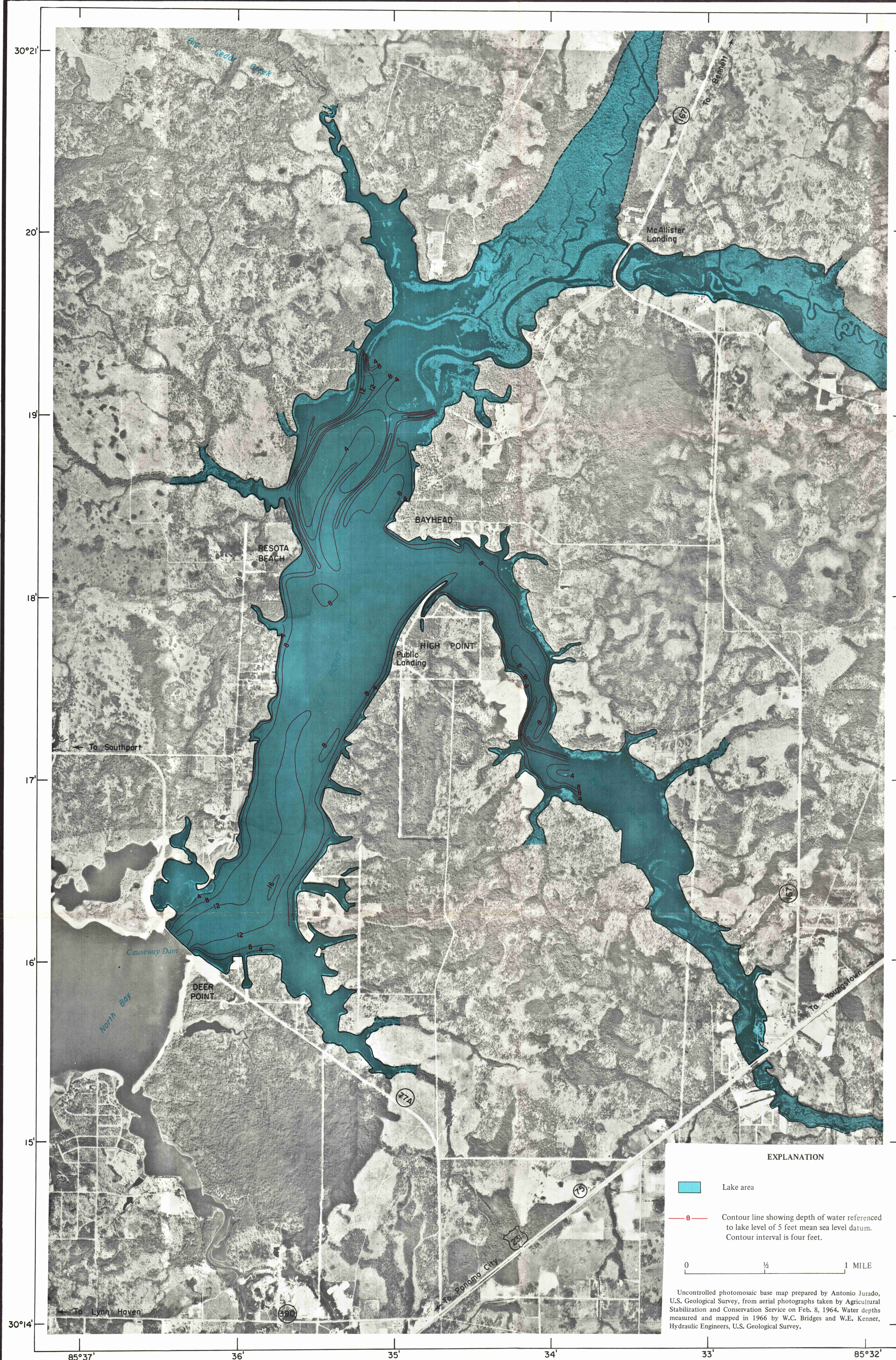




HYDROLOGIC SETTING OF DEER POINT LAKE
NEAR PANAMA CITY, FLORIDA

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ABSTRACT

Deer Point Lake is a much more dynamic water body than is apparent to those who view the lake only casually. The lake level and the temperature of the lake water, for example, vary almost continually within limits of a few feet for the lake level and several degrees for the temperature. The chemical quality of the lake water also varies significantly. Some of these variations are partly documented by data collected in past years; however, useful evaluations of these data require some understanding of the relations and interrelations that exist among the many variables involved. This report compiles much of the hydrologic data that pertain to Deer Point Lake and examines the significance of the data in light of some of the hydrologic principles that apply.

INTRODUCTION

Deer Point Lake was formed in 1961 by construction of a low-head causeway dam across the northern part of North Bay at Deer Point about 8 miles north of Panama City, Fla. See figure 1. The lake provides an ample water supply for the continued economic growth of the Panama City area and adds to the water-oriented recreational facilities available for tourists and residents of that area.

The purpose of this report is to compile much of the hydrologic data that pertain to Deer Point Lake and to cast the data in a meaningful light by relating it to some of the hydrologic principles that apply. The report serves to demonstrate the broad understanding of hydrologic problems required of public officials and other interested parties who are concerned with the wise use of the natural resources of the Panama City area.

Deer Point Lake dam impounds part of the flow of four creeks—Econfina Creek, Bear, Bayou George, and Big Cedar. The remainder of the flow spills into North Bay. Deer Point Lake covers about 4,700 acres and stores about 32,000 acre-feet of water at spillway level of the dam, 4.5 feet elevations herein given as feet above mean sea level. About half the area above the spillway level is open-water areas that were formerly part of North Bay and the inlet to Bayou George Creek. The rest of the lake area extends inland into Econfina Creek, Bear Creek, and Big Cedar Creek drainage basins, where the water is generally shallow and densely filled with aquatic vegetation.

Impoundment of fresh water in Deer Point Lake began with closing of the causeway dam on November 17, 1961. Water began spilling over the dam on November 28, 1961, and stabilized at a level of about 5.0 feet on December 2, 1961. Since that time the lake level has ranged from a maximum of 6.38 feet on September 29, 1963, to a minimum of 4.82 feet on October 14, 1968. Water is from 5 to 16 feet deep in most open-water areas—with the lake at its usual level of about 5.0 feet—and is deepest in the center of the lake near the dam. Small pockets of deep water are found along former stream channels, now covered by the lake.

LAKE-LEVEL FLUCTUATIONS

The level of Deer Point Lake varies with the volume of streamflow passing through the lake, as is evident from the similarity of the streamflow and lake-level variations portrayed by graphs in figure 2. The streamflow variations of Bayou George Creek and Big Cedar Creek are similar to those of Econfina Creek and Bear Creek; however, Bayou George Creek and Big Cedar Creek contribute only about 6 percent of the total streamflow passing through the lake, so these creeks affect the lake level only slightly. Table 1 gives the proportion of streamflow that enters the lake from each of the four creeks for two conditions—average flow and low flow. The average-flow data correspond approximately to the flow that occurred in 1966 (fig. 2), whereas the low-flow data correspond to a drought such as occurred in 1968.

During 1968 the total water withdrawn from Deer Point Lake for municipal and industrial use averaged about 40 mgd (million gallons per day), or slightly less than 15 percent of the streamflow that entered the lake during the crisis of the 1968 drought. Thus, as long as the streamflow is undiminished by upstream developments, the lake and stream system provides a dependable supply of water for appreciable expansion of use in the Panama City area.

Streamflow that enters Deer Point Lake results from rainfall on the drainage basins of the several creeks involved. Consequently, the streamflow varies with rainfall. Variations of the yearly rainfall recorded at Panama City—shown in figure 3—generally apply to nearby inland areas and, hence, to the streamflow passing through Deer Point Lake.

The yearly rainfall recorded at Panama City since 1898 has averaged 58 inches, but it has varied greatly, from a minimum of slightly less than 37 inches in 1917 to a maximum of slightly more than 85 inches in 1959. Although such extreme variations are unusual, yearly rainfalls greater than 70 inches were recorded several times, and the minimum yearly rainfall of record was almost equaled in 1931, 1938, and 1968.

The flow of Econfina Creek has been measured since 1936 at the U. S. Geological Survey's gauging station, Econfina Creek near Bennett, Fla., about 2 miles upstream from Deer Point Lake. See figure 4. The variations in the yearly streamflow generally reflect the variations in rainfall at Panama City.

Because of the relative lack of rainfall in 1967-68, the flow of Econfina Creek gradually declined to a minimum of 210-215 mgd during September and October 1968. During these months Deer Point Lake remained within a few hundredths of a foot of its minimum level of record—4.82 feet on October 14, 1968.

The recorded minimum flow of Econfina Creek near Bennett was 198 mgd on January 9, 1956—a result of the 1954-56 drought. Correlation studies of the flow of Econfina Creek and the level of Deer Point Lake indicate that a change in the inflow to the lake corresponding to a change in the flow of Econfina Creek from 119-215 mgd to 198 mgd could cause only a slight decline of the lake level—probably less than 0.05 feet.

According to Pride and Crooks (1962), the 1954-56 drought was the most severe drought suffered by the state of Florida since at least 1881. Analysis of the record of rainfall at Panama City indicates that the Panama City area conformed to the statewide pattern. Based on the assumption that the magnitude and distribution of past rainfalls apply to future rainfalls, a drought as severe as the 1954-56 drought probably will occur, on the average, only once in every 50-100 years. Consequently, barring upstream developments that would decrease streamflow, the frequency at which the flow of Econfina Creek might decline significantly below 198 mgd should be about the same. Keeping in mind that streams of a given area follow the same flow trends, particularly during dry periods, and that Econfina Creek is the chief source of water for Deer Point Lake during dry periods, and large barring changes in critical features of Deer Point Lake dam and large increases of water withdrawals from the lake, it therefore follows that, on the average, Deer Point Lake probably will decline significantly below 4.8 feet only once in every 50-100 years. Note that if withdrawals of lake water are greatly increased over present withdrawals, however, the lake level may decline more frequently below a level of 4.8 feet during drought periods less severe than the 1954-56 drought.

Deer Point Lake rose to a maximum observed level of 6.38 feet on September 29, 1963, but also reached a level of 6.30 feet twice in 1964, a level of 6.20 feet in 1965, and a level of 6.28 feet in 1966 (U. S. Geological Survey, 1963-66). Thus, the 1963 flood level seems not to represent an outstanding flood.

The rainstorm that produced the 1963 flood level of 6.38 feet at Deer Point Lake caused a flood flow of 847 mgd in Econfina Creek near Bennett on April 2, 1948 (U. S. Geological Survey, 1951). Assuming that the rainfall distribution of the 1963 storm would apply and that the flood flow over Deer Point Lake dam varies directly with the flood flow of Econfina Creek near Bennett, simple computations indicate that a recurrence of the 1948 flood would raise the level of Deer Point Lake to about 9 feet.

In a study of floods in the region including Econfina Creek, Barnes and Golden (1962, p. 42) concluded that the 1948 flood flow of Econfina Creek near Bennett had a recurrence interval greater than 50 years. On this basis, therefore, the probability is less than 2 percent that Deer Point Lake will rise in any one year to a level of 9 feet.

ORIGIN OF THE LAKE WATER

Streamflow that enters Deer Point Lake is derived from rainfall by two different hydrologic routes. Part of the streamflow is runoff that results from the overland flow of rainfall into stream channels. Overland flow occurs only during and immediately after rainstorms, commonly producing relatively high rates of runoff for relatively short periods of time. The abrupt rises in level of Deer Point Lake (fig. 2) are due primarily to runoff.

Rainfall that does not flow directly from the land surface into stream channels is absorbed by surface materials or is temporarily stored in land-surface depressions. Part of the rainfall subsequently evaporates from the land and water surfaces, or is transpired by plants, but part of it percolates downward to the water table. In the creek basins that supply streamflow to Deer Point Lake, the surface materials are generally permeable sands of variable but appreciable thickness that readily absorb rainfall and transmit it to the water table.

According to Musgrove, Foster, and Toler (1965, p. 5), however, "The sands of the water-table aquifer cover a relatively impermeable layer of sandy clay and clayey shell material whose norm is a aquiclude (a formation that confines water to aquifers above and below it) between the water-table aquifer and the artesian aquifers below." This aquiclude is present throughout the basin except where it has been breached by collapse into solution chambers or by erosion along Econfina Creek." The aquiclude generally restricts the downward movement of water in the surficial material and, in fact, most of the rainfall that reaches the water table to emerge in the stream channels.

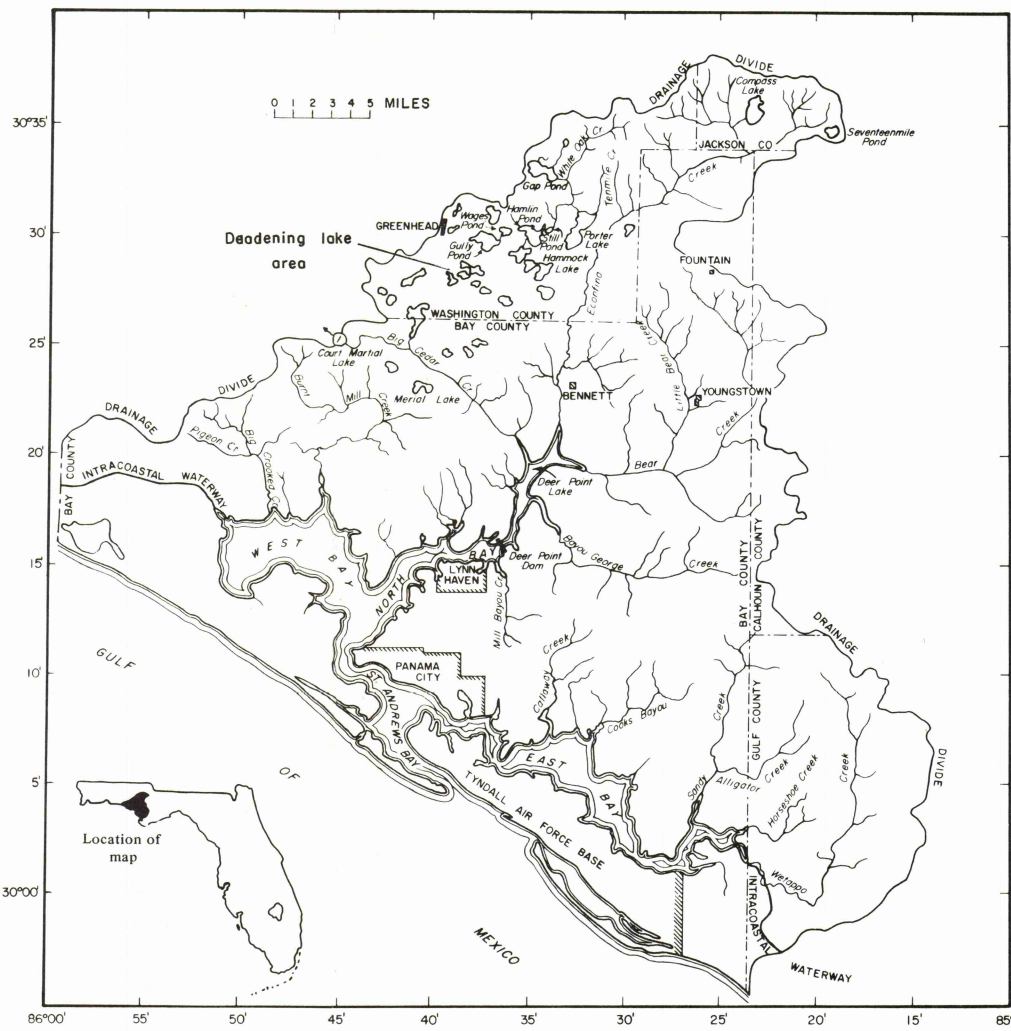


Figure 1. Map of Deer Point Lake and tributary streams.

TEMPERATURE VARIATIONS OF THE LAKE WATER

The temperature of water in Deer Point Lake has not been measured well enough to define the temperature variations that occur. However, some understanding of these variations in shallow lakes in Florida can be gained from consideration of some of the factors involved.

The temperature of water in open areas of a shallow lake, such as Deer Point Lake, generally does not vary appreciably in an areal sense, but it does vary diurnally and seasonally, and at times, it varies appreciably with depth. Temperature variations of lake water basically are due to variations in solar radiation incident to the lake surface. When incident solar radiation follows an increasing trend, as in the spring of the year, the lake temporarily receives more energy from the sun than can be dissipated by radiation, conduction, and evaporation. The lake water stores some of the available energy, thereby increasing its temperature until equilibrium is attained. When the trend of incident solar radiation is decreasing, as in the fall of the year, the lake temporarily can dissipate more energy than is received from the sun because the temperature of the lake water is higher than necessary to maintain equilibrium. The lake water in this case releases stored energy, with a consequent decrease in temperature of the lake water. Hence, the temperature of the lake water increases from winter to summer and decreases from summer to winter. Similarly, the temperature of lake water varies daily, increasing during the morning-until noon or mid-afternoon—and decreasing during the evening.

The temperature variations of water in a shallow lake are similar to and almost in phase with the temperature variations of the local air. However, the diurnal temperature variation of lake water generally is substantially less than that of air. For example, the temperature of surface water of a lake commonly may vary diurnally about 10-12°F (degrees Fahrenheit) if the day is warm, sunny, and calm. Under the same conditions, the temperature of the local air may vary about 20-25°F. The temperature of lake water is generally less than the temperature of air during the day and greater than the temperature of air during the night. For a day, or for periods of a few days, the mean temperatures of lake water and air may differ by several degrees, especially at times of rapid change in weather, but for shallow lakes the monthly mean temperatures of the surface water and the local air seldom differ by more than 4°F. Thus, for conceptual purposes, the mean-monthly temperature of air at Panama City, shown in figure 5, is fairly representative of the mean-monthly temperature of the surface water of Deer Point Lake. This is partly confirmed by results of intermittent measurements of the temperature of Deer Point Lake water made since 1966 which, as figure 5 shows, generally follow the trend of the mean-monthly temperature of air at Panama City.

At times the temperature of the lake water varies appreciably with depth—the temperature generally decreasing from the surface to the bottom. The temperature gradient develops because heating by the sun occurs in the uppermost layers of lake water and because, above a temperature of 39°F, the density of water decreases with increasing temperature. Thus, water heated at the surface tends to remain at the surface. The difference between the temperatures of surface water and bottom water can build up to several degrees. However, other factors that come into play tend to restore the lake water to uniform temperature.

First, cooling of the lake water also occurs at the surface by radiation, conduction, and evaporation. The cooled water sinks below the surface to blend with water of equal density. Currents so induced reduce the thermal gradient, but these currents probably are not strong enough to eliminate the gradient entirely.

Second, and undoubtedly more important, the wind induces currents in the lake water that are powerful enough to mix the water to great depths, the depth depending on the intensity and duration of the wind as well as on the size and shape of the lake basin and the degree of its exposure to the wind.

Because the open-water areas of Deer Point Lake are shallow and open to the wind, the lake water is probably mixed completely by moderate winds. Thus, from top to bottom, the temperature of water in Deer Point Lake is relatively uniform except at times when the wind is calm for periods of several hours on warm and sunny days.

REFERENCES

- Barnes, H. H., Jr., and Golden, H. B. 1966. *Magnitude and Frequency of Floods in the United States, Part 2-B, South Atlantic slope and eastern Gulf of Mexico basins, Apalachicola River to Port River*. U. S. Geol. Survey Water Supply Paper 1674, 409 p.
- Florida State Board of Conservation. 1954. *December 1952: Florida State Board of Conservation, Division of Water Survey and Research Paper No. 11, 334 p.*
- Hem, J. D. 1959. *Study and interpretation of the chemical characteristics of natural waters*. U. S. Geol. Survey Water Supply Paper 1473, 269 p.
- Musgrove, R. H., and Foster, E. B., and Toler, G. G. 1965. *Water resources of the Econfina Creek basin area in northwestern Florida*. Florida State Board of Conservation, Division of Geology, Rept. of Inv. 41, 51 p.
- 1968. *Water resources records of the Econfina Creek basin area, Florida*. Florida State Board of Conservation, Division of Geology, Information Circ. No. 57, 127 p.
- Pride, R. W., and Crooks, L. W. 1962. *The drought of 1954-56, its effect on Florida's surface-water resources*. Florida State Board of Conservation, Division of Geology, Rept. of Inv. No. 26, 65 p.
- U. S. Geological Survey. 1963-66. *Water resources data for Florida, part 1, surface water records, vol. 3, lakes*. U. S. Geol. Survey, Tallahassee, Fla., issued annually.
- 1963. *Water resources data for Florida, part 1, surface water records, vol. 1, streams, northern and central Florida*. U. S. Geol. Survey, Tallahassee, Fla., issued annually.
- 1951. *Surface water supply of the United States, 1948, part 2, South Atlantic slope and eastern Gulf of Mexico basins*. U. S. Geol. Survey, Water Supply Paper 1112, 584 p.
- U. S. Public Health Service. 1962. *Drinking water standards*. U. S. Dept. of Health, Education, and Welfare, Public Health Service Publication No. 356.
- U. S. Weather Bureau. 1954-69. *Climatological data, Florida, Annual Summaries 1953-68*. U. S. Dept. Commerce, U. S. S. A., Asheville, N. C.

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TABLE 2. CHEMICAL ANALYSES OF WATER IN DEER POINT LAKE AND SELECTED TRIBUTARY STREAMS (CHEMICAL CONSTITUENTS IN MILLIGRAMS PER LITER)

Date of Collection	Stage(s) or ft. or discharge (C) in cfs.	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)
5-24-66	5.518	1.0	0.10	8.0	2.2	12	0.6	29	4.0	20	0.1
8-18-66	5.529	3.8	.20	4.4	1.0	4.8	.4	14	.8	8.5	.1
2-24-67	5.510	3.9	.21	6.3	1.4	4.8	.0	24	.8	8.5	.1
5-9-67	5.496	2.1	.02	10	3.0	14	.6	37	4.0	24	.1
6-6-68	5.492	1.3	.10	12	3.3	14	.6	42	5.0	26	.1
Eonoma Creek											
5-12-67	Q 406	5.2	.00	15	2.1	1.4	.2	55	.0	2.2	.1
6-6-68	Q 385	4.8	.10	17	2.3	1.7	.4	64	.4	4.0	.1
Bear Creek											
5-9-67	Q 41	4.2	.04	3.2	.4	1.4	.2	11	.0	2.2	.0
6-5-68	Q 40	8.3	.10	3.1	.5	1.7	.2	4.0	1.4	3.5	.1

TABLE 1. ESTIMATES OF STREAMFLOW ENTERING DEER POINT LAKE FROM DIFFERENT CREEK BASINS (AFTER MUSGROVE, FOSTER, AND TOLER, 1965, p. 16).

Creek basin	Drainage area, sq. miles	AVERAGE FLOW		LOW FLOW	
		MGD	Percent of total	MGD	Percent of total
Econfina Creek	129	355	57.4	226	79.3
Bear Creek	128	226	36.5	52	18.2
Bayou George Creek	61	36	5.7	4	1.4
Big Cedar Creek	62	12	1.9	4	1.4
TOTAL	370	619	100.0	285	100.0

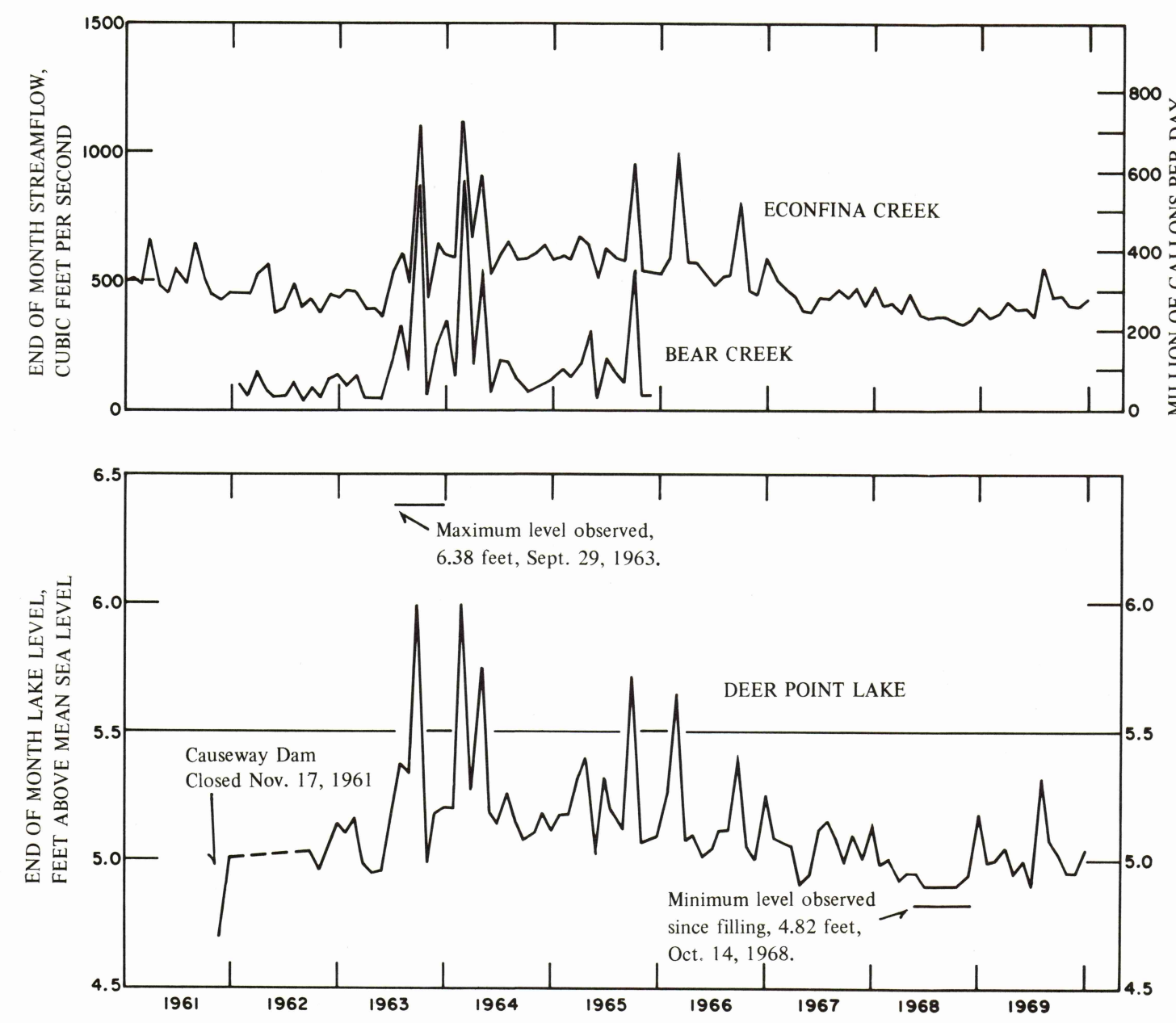


Figure 2. Graphs showing variations in level of Deer Point Lake and in flow of selected tributary streams.

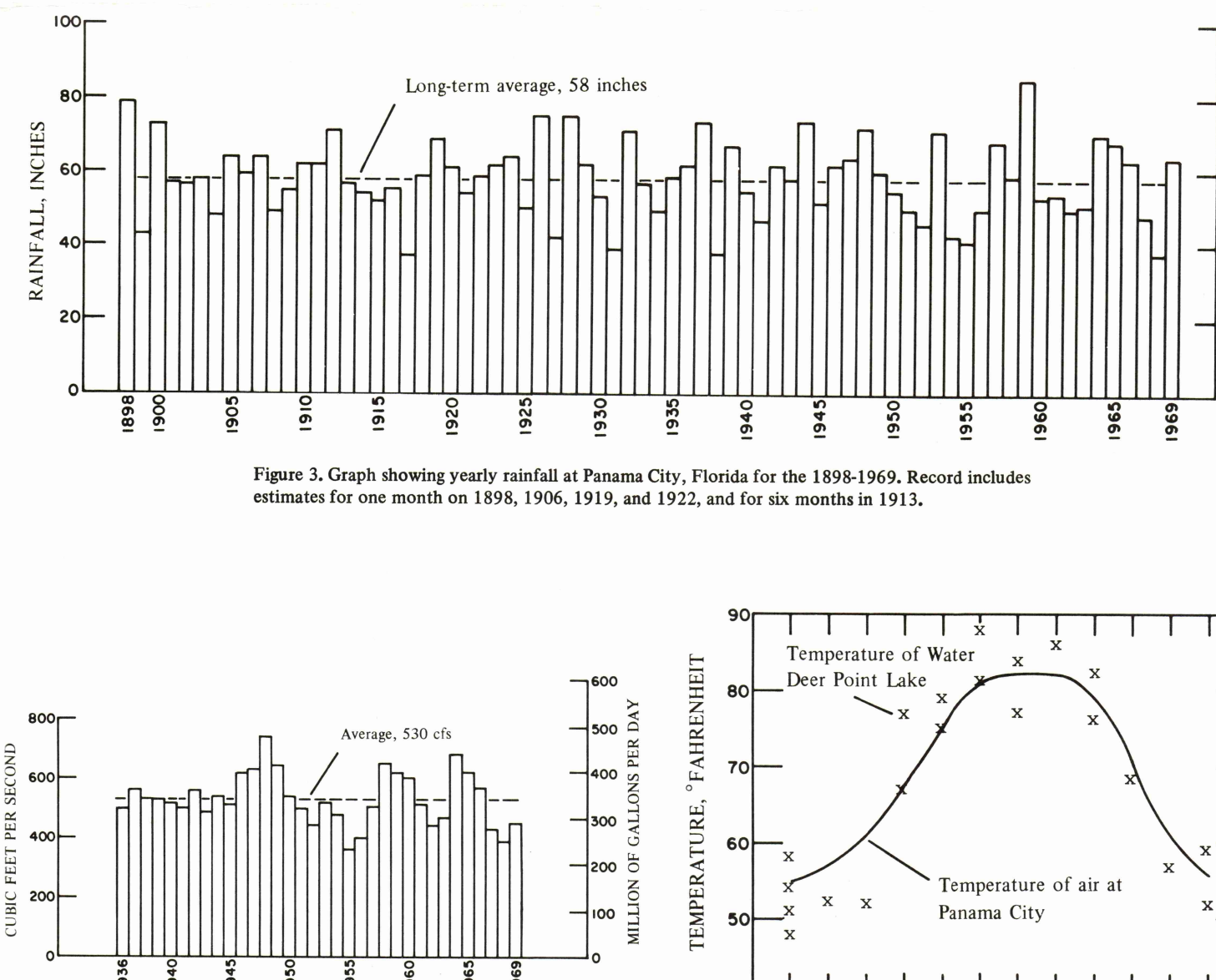


Figure 3. Graph showing yearly rainfall at Panama City, Florida for the 1898-1969. Record includes estimates for one month in 1898, 1906, 1919, and 1922, and for six months in 1913.

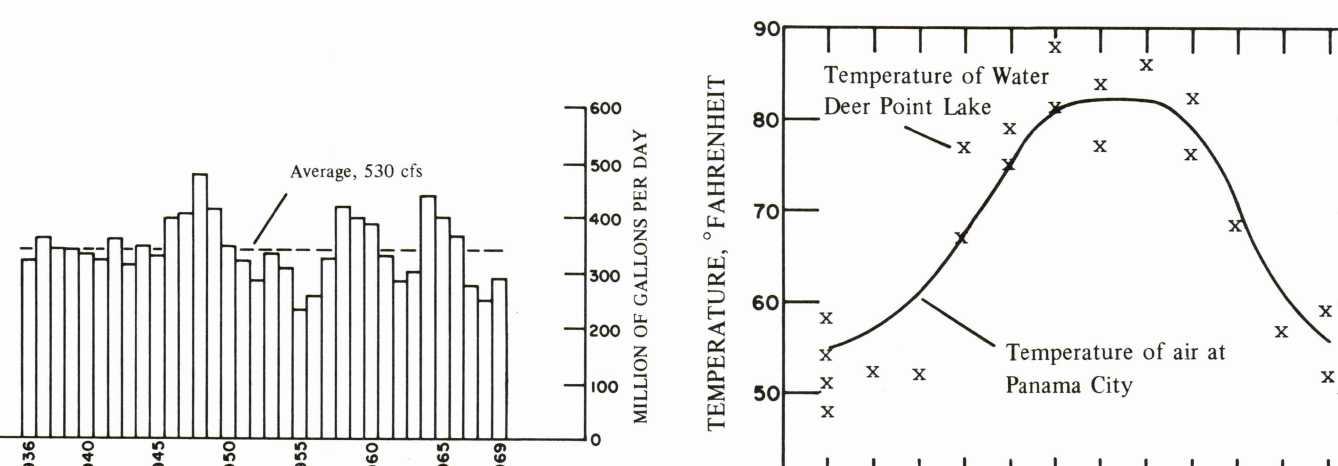


Figure 4. Graph showing yearly flow of Econfina Creek near Bennett, Florida for period 1936-69.

Figure 5. Mean-monthly temperature of air at Panama City, Florida, and mean-monthly temperature of water in Deer Point Lake at different times of month during the 1966-1969 period.