Prepared in cooperation with the
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
and the
SUMTER COUNTY RECREATION AND WATER CONSERVATION
AND CONTROL AUTHORITY

INTRODUCTION

Lakes are an important hydrologic feature in Florida. They not only have esthetic value but are used for recreation, as a source of irrigation water, or for public supply. A lake's environment can be better protected by decision-makers who have knowledge of the hydrologic conditions and problems that exist or may exist.

The internally drained Lake Miona complex includes Lake Miona, Black Lake, Cherry Lake (locally known as Mud Prairie), and several lesser ponds, marshes, and sinks. The study area is in the northeast corner of Sumter County, about 3 miles northeast of Wildwood, the largest community in the county, and about 18 miles northeast of Bushnell, the county seat (fig. 1). Land use in the drainage basin of the study area is mostly cattle pasture. Other land uses include citrus growing, truck farming, and peat mining (at Cherry Lake). Residences in the drainage basin are widely scattered except at the settlement of Cherry Lake at the east end of the basin and at a large golf-course-oriented subdivision at the west end.

This is one of a series of studies on selected lakes made by the U.S. Geological Survey as part of a continuing cooperative program with the Southwest Florida Water Management District and, in this instance, also with the Sumter County Recreation and Water Conservation and Control Authority. The objective of this study, begun in 1982, was to evaluate and document hydrogeologic conditions in the Lake Miona area.

Data collected during the investigation from May 1982 through October 1983 include: (1) lake levels, (2) depth of the lakes, (3) physical and chemical characteristics of lake water and lake-bottom sediments, and (4) water levels in Upper Floridan aquifer wells. The locations of the data-collection sites are shown in figure 1. To augment interpretation of data collected during the project, information was obtained from interviews with local residents and land owners.

GEOLOGIC AND PHYSIOGRAPHIC SETTING

The most important factor in the development and configuration of the Lake Miona complex is the geologic setting. Northeast Sumter County is underlain by a limestone aquifer (the Floridan aquifer system) several thousand feet thick that is susceptible to dissolution by water that passes through its pores and fractures. The veneer of sand and clay overlying the limestone is relatively thin in the study area, thus a large part of the local rainfall, charged with carbon dioxide, enters and then dissolves the limestone as it moves toward discharge areas. This dissolution process has formed the karst (sinkhole) topography shown by the land-surface contours in figure 1 and has contributed in making the area among the best in Florida for recharge to the Floridan aquifer system. A stream system has not developed in the area. Drainage is internal and eventually downward into the limestone aquifer.

Mapping by Buono and Rutledge (1979), Buono and others (1979), and Wolansky and others (1979) indicate that the surficial deposits consist of about 25 feet of relatively impervious materials that form confining beds that overlie the Upper Floridan aquifer. These beds are in turn overlain by about 25 feet of pervious materials that make up the surficial aquifer in the area. The lakes and ponds in the Lake Miona area have formed where solution of the underlying limestone has caused the surficial deposits to subside to altitudes below the water table.

The karstic terrain in the study area is characterized by many sinkhole depressions between topographic divides and the lakes of the study area. These sinkholes are permanently isolated from the lakes, making delineation of the drainage area difficult. Therefore, the drainage basins of the lakes were delineated arbitrarily for a condition of extreme high water to include all sinkholes from which water can flow at altitudes less than 65 feet, but to exclude those in which water must exceed an altitude of 65 feet before it can flow out. Prior to 1960, the area of ponds and marshes north of State Highway S-466 was part of the Lake Miona complex at extreme high water. However, in 1960 the road fill was raised enough to effectively isolate the ponds and marshes north of the highway from the rest of the area.

Below are data on the drainage area, the surface area, volume, and average depth of the lakes when they are at altitude 56 feet. The area of the lakes is included in the drainage area.

Lake name	Drainage area (acres)	Surface area (acres)	Volume (acre-feet)	Average depth (feet)
Lake Miona	1,590	418	5,850	14
Black Lake	1,860	245	1,470	6
Cherry Lake	[a]1,360	448	2,690	6

[a] Prior to 1960 the drainage area was 2,410 acres.

HYDROLOGIC SETTING

Few data are available to evaluate the hydrologic setting of the Lake Miona complex. However, inferences can be made from the available data and inspection of topographic maps and aerial photographs. Figure 2 shows the altitudes of the water surface of lakes and ponds in the Lake Miona complex and the altitude and configuration of the potentiometric surface of the Upper Floridan aquifer in October 1983. Except for Cherry Lake, which may have been affected by pumping, surface-water altitudes were close to those indicated on the topographic maps. The potentiometric contours show that a potential exists for water from the Upper Floridan aquifer to move upward into Cherry Lake at the east end and downward at the west end when the lake surface altitude is at 56 feet. The topographic map (fig. 1) incorrectly indicates that Cherry Lake is connected to Black Lake at altitude 56 feet, but spirit levels show that the lakes are not connected naturally unless one of the lakes exceeds an altitude of 58.5 feet. A potential exists for water in Black Lake and Lake Miona to seep downward to the Upper Floridan aquifer.

The water-surface altitudes of the lakes and adjacent ponds obtained by spirit level in October 1983 cannot be used to evaluate natural head relations between the lakes and the water table in the surficial aquifer because of the apparent unusually low stage of Cherry Lake. However, these data, when augmented by interpretation of the conditions in sinkholes adjacent to the lakes shown on the topographic maps, indicate the gradient of the water table is toward the lakes from the southeast, slightly toward the lakes from the north and south, and away from the lakes to the west.

The foregoing discussion suggests that altitudes of the lake surfaces under natural conditions would be successively lower from east to west. However, local residents report that, except when Black Lake and Cherry Lake were connected, Cherry Lake was naturally lower than both Black Lake and Lake Miona before pumps were introduced to the complex. Further, when the lakes were connected, flow was naturally from Black Lake to Cherry Lake.

There are two explanations for the natural conditions reported by the local residents. Either the water balance for the lakes is such that Cherry Lake receives less input than Black Lake and Lake Miona, or seepage from Cherry Lake to the Floridan aquifer system is greater than seepage from Black Lake and Lake Miona. The smaller head difference between Cherry Lake and the potentiometric surface of the Upper Floridan aquifer would require the material between the lake and the aquifer to be more permeable than that between Black Lake and Lake Miona and the Upper Floridan. In any case, conditions are such that Cherry Lake rises more slowly and falls more rapidly than Black Lake and Lake Miona when all are identically affected by climatological stress.

RAINFALL, EVAPORATION, AND STAGE FLUCTUATIONS OF LAKE MIONA

Rainfall, which is the source of water in Lake Miona, is extremely variable with time and location. Although rainfall is intermittent, the time during which it affects the altitude of Lake Miona is prolonged by temporary surface and subsurface storage. Evaporation and seepage to the Upper Floridan aquifer, that comprise the water loss from Lake Miona, are much less variable temporally than rainfall. Thus, the rate of input to the lake is seldom balanced by output and the lake usually is either rising or falling. The natural imbalance between input and output may be modified by the activities of man.

Records of the water levels of Lake Miona are too short and the effect of man's activities are too great to permit a definitive long-term evaluation of the relation between the climate and the water-level fluctuations of Lake Miona. However, because Lake Miona is in the recharge basin of Silver Springs (fig. 3) which is 22 miles north, and near an Upper Floridan aquifer well at Wildwood, which is 3 miles southwest, the probable pattern of fluctuation and the time of occurrence of the extremes during the 40 years ending in 1982 can be inferred from the data in figure 4. The minimum stage of Lake Miona probably occurred in 1956 or 1957 and maximum stage probably occurred in 1960. A local resident stated that at the time the lakes reached their highest level in 1960, he was standing in about 1.5 feet of water at the divide between Black Lake and Cherry Lake. The divide was found by spirit levels to be at altitude 58.5 feet and, therefore, the highest lake level was estimated to be about 60 feet. The approximate area flooded when the lakes are at altitude 60 feet is shown by the blue shading in figure 1. The rise in the stage of Lake Miona in 1979 and 1980, when the records for Silver Springs and the Wildwood well show below-average but stable conditions, may have been caused by man's activities.

The hydrographs in figure 5 were prepared by using (1) rainfall data for Wildwood Fire Tower and Candler Fire Tower (fig. 4) provided by the Southwest Florida Water Management District, (2) records of pan evaporation at the National Oceanic and Atmospheric Administration station at Lisbon (fig. 3) adjusted to lake evaporation using coefficients determined at Lake Okeechobee 1941–46 (Kohler, 1954), (3) water-level data from the Wildwood well adjusted to the level at Lake Miona using a curve of relation between the Wildwood well and the well at Lake Miona (fig. 4), and (4) periodic readings of the Lake Miona staff gage (fig. 4). Although none of these data, except the staff-gage readings, can be rigorously applied to Lake Miona, they are useful in indicating the general trends and relations.

In 1981, when the average level of Lake Miona was about 5 feet higher than the potentiometric surface of the Upper Floridan aquifer, net change in the lake exclusive of rainfall and evaporation was a loss of 1.7 feet. In 1982, when the lake averaged only about 1.5 feet higher than the potentiometric surface, the net change exclusive of rainfall and evaporation, was a gain of 3.4 feet. This is as expected because the potential for seepage out of the lake was more than three times greater in 1981 than in 1982, whereas the potential for surface inflow and seepage into the lake was much greater in 1982 than in 1981. The effect of man's activities on the lake during 1981 and 1982 is not known.

WATER QUALITY

Lake Miona was sampled four times in 1982 and 1983 and Black Lake and Cherry Lake were sampled once in 1983 at the locations shown in figure 1. Low water levels and dense, emergent aquatic growth prohibited the sampling of Black Lake and Cherry Lake at the beginning of the project.

The single samples from Black Lake and Cherry Lake may not be true indicators of the continuing water quality in these two lakes. The three lakes were sampled for various water-quality constituents that include major inorganic anions and cations, selected nutrients, trace metals, and chlorophyll. Lake Miona was sampled twice and Cherry Lake was sampled once for pesticides.

A comparison of the major inorganic composition of water from the Upper Floridan aquifer well at Wildwood, of bulk precipitation (a combination of rainfall and dry fallout) collected at Orlando and Ocala, and of Black Lake, Cherry Lake, and Lake Miona is shown by the diagrams in figure 6. Water from the Upper Floridan aquifer well is a calcium bicarbonate type. Bulk precipitation also is mostly a calcium bicarbonate type (Irwin and Kirkland, 1980), but it is considerably less mineralized than water from the lakes and Upper Floridan aquifer. Water from Lake Miona is consistently a calcium bicarbonate type, whereas the waters in Black Lake and Cherry Lake are similar and are sodium chloride types. Because of the low mineralization of the water in the three lakes, the balance between the ions may change after input from precipitation or storm runoff.

The differences in water quality among the three lakes are probably related to a combination of factors including land use, soil types, surficial aquifer water quality and seepage rates, and vegetative growth.

Nitrogen and phosphorus are important because they are the major plant nutrients. Excessive amounts create an ideal environment for abnormal rapid growth of algae and lead to a gradual degradation of lake quality. For instance, Black Lake and Cherry Lake have extensive emergent bottom-rooted aquatic growth over virtually their entire area. Lake Miona has submerged rooted aquatic plants over much of the area of the lake but is also much deeper than the other lakes. Permissible nutrient concentrations for eutrophication control are difficult to establish, chiefly because of the many variables associated with plant production. The Florida Department of Environmental Regulation has not set specific criteria, but Mackenthun (1973) suggested that total phosphorus should not exceed 0.025 milligrams per liter (mg/L) in lakes and the U.S. Council on Environmental Quality (1975) suggested a limit of 0.6 mg/L of nitrate-nitrogen. Based on these suggestions, phosphorus concentrations were excessive in one of four samples from Lake Miona and in the Black Lake sample (table 1). Nitrate-nitrogen concentrations were lower than 0.6 mg/L in all samples. Data are inadequate to make conclusive lake-to-lake comparisons of water quality; neither is it known whether or not the high phosphorus (0.11 mg/L) in the Black Lake sample is representative of recurring water quality in the lake. However, the generally low concentrations of nutrients in the lakes indicated by the data suggest that either few nutrients enter the lakes in runoff, or that, if nutrients do enter the lakes, plants in the lakes quickly assimilate the nutrients.

Inorganic nitrogen (ammonia, nitrate, and nitrites) usually enters a lake or stream from runoff from fertilized fields and other sources foreign to the natural environment, but organic nitrogen found in the lake is usually a product of the decomposition of plant matter or other organic wastes from living plants. In Lake Miona, Black Lake, and Cherry Lake, organic nitrogen concentrations of 0.87 to 1.3 mg/L indicate that some plant decomposition may be occurring. Nitrate-nitrogen and nitrite-nitrogen concentrations were present in minor amounts (less than 0.1 mg/L) in the three lakes, and only in Cherry Lake was the concentration of ammonia nitrogen more than 0.04 mg/L. The concentration of phosphorus, which ranged from 0.02 mg/L to 0.06 mg/L in four samples from Lake Miona, was 0.01 mg/L in Cherry Lake and 0.11 mg/L in Black Lake.

Results of analyses of samples from the lakes for selected trace elements and the recommended limits for Class III waters (classified for recreation and propagation of wildlife) set by the Florida Department of Environmental Regulation (Florida Department of State, 1983) are given in table 2. Concentrations of cadmium are at the minimum analytical detection levels and may not actually exceed the recommended limits. Concentrations of several constituents were slightly higher in Cherry Lake than in either Lake Miona or Black Lake. Mercury and zinc were at the recommended limits for these elements in the sample from Cherry Lake.

Water and bottom sediments from Lake Miona and Cherry Lake were sampled for pesticides (table 3). In Lake Miona, silvex and 2,4-D were found in the water and chlordane, DDD and DDE were found in the bottom sediments. In Cherry Lake, malathion and diazinon were found in the water and DDD and DDE were found in the bottom sediments. Concentrations of other pesticides were below detection limits for each analytical method.

Malathion and diazinon are short-lived pesticides used for lawn or garden maintenance. Silvex and 2,4-D are short-lived herbicides used commercially for weed control.

DDT and its metabolites DDD and DDE, and chlordane were found only in bottom sediments. These long-lived pesticides have settled out of the water or leached from the surrounding soil and adsorbed onto the bottom sediments before being buried. The amounts found in the sediment are minor and are metabolizing from DDT to its metabolites, DDE and DDD. Use of DDT has been banned since 1972 (Nebel, 1981), but due to its longevity (half life is about 10 years), DDT and its metabolites will persist for years to come.

Lakes derive dissolved oxygen (DO) from the atmosphere and from plant photosynthesis. The amount of oxygen that the lake can retain in solution is controlled by the temperature of the water. Figure 7 shows vertical profiles of temperature and DO of the three lakes. Thermal stratification did not occur in the three lakes, but an oxycline, or sharp decrease in DO concentration, was found. The oxycline may be attributable to restriction of circulation by the 6 to 8 feet of dense aquatic plant growth rooted in the bottom of the lakes or the need for oxygen to support the plant decomposition suggested by the presence of organic nitrogen. In Lake Miona, DO concentration was constant at about 6.5 mg/L to a depth of 7 feet then decreased to 0.3 mg/L at 11 feet. In Black Lake, the shallowest lake at the point of sampling, the DO concentration decreased at a generally steady rate from about 5.5 mg/L at the surface to nearly zero at the bottom. DO in Cherry Lake was constant 5 mg/L to a depth of 4 feet, decreased to 3 mg/L between 5 and 6 feet and then gradually declined to 1.7 mg/L at the bottom.

Measurements for these profiles were made about noon in open areas of water near the centers of the lakes, and are probably not representative of other areas of the lakes where aquatic plants are denser or of other times of the day, especially the nighttime hours. DO concentrations of the lakes were below saturation (mostly 4 to 8 mg/L near the surface) in all samples.

pH is an important factor in the biological systems of natural waters. Freshwater fish live ideally in waters with a pH range of 6.5 to 9.0 units (U.S. Environmental Protection Agency, 1976, p. 180). The pH in Lake Miona ranged from 6.6 to 8.9 units. The pH in Black Lake (6.0 units) and in Cherry Lake (6.6 units) in July and August 1983, were less than the pH of the ideal range for fish, but apparently the lakes have enough biological activity to overcome any problems that might create an imbalance in the water chemistry.

Chlorophyll *a* is the primary photosynthetic pigment and is present in all algae. Chlorophyll *b*, also a major photosynthetic pigment, is present in green algae (Lorenzen, 1970). Of the three lakes sampled, Cherry Lake contained the most chlorophyll *a* (24 µg/L) but had very little chlorophyll *b*. Black Lake had the most chlorophyll *b* (2.2 µg/L) of the three lakes but much less chlorophyll *a* (4.3 µg/L) than Cherry Lake. In three samples taken from Lake Miona, chlorophyll *a* never exceeded 4.7 µg/L and chlorophyll *b* never exceeded 0.1 µg/L.

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ABBREVIATIONS AND CONVERSION FACTORS

For those readers who may prefer to use metric units (SI) rather than inch-pound units, the conversion factors for the terms used in this report are listed below.

Multiply	*By*	*To obtain*
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
acre	0.4047	hectare (ha)

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows:

$$°F = 1.8 °C + 32$$

Table 1.—*Concentrations of nitrogen and phosphorus in water from Lake Miona, Black Lake, and Cherry Lake*

[Units are in milligrams per liter]

Location	Date	Organic nitrogen as N	Ammonia nitrogen as N	Nitrite nitrogen as N	Nitrate nitrogen as N	Total phosphorus as P
Lake Miona	5-19-82	1.1	0.03	0.00	0.00	0.02
	8-28-82	1.0	.04	.00	.01	.02
	4-05-83	.87	.03	.01	.04	.02
	7-21-83	.88	.02	<.01	—	.06
Black Lake	7-21-83	1.3	.02	<.01	—	.11
Cherry Lake	8-03-83	1.1	.88	<.01	—	.01

Table 2.—*Concentrations of selected trace elements and criteria (recommended limits) set by Florida Department of Environmental Regulation for Class III (recreational) waters*

[Units are in micrograms per liter]

Location	Arsenic	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Zinc
Lake Miona	1	<10	1	20	2	70	7	20	<0.1	1	<1	10
Black Lake	1	<10	1	20	1	210	11	20	<.1	1	<1	10
Cherry Lake	1	<10	<1	20	5	550	15	40	.2	9	<1	30
Florida Department of Environmental Regulation criteria for Class III waters.	50	[a]11	[a].8	50	30	1,000	30	[b]	.2	100	25	30

[a] For waters with hardness not exceeding 150 milligrams per liter as calcium carbonate.

[b] Criteria not established.

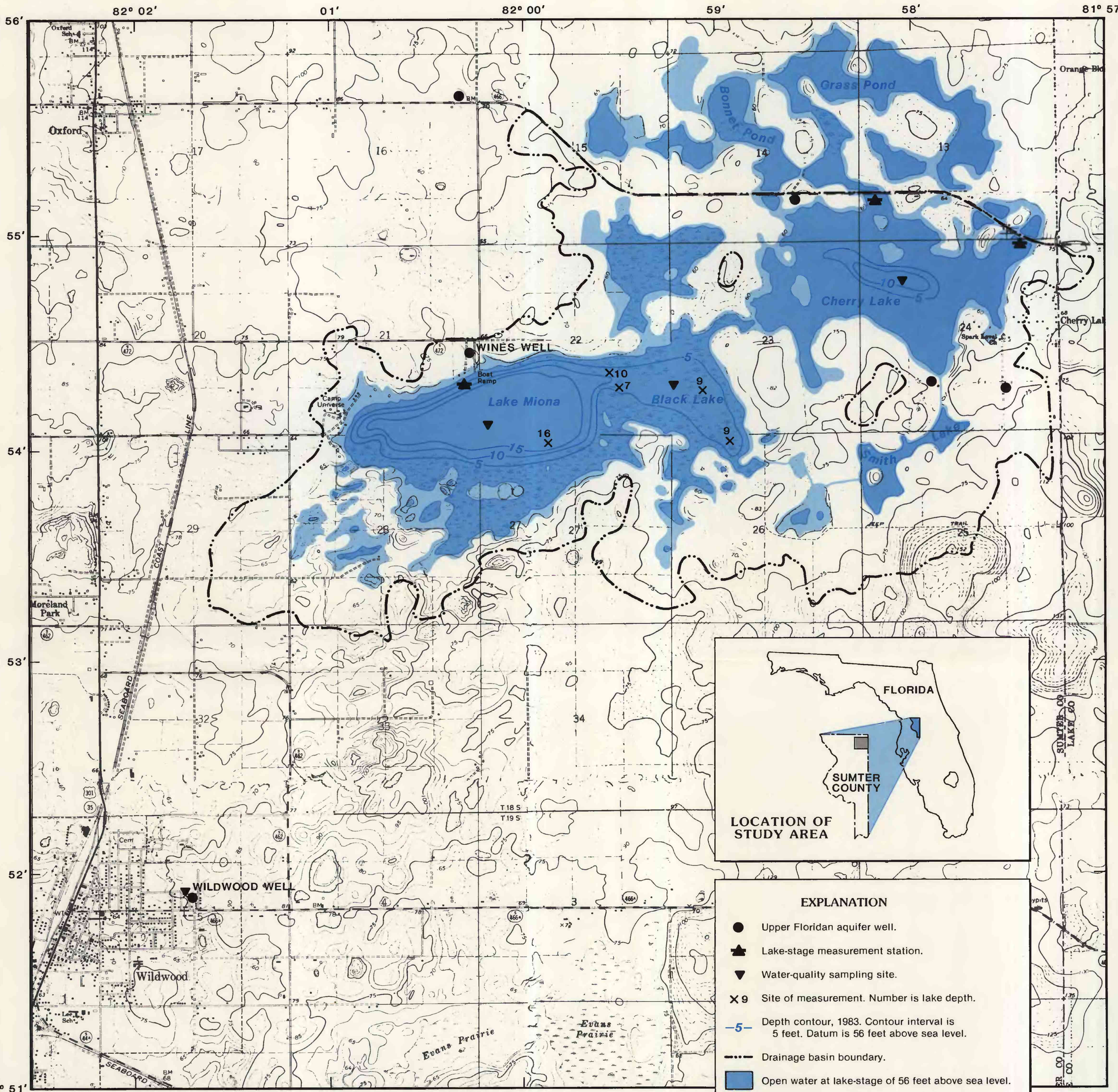

Figure 1.—Lake Miona, Black Lake, Cherry Lake, and surrounding area, with data-collection sites and selected hydrologic information.

Table 3.—*Concentrations of pesticides in water and bottom sediment in Lake Miona and Cherry Lake*

[All values are in micrograms per liter (µg/L) or micrograms per kilogram (µg/kg), as noted]

Pesticides	Total in water (µg/L) and date: Lake Miona 82-05-19	Lake Miona 82-08-28	Cherry Lake 83-08-03	Total in bottom material (µg/kg) and date: Lake Miona 82-05-19	Lake Miona 82-08-28	Cherry Lake 83-08-03
Naphthalenes, polychlorinated	< 0.10	< 0.10	< 0.10	—	—	—
PCN	—	—	—	< 1.0	< 1.0	< 1.0
2,4-DP	< .01	< .01	< .01	—	—	< .1
Perthane	< .1	< .1	< .1	< 1.00	< 1.00	< 1.00
Aldrin	< .010	< .010	< .010	< .1	< .1	< .1
Lindane	< .010	< .010	< .010	< .1	< .1	< .1
Chlordane	< .1	< .1	< .1	8.0	< 1.0	< 1.0
DDD	< .010	< .010	< .010	8.0	.2	3.0
DDE	< .010	< .010	< .010	.8	< .1	.6
DDT	< .010	< .010	< .010	< .1	< .1	< .1
Dieldrin	< .010	< .010	< .010	< .1	< .1	< .1
Endosulfan	< .010	< .010	< .010	< .1	< .1	< .1
Endrin	< .010	< .010	< .010	< .1	< .1	< .1
Ethion	< .01	< .01	< .01	< .1	< .1	< .1
Toxaphene	< 1	< 1	< 1	< 10	< 10	< 10
Heptachlor	< .010	< .010	< .010	< .1	< .1	< .1
Heptachlor epoxide	< .010	< .010	< .010	< .1	< .1	< .1
Methoxychlor	< .01	< .01	< .01	< .1	< .1	< .1
PCB	< .1	< .1	< .1	< 1	< 1	< 1
Malathion	< .01	< .01	< .02	< .1	< .1	< .1
Parathion	< .01	< .01	< .01	< .1	< .1	< .1
Diazinon	< .01	< .01	.05	< .1	< .1	< .1
Methylparathion	< .01	< .01	< .01	< .1	< .1	< .1
2,4-D	.04	.07	< .01	—	—	< .10
2,4,5-T	< .01	< .01	< .01	—	—	< .10
Mirex	< .01	< .01	< .01	< .1	< .1	< .1
Silvex	< .01	.02	< .01	—	—	< .1
Trithion	< .01	< .01	< .01	< .1	< .1	< .1
Methyltrithion	< .01	< .01	< .01	< .1	< .1	< .1

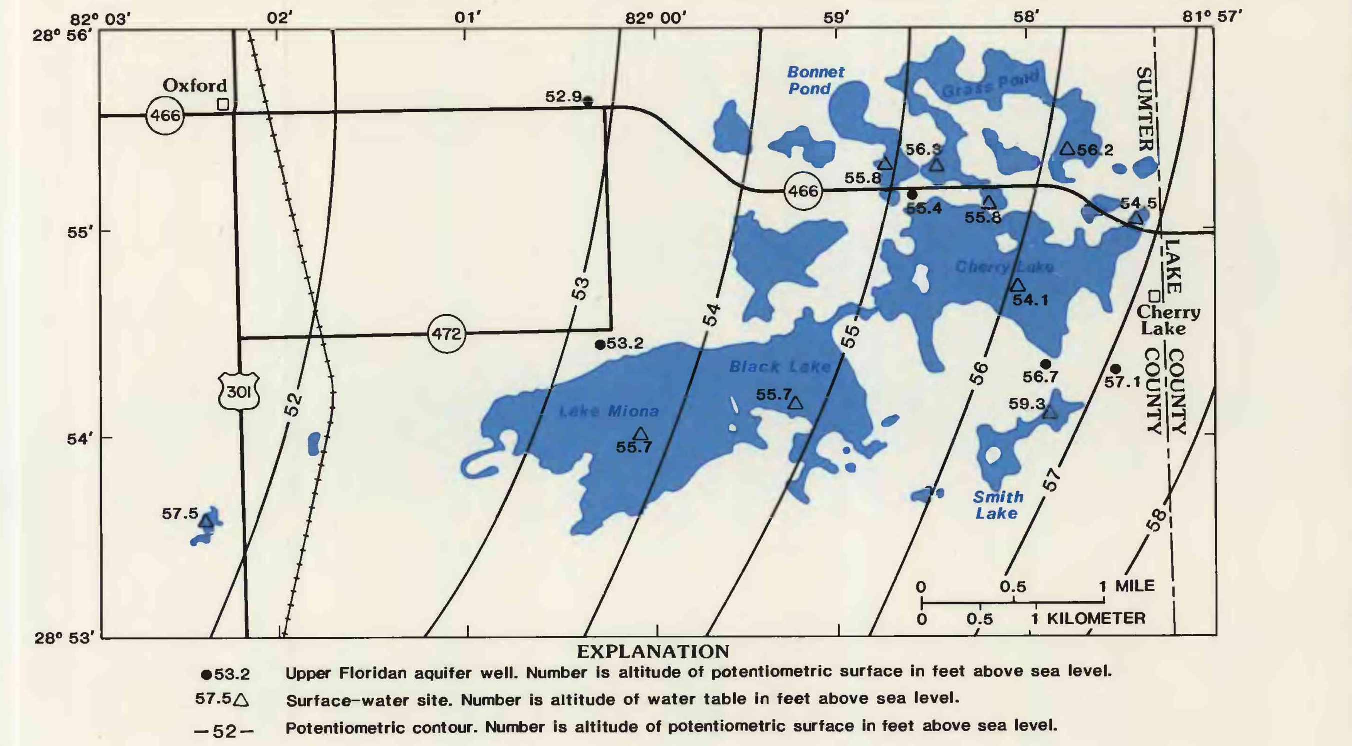

Figure 2.—Potentiometric surface of the Upper Floridan aquifer and altitude of surface-water sites in the Lake Miona area, October 1983.

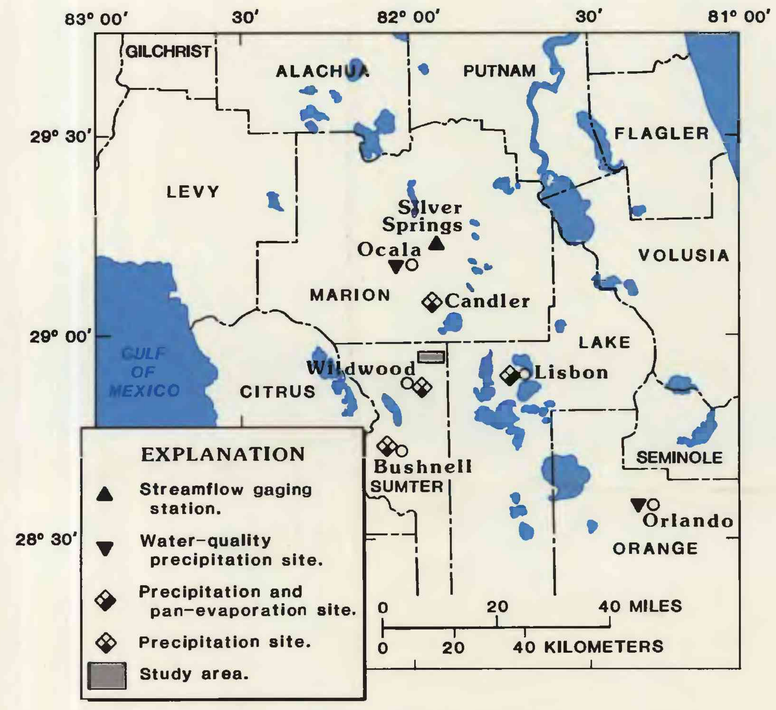

Figure 3.—Location of Silver Springs streamflow gaging station, precipitation sites, and pan-evaporation site.

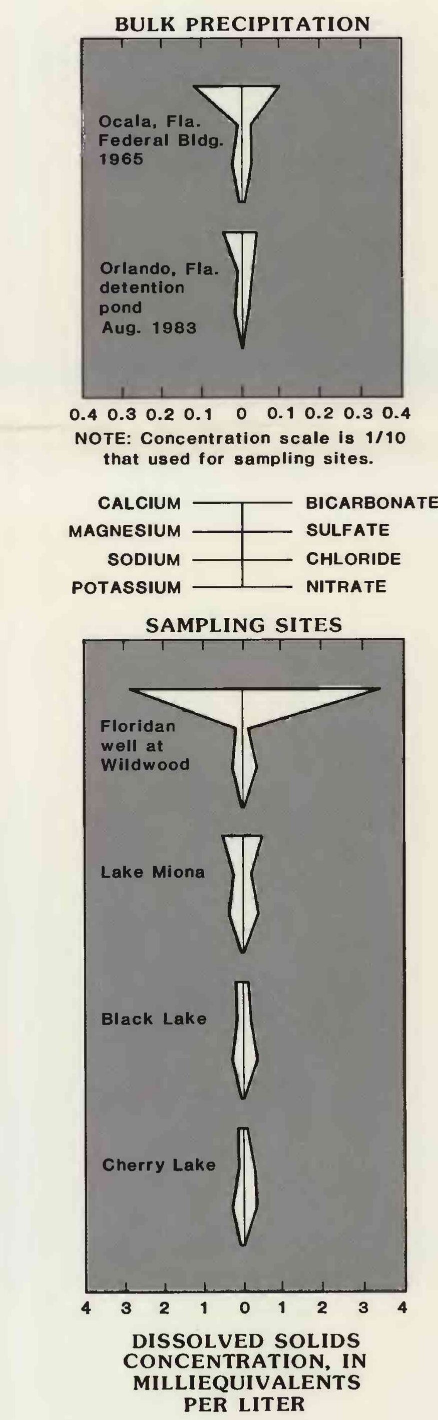

Figure 6.—Major dissolved constituents in water from four sites and in bulk precipitation.

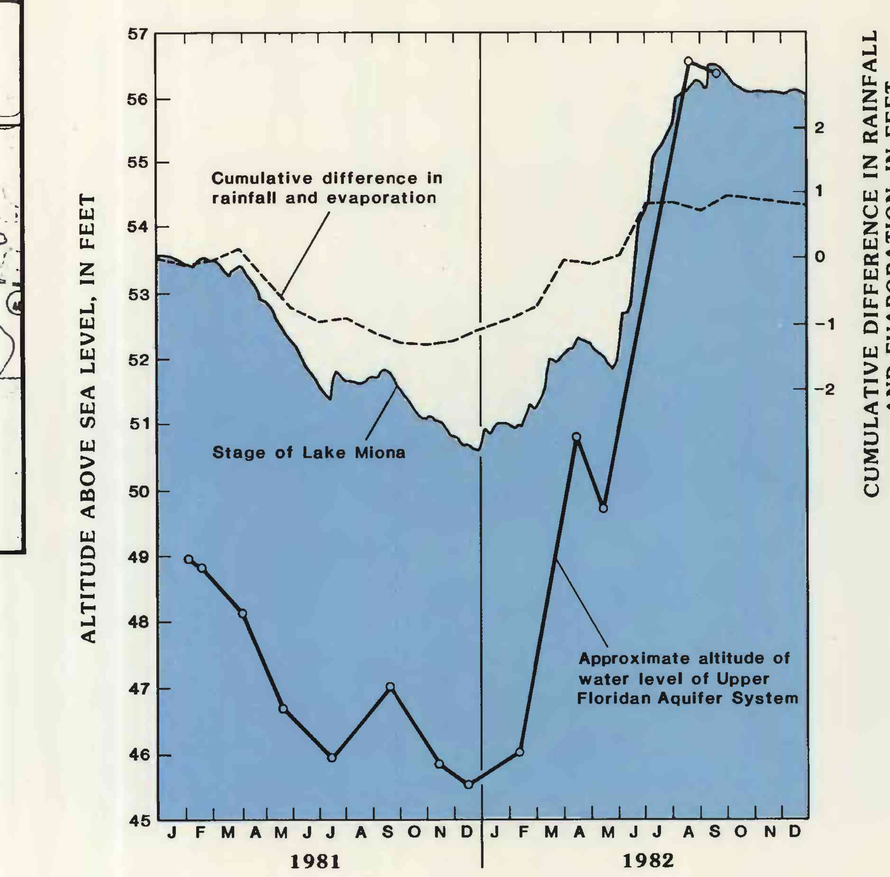

Figure 5.—Cumulative difference in rainfall and lake evaporation, stage of Lake Miona, and approximate altitude of the potentiometric surface of the Upper Floridan aquifer at Lake Miona.

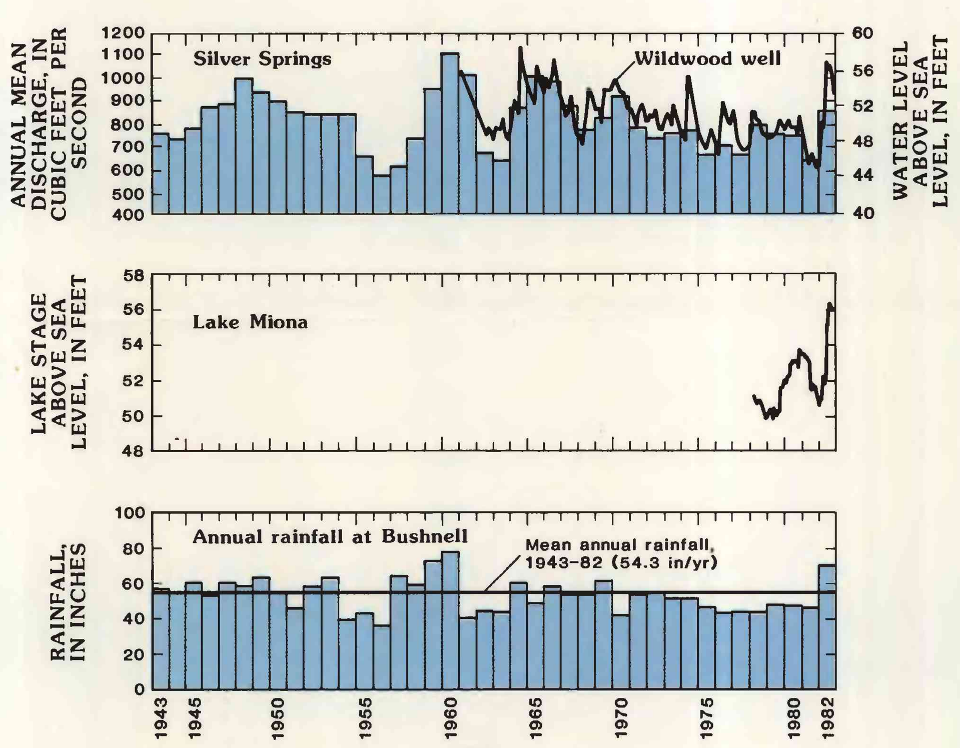

Figure 4.—Water level of the Upper Floridan aquifer near Wildwood and annual mean discharge of Silver Springs, lake stage of Lake Miona, and long-term rainfall at Bushnell.

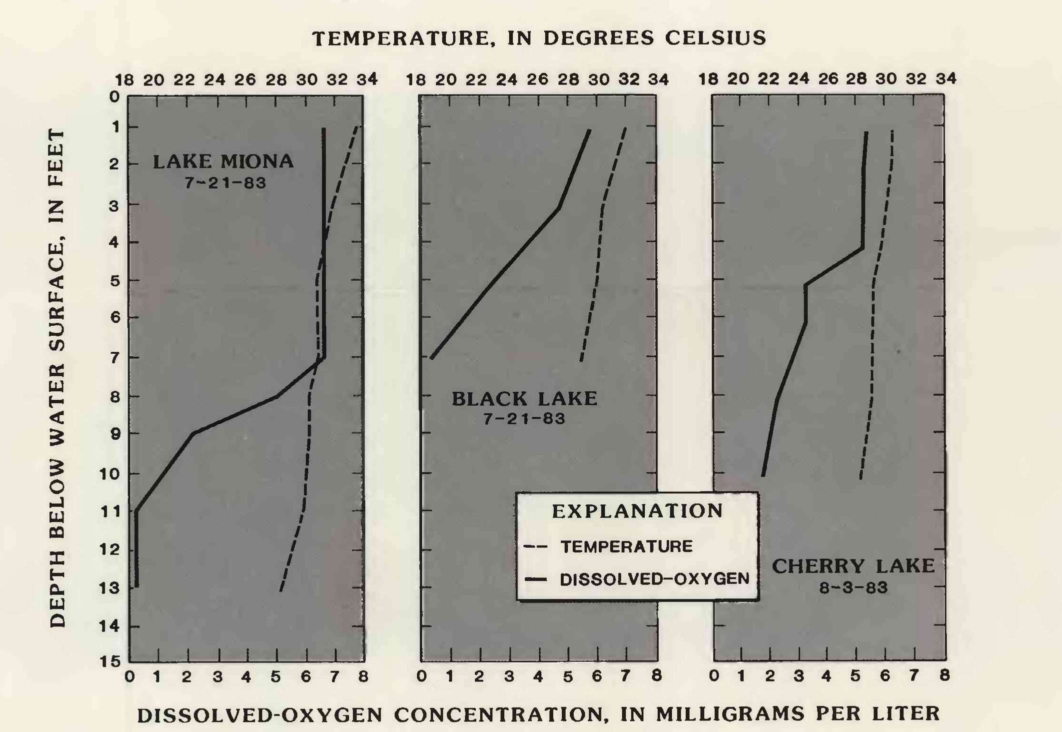

Figure 7.—Vertical profiles of temperature and dissolved-oxygen concentration in Lake Miona, Black Lake, and Cherry Lake.

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HYDROGEOLOGY OF THE LAKE MIONA AREA, NORTHEAST SUMTER COUNTY, FLORIDA

By
L. A. Bradner
1986