributed to the increased phosphorus levels in the lake. Backpumping from the Everglades Agricultural Area on the south end of the lake has been blamed for contributing to the increased levels of nitrogen in the lake.

Steps are being taken by various state and local governmental agencies to remove the sources of pollution. Dairy farmers are being required to install Best Management Practices (BMP's) which will keep cattle from waterways. BMP's will also be installed on dairies in both the Kissimmee River Basin and the Taylor Creek/Nubbin Slough to retain runoff from dairy barns in retention ponds.

Plans are being discussed and studied by the Water Management District and the Corps of Engineers for the construction of a large reservoir to be located in parts of Okeechobee, St. Lucie and Martin counties. The runoff from Taylor Creek/Nubbin Slough farms would be diverted to this area, where the waters would then be used for ir-
The demonstration project on the Kissimmee River is producing results even beyond the initial expectations of water management officials. The quality of the waters flowing through the oxbows is improving dramatically. Wildlife is returning to the area. Hopefully, the floodplain will be returned to its former state and will again act as a sponge to help remove excess nutrients from the water before it reaches the lake.

Scientists at the University of California are constructing a model of the river and studying what the effects of partial and complete backfilling of the C-38 canal would be.

Sport fishing on the lake attracts thousands annually. Some of the more popular game fish taken from Lake Okeechobee include: speckled perch, large mouth bass, catfish and blue gills. Marinas and fish camps dot the entire 135 mile shoreline of the lake. Each year, the number of visitors during the winter months increases, and the number who decide to settle permanently around the shores of Lake Okeechobee increases, as well.

Lake Okeechobee will probably never return to that “quiet, mysterious body of water” written about over the centuries. But, with the help of a lot of the lake’s friends, it is hoped that her waters can be preserved to give pleasure to many generations to come.

Editor’s Note: In the interest of saving space, references cited in this article were not printed. Upon request, references for this and other articles can be obtained from the editor.

The North New River Canal—Florida’s Southeast Coast Link To Lake Okeechobee

by

David L. Sutton

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Several rivers play important roles in the regulation of water for Lake Okeechobee. These rivers, for the most part, have been altered considerably from their historical flow patterns, and may be better defined as large canals than rivers. New River, which historically did not originate from or drain into Lake Okeechobee, has however become an integral part of this body of water within the past 70 years.

Originally New River was probably about 20 miles in length, and provided drainage from the eastern side of the everglades through the sand ridge in Broward County to the Atlantic Ocean. An old photograph taken by Commodore Ralph Middleton Munroe in 1885 or 1886 shows a narrow, deep, fast-flowing stream lined with moss-draped cypress trees and spatterdock (Nuphar Luteum (L.) Sibth. and Smith) plants along its banks.

Several theories surround the origin of New River. One holds that New River was an ancient natural stream. A second holds that New River was created by the Army Corps of Engineers as a result of the C-38 canal. A third theory holds that New River is a man-made canal that was constructed when the New River Lock and Dam were built in 1933.

The North New River Canal—Florida’s Southeast Coast Link To Lake Okeechobee was the first in a series that allowed for boat traffic to travel from Fort Lauderdale to Lake Okeechobee for over 20 years.
name given to this river. Indian legend claims that one night the mighty Chief Al-la-pa-taw (Alligator Man) and his people witnessed violent and frightening electric storms followed by a giant earthquake. In the morning, after the storm had passed, they saw a crystal-clear river flowing to the sea. Chief Al-la-pa-taw named it "Himmarshew" which means "the New River." Other theories claim that an early mapmaker or explorer simply observed a "New River" that other explorers had previously overlooked.

Since the days of the early explorers, the inlet to this river has moved at least three times. Perhaps the "new river inlet," as one early settler informed another of its location, became "New River Inlet" as the river shifted from one course to another.

The records of William Gerard De Braham, an official surveyor for King George III of England in 1773, states "The great Rains in May 1765 filled this River and its Marshes with so much water that its weight within and the Sea without by Force of the N.E. gales demolished the Bank and made this Inlet between 25th and 30th May 1765."

The earliest document, probably of Flemish origin, to officially record the New River lists "R. Novo" in 1631 on the "American Septentrionalis" map. On this map, the name "Florida" is given for the entire southeastern portion of the country from the Mississippi River to Virginia.

Florida was discovered in 1513 by the Spanish explorer Juan Ponce de Leon but it is not known when the first white settlers arrived on the banks of the New River. Sailing ships frequented the river since it was one of the few sources of fresh water along the Florida east coast. New River's reputation, along with the entire south east coast of Florida, as a haven for pirates and rogues, did little to encourage settlement in the area.

In 1819 Spain agreed to sell Florida to the United States, and the Territory of Florida was established 3 years later with settlers moving into the northern portion of the state and pushing the Indians to the south. Conflicts with the Seminole Indians prevented any meaningful settlement around New River until the late 1800s. A census taken in 1870 reported only 85 white people, not including Indians, in the area stretching from the St. Lucie Inlet to Jewfish Creek in the upper keys.

The severe cold winter in 1894 to 1895 convinced many early Florida farmers to move their operations south. However, the census in 1910 could account for only 143 residents in Fort Lauderdale. However, during a 1-week period in March 1911, over 3,000 people descended on the town seeking a new life.

Movement of people to Florida has continued at this rapid pace, and it is estimated that by the year 2000, only the states of California and Texas will contain more people. The impact of an estimated population of over 17 million people on Florida's fresh water supplies will be staggering.

The high sandy ridge along the south eastern coast of Florida provided suitable living sites for early Floridians. But as they moved west toward the edge of the Everglades, it soon became apparent that drainage of the land would be necessary if it were to be farmed. These early Floridians had believed for many years the Everglades could be drained by simply cutting a few channels through the coral ridge on its eastern boundary.

Following the survey by Captain John H. Newman who crossed the Everglades in 1892, and then again in 1905, the trustees of the Internal Improvement Fund selected the New River as the site for the drainage of the Everglades and a canal to link the east coast to Lake Okeechobee. The canal would also provide a waterway for transportation to the west coast of Florida via the Caloosahatchee River. Florida's Governor Napoleon Bonaparte Broward was instrumental in providing much of the initiative for draining the Everglades although he favored a canal beginning in the St. Lucie River.

On July 4, 1906, the dredge "The Everglades" began digging in an area that eventually became the North New River Canal. In 1909, the "Caloosahatchee" started digging south from Lake Okeechobee expecting to link up with the "The Everglades. An erratic compass heading by the survey crew of the "Caloosahatchee" resulted in a westerly jog of the canal near present day State Road 84 and Andytown. However, the mistake was never corrected, and the North New River Canal was completed in 1912.

If aquatic plants caused problems soon after the North New River Canal was dug, either they were not present in sufficient amounts to be recorded by early travelers on the canal or else they were dealt with and removed in the same manner as any other problem that was confronted by those using this waterway.

Dr. Thomas E. Will wrote that travel on the North New River Canal was "...a combination of heroism and tragedy, including wrecks time without number, the beating and battering of keels and propellers on the rocks that were never blasted out of this canal and the boulders that lay loose in the bottom of the canal."

However, an entirely different picture is painted by Mrs. Eva Bryan Oliver who wrote about her trip on the 70-foot sternwheeler the "Sawannee", "...such a grand trip it was. We had our meals on the boat. We left Fort Lauderdale late in the afternoon and arrived at the lake the next morning. We began our stops at the different farms. At that time sugar cane was three times as high as a person, and the vegetables and flowers were gorgeous. We came back down the canal in daylight and saw thousands of birds."

With the opening of the North New River Canal, Fort Lauderdale became one of the largest vegetable shipping centers in the United States.

Lock Number 1 (Figure 1) was the first in a series of locks on the North New River Canal. The parallel sides of the lock were made of poured concrete 6 feet thick at their bases. Large timbers were used to construct the gates that were operated by a geared rack.
and-pinion mechanism. In March 1978 this lock was placed on the National Register of historical sites.

The North New River Canal remained in operation until the 1930s when roads and railways supplanted its use. Also, siltation was blamed in part for loss of steamboat traffic between Fort Lauderdale and Lake Okeechobee.

Today the North New River Canal functions for flood control, and provides a waterway for fresh water supplies from Lake Okeechobee to Broward County. It is estimated that without flood control, 80% of the people who live in Broward County would not be able to do so.

Heavy rains in 1947, some weather stations recorded over 100 inches for the year compared to the normal 50 inches, resulted in major flooding for South Florida. Primarily as a result of these rains, the Central and Southern Flood Control District (recently renamed the South Florida Water Management District) was given jurisdiction of over 1,340 square miles of land to prevent the reoccurrence of major flooding in the area again.

Aquatic plant problems in the many canals in South Florida hamper the ability of the District to reduce the likelihood of flooding problems.

Agriculture had become such a dominant feature of the land around the North New River Canal that in the fall of 1952, Mr. Frederick Peters, a farmer in Broward County, donated a 90-acre tract of land to be used by the University of Florida for research on any aspect relating to agriculture in the area. The Plantation Field Laboratory was thus created and located just north of Peters Road in Plantation.

Growth of aquatic plants in the North New River Canal and other drainage and irrigation ditches also had reached sufficient amounts that research was begun on their control. Mr. John C. Stephens of the USDA Soil Conservation Service (Research), later reorganized as the USDA Agricultural Research Service, Soil and Water Conservation Research, began the first studies on aquatic weed control in South Florida at the Plantation Field Laboratory.

The Plantation Field Laboratory in the late 1960's and early 1970's was moved to College Avenue in Davie on the site of the old World War II Forman Field naval training facility and recently renamed the "Fort Lauderdale Research and Education Center."

Early research at the Plantation Field Laboratory focused on southern naiaid (Najas guadalupensis [Spreng.] Magnus.) and other native aquatic plants. Today the exotic plant hydriilla (Hydriilla verticillata Royle) is the major submerged weed problem in the North New River Canal. Aquatic plant research at the Fort Lauderdale Research and Education Center, conducted by two faculty members with the University of Florida and three USDA scientists, focus on chemical and biological methods to control growth of hydriilla and other aquatic plant problems.

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Featuring Sonar® Herbicide from Elanco.
Although boats can no longer travel from Fort Lauderdale to Lake Okeechobee by way of the North New River Canal, this waterway continues to play a major role in the movement of water along the south east coast area.

Today the North New River Canal is an integral part of the drainage system in the area, and also provides recreational benefits of fishing, boating, and water skiing. Management of aquatic plant problems in the canal is essential in order for it to function properly in the regulation of water levels in the surrounding area. (References for this article are available from the editor.)

Lake Okeechobee Fisheries

by

Donald Fox

Biological Administrator I
Florida Game and Fish Commission
Okeechobee, Florida

Lake Okeechobee is one of the Nation’s most valuable natural resources and is Florida’s largest lake. It is an integral part of the Kissimmee — Okeechobee — Everglades ecosystem and often is referred to as the “liquid heart of South Florida.” The lake plays an essential role in flood control, water supply, recreation, and fish and wildlife (Florida DER 1986). It is with the recreational fisheries of Lake Okeechobee that most individuals are familiar. Lake Okeechobee is renowned for its black crappie and largemouth bass fishing. However, Lake Okeechobee also supports a viable commercial fishery. It was commercial fishing activities that first drew large scale attention to the fishery resources of Lake Okeechobee, and was the impetus for early settlement of the lake area.

Commercial fishing activities on Lake Okeechobee are reported to have begun around 1890 (Dequine 1948). The primary commercial fishing device used in the early years was trotlines. Haul seines were first used on the lake around 1900 (Will 1965). The haul seine gear proved very effective and commercial fishing began on a large scale on Lake Okeechobee. Haul seines became the primary fishing gear used by commercial fishermen on the lake, however, trotlines continued to be utilized as were pound nets and wire traps.

Catfish were the fish most commonly sought by commercial fishermen, for large markets existed for these fish in the north and midwest. There, the catfish were marketed under the pseudo-names “southern bass” and “Okeechobee salmon” (Will 1965). In addition to catfish the haul seiners took scalefish (bluegill, redear sunfish, black crappie), largemouth bass, mullet, and occasionally soft-shell turtles. However, catfish were the first choice of the commercial fishermen since they could be harvested in large quantities and always brought a good price. Dressed catfish generally brought the seller .05 cents per pound while scalefish weren’t as desirable and only demanded .01 cent per pound. Largemouth bass generally sold for .08 cents per pound, but prices reached as high as .15 cents per pound.

The first fish camps on Lake Okeechobee were located at the mouth of the Kissimmee River. Steamboats pushing refrigerator barges or launches with ice boxes, would transport the fish 200 miles up the Kissimmee River to the town of Kissimmee, for water was the only mode of transportation. From Kissimmee the fish were shipped to markets in the north...
and midwest. The completion of the railroad to Fort Myers in 1904 gave the commercial fishermen a closer market for their product. The travel distance by water was cut in half. Fort Myers remained the primary outlet for Lake Okeechobee fish until the North New River Canal was opened in 1912. With the opening of the canal fish were transported to Fort Lauderdale. Fort Lauderdale’s reign as the major outlet for Lake Okeechobee fish was to be short lived. In early 1915 the Florida East Coast Railway built a branch line from New Smyrna to Tantie, now the town of Okeechobee. Fishermen now had to travel only four miles from the lake to obtain the precious ice they needed and get their catches to market (Will 1965). Okeechobee remained the catfish capital.

The early years were the boom years for Lake Okeechobee commercial fishermen. By 1913 nearly 50 fish camps were located on the lake, mostly on the east and northern shores (Will 1965). Haul seine catches reportedly average 3100 pounds of catfish, however, catches as high as 36,000 pounds were reported (Will 1965). In the book, *Okeechobee Catfishing*, Lawrence Will stated, “for eight or nine years shipments from here (Okeechobee City) averaged five to ten railroad cars a week. A carload might be from 75 to 120 barrels, each holding 200 pounds of fish”’. Early in the boom years many commercial fishermen recognized the need for regulation of the industry if their way of life was to be preserved. In an attempt to sustain the fishing resources the Florida Legislature in 1916 imposed a four month closed season on haul seining during the summer months, and limited haul seine nets to a maximum length of 1000 yards and a minimum mesh size of three inches (Will 1965). However, by 1918 commercial catches were waning. The compounding effects of too many haul seines, no closed season, and declining water levels had taken their toll. Long periods with little rainfall and the state’s aggressive drainage program had lowered lake levels to the point that thousands of acres of sawgrass marshes were no longer inundated. Sawgrass was reported as the major spawning area of catfishes in Lake Okeechobee (Will 1965). Normal rainfall returned in the early 1920’s, but the state’s levee on the southern shores of Lake Okeechobee now prevented lake waters and catfish desiring to spawn from entering the sawgrass marshes. About this same period another adversary to the commercial fisherman arose.

Fishing as a recreational activity began to expand in the 1920’s. The growing ranks of sport fishermen and the sport fishing industry strongly felt commercial utilization of gamefish, and particularly haul seining, was detrimental to gamefish populations. In 1925 sport fishing interest succeeded in having legislation passed which prohibited haul seining in all state waters, along with the sale of gamefish; however, Lake Okeechobee was one of two water bodies exempted from the law, the other being the Lake George area of the St. Johns River (Dequine 1948; Will 1965).

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A. Waterhyacinth
B. Salvinia
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1965). The exemptions were accomplished as the result of the two water bodies being classed as "salt waters" due to their great area and productivity, as well as, the presence of marine species (Dequine 1948). Black bass fishing came into prominence during the period 1920 to 1930, and both Lake Okeechobee and Lake George supported renowned bass fisheries (Dequine 1952). As a result, in 1935 legislative action was taken to prevent the commercial harvest of black bass (Dequine 1948). The year prior to the prevention of the commercial harvest of black bass one fish house of Lake Okeechobee alone reportedly sold 50,000 pounds of bass (Will 1965).

Organized sportsmen continued to insist that commercial operations in Lake Okeechobee and Lake George were detrimental to gamefish populations in these water bodies; therefore, on October 1, 1946, the Florida Game and Fresh Water Fish Commission (FGFWFC) established rules which prohibited the sale of all gamefish within the state and limited trotlines as the only legal gear by which nongame fish could be taken (Dequine 1952). This was despite the endorsement of a study completed in July 1946 by Nelson Marshall, University of Miami Marine Laboratory, which concluded "the commercial fisheries on Lake Okeechobee and the St. Johns River probably benefit the sport fish in these areas". The gear types eliminated on Lake Okeechobee included haul seines, wire traps, and wire catfish traps were permitted to be used in Lake Okeechobee and only to harvest nongame fish. Trotlines and wire catfish traps continue to be legal fishing devices on Lake Okeechobee.

As early as 1971 it was recognized that deteriorating water quality was threatening Lake Okeechobee. In 1971 a special task force entitled the "Governor's Conference on Water Management in South Florida" was organized to assess water quality and management of South Florida waters (Fl. Div. of State Plan. 1976). Recognizing the threat to the water quality of Lake Okeechobee due to excessive nutrient loading the task force formulated recommendations to improve water quality within the system and drainage basin (Ager et al. 1976; Fl. Div. State Plan. 1976). One such recommendation was the harvest of fish from Lake Okeechobee as a means of nutrient removal (Ager et al. 1976). At the same time it was becoming apparent that the structure of some sport fish populations in Lake Okeechobee, primarily black crappie, were becoming undesirable due to declined growth rates (Ager et al. 1976). Comparison of black crappie investigations conducted on the lake during 1950 (Dequine 1951), 1956 (Crittenden et al. 1956) and 1970 (Ager et al. 1976) indicated a progressive decline in

operators were allowed to keep all nongame fish, but all gamefish had to be immediately returned to the water. In addition to haul seines, wire traps and pound nets were included in the study, but to a lesser degree.

Based on recommendations derived from data collected during the three year (1948-1950) experimental program, a controlled fish management program was implemented on Lake Okeechobee (Dequine 1952). The program was projected to last a minimum of three years and utilized haul seines (maximum of 10), wire traps, and pound nets to harvest bream, black crappie, catfish, and other nongame fishes (Dequine 1952). Largemouth bass and pickerel were released to the water unharmed. Fish removal operations began on Lake Okeechobee during July 1952 and extended through February 1953, when the four month "closed season" went into effect (Phillipppy and Ager 1967). However, as the result of continued pressure from organized sport fishermen the harvest of gamefish, and the use of haul seines and pound nets was not re-instated and the program was abandoned. Only trotlines and wire catfish traps were permitted to be used in Lake Okeechobee under special permit the FGFWFC allowed seven haul seines to operate from 1948 to 1950 in Lake Okeechobee. Conditions of operation of the haul seines specified that a FGFWFC employee would accompany each haul seine crew. The concept of the program was to give biologists the ability to collect data in order to determine the effect of various commercial fishing operations upon gamefish populations, develop methods of improving sport fishing, and assess potential annual production of the lake's fishery resources (Dequine 1951). The haul seine

Black crappie fishing pressure off Taylor Creek. Between December and May of 1986, 487,000 hours were expended for a reported catch of 1.2 million crappie.
growth rates. In 1950 Age II black crappie ranged from 9.0-11.0 inches total length, while in 1956 the same age fish ranged from 8.1-9.9 inches total length. By 1970, growth rates had declined to the point where Age II black crappie only ranged from 6.4-8.4 inches total length. Recognizing that the removal of fish was an accepted and practical fishery management tool to improve the structure of fish populations and accomplish nutrient removal the FGFWFC implemented a supervised large-scale commercial fishing program in Lake Okeechobee (Ager et al. 1976; Schramm et al. 1981). This program was titled “Okeechobee Fisheries Utilization and Management Program (OFUMP). OFUMP objectives were to allow the utilization of a renewable fishery resource, to provide for nutrient removal from the lake, and to improve the quality of sport fishing. OFUMP was implemented in October 1976 and provided for the commercial harvest of nongame and gamefish exclusive of largemouth bass, chain pickerel and redfin pickerel. In addition to the already legal and traditional gears (trotlines and wire catfish traps), legal devices for commercial harvest also included hook and line, wire scalefish traps, haul seines and trawls. Haul seines and trawls were required to operate under special permit and regulations. A maximum of 40 haul seine permits and 200 trawl permits were available for issue. No haul seine or trawl was allowed to be in use or operate within one mile of rooted emergent aquatic vegetation or any area so designated as closed (Ager et al. 1976). A FGFWFC approved identifying tag was required to be affixed to the gill cover of each commercially harvested fresh water gamefish prior to sale.

Several significant regulatory changes occurred during the existence of OFUMP. To prevent conflict between commercial and sport fishermen South Bay was closed to haul seines and trawls in July 1977. A closed season on the commercial harvest of all gamefish from Lake Okeechobee was implemented between October 15, 1978 and December 6, 1978. This closed season was implemented to insure that Age II (1977 year class) black crappie could attain appreciable growth and counteract an anticipated decline in sport fishing success during the 1978-79 season. Age III (1976 year class) black crappie, which would have been a substantial portion of the sport harvest were scarce as the result of a failure of the 1976 year class due to poor lake conditions in the spring of 1976 (Ager et al. 1979). The number of trawls permitted to operate in the lake was reduced from 200 to 125, and the mesh size of trawls was increased in July 1979. The intent was to reduce the overall commercial harvest of black crappie and make small (unmarketable) crappie less susceptible to the gear. A closed season on the harvest of gamefish was imposed January through February 1980. In addition, regulation changes were implemented in January 1980 that restricted the placement of wire scalefish traps to lakeward of the one-mile commercial boundary, and specified that all wire traps have three feet clearance between the highest point on the trap and the water surface (Ager et al. 1980; Schramm et al. 1981). The restriction of wire scalefish traps to the limnetic area greatly reduced their efficiency. Also, to prevent conflicts between sport and commercial fishermen the area from Taylor Creek to the mouth of the Kissimmee River was closed to wire trap usage. The commercial harvest of gamefish was closed during the period January through February 1981.

Historically low water levels occurred in Lake Okeechobee during the spring of 1981. The majority of the lake marsh was dewatered and most fish were driven into unprotected open-water areas. Fear of over exploitation of fish populations and the predominance of unharvestable size black crappie in the black crappie population resulted...
in the emergency closure of OFUMP in May 1981 (Ager et al. 1981). After the closure of OFUMP, commercial harvest was allowed to continue with trotlines and wire catfish traps. However, only nongame fish could be harvested, and all regulations imposed on these gears during OFUMP continued to apply.

The Okeechobee Fisheries Utilization and Management Program resulted in the harvest of 33,116,194 pounds of fish (Ager et al. 1979; Ager et al. 1980; Ager et al. 1981). This equated to the removal of 409 tons of nitrogen and 131 tons of phosphorus from Lake Okeechobee. Also, the program was responsible for the direct contribution of approximately 8.9 million dollars into the economies of local communities. The program also was successful in stimulating the growth rate of black crappie. By the end of the program Age II black crappie were nine inches in total length and Age III fish were up to 11.5 inches in total length (Ager et al. 1981). This growth rate produced nine and eleven inch black crappie one year sooner than prior to OFUMP. During the existence of OFUMP, a strong 1980 black crappie year class was produced which continues to contribute significantly to the fishery in 1987.

By the fall of 1982, water levels in Lake Okeechobee had returned to normal historical levels. In November 1982 haul seine gear was again authorized as legal commercial gear in Lake Okeechobee (Powell et al. 1983). Under special permit, the FGFWFC issued ten haul seine gear licenses. Only the ten permitted haul seine were allowed to harvest gamefish, and then only bluegill, redear sunfish, and warmouth. All black crappie, largemouth bass, chain pickerel, and redfin pickerel were required to be released immediately.

Today the commercial fishery of Lake Okeechobee consists of ten haul seines operating under special permit, and an unlimited trotline and wire catfish trap fishery. Approximately 80 individuals utilize trotlines and wire traps commercially on Lake Okeechobee to fish for catfish. The commercial harvest from Lake Okeechobee for the 1 July 1985 to 30 June 1986 reporting period totalled 4,936,603 pounds of fish. Composition of the harvest was 69.6 percent catfish (white and channel catfish, brown and yellow bullheads), 18.1 percent bream (bluegill and redear sunfish), 8.1 percent shad and gar, and 4.2 percent striped mullet (Fox et al. 1986). Trotlines accounted for 58.2 percent of the harvest, while haul seines and wire traps accounted for 36.6 percent and 5.2 percent of the harvest, respectively. White catfish dominated the commercial catch, representing 57.1 percent (2,819,655 pounds) of the total harvest. The commercial fishery of Lake Okeechobee appears very healthy when compared to historical data for the system. In 1985-86 the ten net haul seine program harvested 892,216 pounds of bream, 308,255 pounds of catfish, and 398,377 pounds of shad and gar (Fox et al. 1986). Crittenden et al. (1956) stated that the eight net haul seine fishery in 1953 reported an annual harvest of 253,345 pounds of bream, 155,267 pounds of catfish and 357,073 pounds of shad and gar. The annual average harvest of bream and catfish from Lake Okeechobee by all gear types from 1936 to 1945 was 428,851 pounds and 1,192,647 pounds, respectively (DeQuine 1951). The increased productivity of Lake Okeechobee is exemplified in the increased estimates of fish biomass. Ager et al. (1976) reported the standing crop of the limnetic area of the lake to be about 100 to 150 pounds of fish per acre. Crittenden et al. (1956) in 1955-56 conducted fourteen one acre rotenone samples in the northwest shore littoral area of Lake Okeechobee and arrived at a standing crop estimate of 33 pounds of fish per acre.

Studies conducted in more recent years have indicated a much higher standing crop. In 1982-83 the standing crop estimate in eight one acre rotenone samples in vegetated littoral areas was 254 pounds of fish per acre (Powell et al. 1983). The average standing crop estimate in the littoral area of the lake for the period 1976 through 1982 was 187 pounds of fish per acre, with a range of 97 to 276 pounds per acre for the six year period. The weight ratio of gamefish to roughfish in the rotenone samples reveals Lake Okeechobee fish populations are predominately comprised of game species. In 1955-56 Crittenden et al. (1956) noted the percentage of gamefish to roughfish was 49 percent to 51 percent. Powell et al. (1983) indicated the percentage of gamefish to roughfish in rotenone samples conducted in 1982-83 was 69 percent to 31 percent, while the average for the six year period 1976 to 1982 was 58 percent to 42 percent. As a system moves into a higher state of eutrophication the structure of fish populations in the system change to one that is dominated by rough-fish (Marshall et al. 1972). The excessive nutrient loading and accelerated eutrophication of Lake Okeechobee has been well documented. However, the predominance of roughfish has not been observed in Lake Okeechobee. This should be viewed cautiously though, because fish populations are one of the last areas in a system to exhibit negative impacts as the result of accelerated eutrophication.

Since World War II fishing as a recreational activity has increased dramatically. The sale of fishing licenses in Florida totalled 30,843 in 1940, however, by 1951 the number had risen to 286,804 (DeQuine 1952). In 1985, 823,333 licensed anglers were fishing Florida’s fresh water (Sport Fishing Institute 1986). As sport fishing interest has increased so has the popularity of Lake Okeechobee. The total annual fishing pressure on Lake Okeechobee from March 1955 through February 1956 was estimated at 879,980 hours (Crittenden et al. 1956). The total angler effort on Lake Okeechobee during the six month period December 1985 through May 1986 was estimated at 860,194 hours (Fox et al. 1986). More and more anglers and tourists appear to be finding and enjoying Lake Okeechobee. The growing popularity of Lake Okeechobee to the angling public has been a major impetus to the expanding economies of local communities. The FGFWFC is pres-
ently engaged in a study to determine the current economic value of the sport and commercial fisheries of Lake Okeechobee.

The structure of the angling public has changed with Lake Okeechobee’s increasing popularity. A creel census conducted in February 1948 to November 1950 indicated expenditures of fishing effort on the lake was 78 percent for largemouth bass, 12 percent for bream, and 10 percent for black crappie (DeQuine 1951). Crittenden et al. (1956) reported largemouth bass fishing constituted 40 percent of the lakewide fishing pressure in 1955-56. Today, fishing for black crappie is most prevalent on Lake Okeechobee. During the 1985-86 winter-spring season black crappie fishing represented 57 percent of the total angler effort, while largemouth bass and bream fishing represented 34 percent and 8 percent of the effort, respectively (Fox et al. 1986). Anglers harvested 1,211,347 black crappie, 199,471 bream, and 90,751 largemouth bass during the 1985-86 season. Estimated success rates, in fish per hour, were 2.47 for black crappie, 2.42 for bream, and 0.32 for largemouth bass.

Recognizing the importance of black crappie to the sport fishery of Lake Okeechobee, FGFWC biologists have intensively studied the species since 1972. Information has been gathered on the age structure, growth rates, relative abundance, food habits and year class strength of black crappie. The diet of black crappie in Lake Okeechobee has been found to be comprised mainly of mysid shrimp, copepods, amphipods, chironomids and fish, generally small shad. Fish were found to increase in importance as a food item as the length of black crappie increased (Powell et al. 1983). The primary food of black crappie is shown to shift from crustaceans to fish when the crappie approach nine inches total length. Otter trawls have been used to sample the black crappie population in Lake Okeechobee since 1972.

Quarterly catch per unit effort (CPUE) values of black crappie collected by the trawl from 1972 to 1986 are plotted in Figure 1. The high density of black crappie in the lake is negatively impacting the structure of the black crappie population. Relative condition factors indicate below average condition (Fox et al. 1986). Weights of harvestable size (8+ inches) black crappie declined an average of 7.5 percent from October 1983 to October 1985. The mean length of Age II and Age III black crappie in October 1985 was 10.6 and 11.1 inches, respectively; however, by October 1986 the mean length of the same age fish had declined to 9.4 and 10.0 inches, respectively. This was a mean length decline of 11.7 percent for Age II fish and 9.5 percent for Age III fish. Even though growth rates for black crappie are declining they have not reseeded to pre-OFUMP levels, when Age II fish were between 6.5 to 8.5 inches.

Figure 1. Mean quarterly CPUE values for black crappie collected from Lake Okeechobee by regular mesh otter trawl 1972-1986.

A significant positive correlation has been shown between the CPUE of January trawl samples and angler harvest. The CPUE of the January 1986 and January 1987 trawl samples were very similar, indicating continued high crappie densities. Even though black crappie densities are extremely high, creel results indicate the 1986-87...
winter-spring harvest may be slightly lower than the previous year. Anglers are apparently selecting for larger size fish and releasing the smaller undesirable fish. Black crappie less than or equal to 8.6 inches comprised 63.1 percent of the January 1987 trawl sample; however, fish in this category only comprised 3.28 percent of the angler harvest observed January through March 1987.

Lake Okeechobee also supports a viable largemouth bass fishery. FGFWFC biologists are in the final year of a three-year investigation designed to assess growth, condition, year class strength, mortality, and movement of largemouth bass in Lake Okeechobee. The 1985, 1984, and 1983 year classes presently dominate the largemouth population, making up 35, 25, and 32 percent of the population, respectively (Fox et al. 1986). The 1986 year class also appears to be strong but is not yet totally susceptible to the sampling gear. No missing year classes were observed in the bass population. Length-at-age information indicates rapid growth of largemouth bass in Lake Okeechobee as compared to other waters in Florida. Average lengths for Age I through V largemouth bass are 7.1, 11.1, 13.6, 14.1, and 14.4 inches for males and 7.2, 12.0, 16.0, 18.2, and 19.9 inches for females. Sixteen percent of the males and 19 percent of the females had reached a harvestable size (12-14 inches) in their second growing season. By the end of their third growing season all fish had recruited into the fishery. This growth can be related to the forage base and foraging characteristics of largemouth bass in Lake Okeechobee. Food habit analysis revealed largemouth bass in the lake are feeding on a variety of organisms, and are not dependent on any one organism for subsistence (Figure 2). Surprisingly grass shrimp comprised 15.9 percent of the diet, while shad represented only 2.2 percent. Annual mortality estimates determined from catch curve analysis were 0.64 for Age II through V fish. Currently a tagging study is underway to determine what percent of the annual mortality is due to natural factors and what percent is related to angler exploitation. Analysis of movement data indicated open-water fish were more mobile than those tagged in shoreline areas. The average distance between the point of tagging and the point of recapture of largemouth bass tagged in the open-water was 8.0 miles and no fish were recaptured less than 1 mile from their site of release. In comparison, the average distance between the point of tagging and the point of recapture was 2.17 miles for fish tagged in shoreline areas. Furthermore, greater than 73 percent of all re-captures occurred less than 1 mile from the site of release. Directional movements of fish tagged in both open-water and shoreline areas were generally along the southern and western areas of the lake.

<table>
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<th>LARGEMOUTH BASS FOOD HABITS</th>
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<td>FALL 1986: N = 162</td>
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The blue-green algae bloom in August 1986 accentuated the problem of excessive nutrient loading to Lake Okeechobee. Never before had an algae bloom of this magnitude (120 square miles at the peak) been observed on the lake. In addition, the species of blue-green algae, *Anabaena circinalis*, had never been reported previously in the lake at such high concentrations (SFWMD 1987). The FGFWFC will implement two studies in Lake Okeechobee in 1987 to aid in the assessment of the impact of excessive nutrient enrichment. An intensive aquatic macroinvertebrate study will be implemented in May 1987. Goals of the program are to compile quantitative baseline data on the species composition, density, and biomass of the invertebrate community within Lake Okeechobee. Areas receiving nutrient laden effluents will be evaluated to determine if impacts to invertebrate communities are occurring. If negative impacts are observed upon invertebrate communities the possible consequences to consumers higher in the food chain will be evaluated. An extensive lake wide trawling program will be implemented July 1987 to evaluate the possible change in the structure of fish populations in the limnetic area of Lake Okeechobee. Indices will be developed on the species composition, length structure, and relative abundance of fishes in the open-water. The primary thrust of the program is to develop baseline data to determine if shifts occur in the nongame-gamefish ratio in the limnetic area. A shift to a higher ratio of non-game would be indicative of a highly stressed system facing serious ecological problems.

(References for this article are available from the editor.)
In August 1986, one of the largest algal blooms ever documented appeared in Lake Okeechobee. The bloom, which had been building since mid-July in the center of the lake, attracted national attention after a week of strong southeasterly winds pushed the algae toward the shore, where it piled up and decomposed among the aquatic vegetation. Aerial observation revealed a bright green patch of 120 square miles in the western quarter of the lake, which contrasted distinctly with the lake's usual muddy brown color. Along the bulrushes on the north and west shores, a narrow band of water had turned a milky white where an explosion of bacterial growth had responded to the accumulation of dying algae. Low dissolved oxygen levels and high ammonia concentrations killed virtually all invertebrate life within this 13 mile-long strip, but no fish kills were observed, as the fish had apparently vacated the area. After three to four weeks, the bloom completed its growth cycle and dissipated.

The appearance of this bloom greatly concerned lake scientists and managers, government leaders, and environmentalists, and raised public awareness of the lake eutrophication issue. Although algal blooms frequently occur in the warm months of summer and fall, this bloom was distinguished by its magnitude and the species involved, *Anabaena circinalis*, a particularly noxious blue-green algae frequently dominant in highly eutrophic lakes. This species has been reported in the lake before, but it has never been previously documented as a bloom species in Lake Okeechobee.

The significance of this bloom is a point of debate. Some parties are convinced that the bloom signals the impending demise of Lake Okeechobee as a productive fishery, unless drastic measures to cut nutrient inputs are taken immediately. Others believe that the lake is not in immediate danger of suffering an ecological crash, but that appropriate steps should be taken now to control nutrient inputs so
that the lake will remain healthy. Most of those concerned with the lake do concur, however, that last year’s bloom is a warning sign that Lake Okeechobee is threatened by excessive nutrient inputs from agricultural activities in the basin.

Lake Description
Lake Okeechobee is the heart of south Florida’s water supply and flood control system in addition to being a world renowned recreational fishing and hunting area. To accommodate these varied uses, the lake and its inflows and outflows have been considerably altered, beginning with dredging projects in the 1880’s and culminating in the complex water management system called the Central and Southern Florida Flood Control Project. The lake is now completely surrounded by the 25 ft. Hoover Dike and all inflows and outflows, with the exception of Fisheating Creek, are controlled by a gated structure or a pump station.

Although Lake Okeechobee’s surface area is nearly 700 square miles at its maximum stage, its mean depth is only about 9 feet. Consequently, this lake never stratifies. Approximately 20 percent of its area is marsh, extending to as much as 9 miles wide on the western side. Sediment types include mud, sand, limestone rock, marl, shells, and peat. The mud sediment occupying the central portion of the lake is a major influence on the lake’s trophic state because wave-induced sediment resuspension is important in cycling phosphorus and nitrogen. Total and dissolved phosphorus and dissolved inorganic nitrogen peak in the winter and spring months when cold fronts moving through Florida disturb these sediments.

Eutrophication Research
The first comprehensive water quality study of Lake Okeechobee began in 1969, when the U.S. Geological Survey in cooperation with the Central and Southern Florida Flood Control District (now the South Florida Water Management District) initiated a three year program to assess the trophic state of the lake. This study concluded that the chemical and biological characteristics of Lake Okeechobee were indicative of an early eutrophic condition. The District desired to maintain a water quality data base for the lake, and in 1973, it began another water quality program to monitor water quality trends, develop nutrient budgets, and provide continuing assessment of trophic state. This program, now in its fifteenth year, has produced the lake’s largest and most complete data base. The District samples all major inflows and outflows, as well as in-lake sites, every two to four weeks. Continuous gaging of all major surface flows allow the routine measurement of phosphorus and nitrogen inputs, and permit the development of one of the most complete nutrient budgets available for any
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Aerial view of the blue-green algae bloom (Anabaena circinalis) that reportedly covered 120 square miles of the lake surface at its peak in August of 1986. An algae bloom of this magnitude had never before been observed on the lake.

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for only 4 percent of the water inflow. BMP's include the fencing of cattle from waterways and the installation of lagoon wastewater treatment systems, and is encouraged by the State of Florida and federal agricultural agencies through cost-share programs. It is anticipated that these measures will reduce the phosphorus export from this basin by up to 50 percent, or about half of the 90 percent reduction needed. Full implementation of these programs is near and trend analysis indicates that phosphorus concentrations in this basin have already declined by 15 percent. Further monitoring is being conducted to establish the link between this reduction and BMP's.

Recognizing that a 50 percent phosphorus reduction is not enough, the District has supported the concept of catching, storing, and treating all the runoff from intensive cattle holding areas adjacent to milking barns. It is thought that this additional layer of BMP intensity will achieve 75 to 80 percent reduction in phosphorus runoff from dairy operations. Other actions, including partial diversion of Taylor Creek/Nubbin Slough from the lake, are being considered to further reduce phosphorus reaching Lake Okeechobee.

Similar BMP programs are planned for the lower Kissimmee River valley and other smaller basins north of the lake that contain dairy and beef cattle operations. The Kissimmee River, the lake's largest inflow, contributes 30 percent of the water input and 20 percent of the phosphorus load.

The control of nutrient inputs from the Everglades Agricultural Area has required a different strategy. This area south of the lake, planted mostly in sugar cane, contains organic muck soil that is rich in nitrogen. Historically, runoff containing readily leached nitrate has been pumped to Lake Okeechobee or to the Water Conservation Areas (WCA's) to the south. The two largest pump stations to the lake contributed 26 percent of the lake's nitrogen input. Due to the flat topography, most runoff can be pumped in either direction, so the District adopted a plan to pump more runoff to the WCA's. Although suspended twice for water supply purposes since it was implemented in 1979, this plan, when in use, has been successful in reducing long-term nitrogen loading to the lake from the EAA by 67 percent. While a significant reduction, it still misses the targeted level of a 90 percent cutback. Also, it is recognized as a temporary remedy, since the increased flow to the WCA's (an Everglades habitat) will eventually cause undesirable shifts in aquatic plant species near these inflows. Additional management actions for the EAA basin are being studied.

In-lake phosphorus management strategies are also being examined. The District is experimenting with aquatic weed harvesting to remove phosphorus from the lake, and improved herbicide treatment to reduce phosphorus recycling from decomposing weeds.

Future Research
The District's key role in managing Lake Okeechobee requires the continuation of strong water quality programs to monitor trends in the lake and measure progress toward achieving nutrient reduction goals. So far, eutrophication models applied to the lake have treated it as a homogeneous, completely-mixed system, although it is realized that the extensive littoral zone exhibits very different water quality characteristics. The District has recently expanded its efforts to include intensive littoral zone monitoring in its research programs. Plans are also underway to further investigate internal nutrient loading processes in the lake and their contribution to its eutrophic nature. These processes include sediment resuspension and macrophyte decomposition. Research will focus on the ability of sediment to assimilate incoming phosphorus, the quantity of phosphorus returned to the water column from resuspended sediment, the release and transport of phosphorus from decomposed littoral vegetation to the open lake, and the possible influence of lake stage on these recycling processes.

(References for this article are available from the editor.)

COMING UP IN THE SEPTEMBER
AQUATICS
Lake Okeechobee's Waterfowl Habitat: Problems and Possibilities.
by Fred Johnson
A Report from the Lake Okeechobee Technical Advisory Committee.
Cooperative Aquatic Plant Control Program Operations in Lake Okeechobee.
by Brian Nelson
The Eutrophication of Lake Okeechobee: An Alternative View.
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