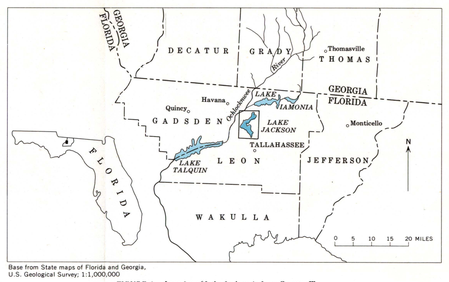
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
DIVISION OF GEOLOGY
FLORIDA STATE BOARD OF CONSERVATION
LEON COUNTY BOARD OF COMMISSIONERS
AND THE
CITY OF TALLAHASSEE

HYDROLOGIC INVESTIGATIONS
ATLAS HA-369

Uncontrolled photomosaic base by Florida State Road Department from aerial photographs taken March 7, 1966. Aerial photography by Florida State Road Department

Topography between the 87- and 81-foot contours within the inundated area of Lake Jackson by photogrammetric methods from aerial photographs taken by Agriculture Commodity Stabilization Service in December 1954 with lake at a level of 81 feet. Topography for all other areas compiled from U.S. Geological Survey maps. Photogrammetric work and compilation of topography by Antonio Jurado, U.S. Geological Survey



Base from State maps of Florida and Georgia, U.S. Geological Survey; 1:1,000,000

FIGURE 1.—*Location of Lake Jackson in Leon County, Fla.*

HYDROLOGIC SIGNIFICANCE OF 1966 FLOOD LEVELS AT LAKE JACKSON NEAR TALLAHASSEE, FLORIDA

The accompanying photomosaic map shows Lake Jackson flooded at a level of 96.35 feet (mean sea level datum) on March 7, 1966. The lake continued to rise slightly in the months that followed and reached a maximum level of 96.53 feet on June 18, 1966. This report shows that the 1966 flood level has not been equaled or exceeded since at least 1886, based primarily on analysis of rainfall records for Tallahassee and other areas near Lake Jackson. The conclusion is confirmed for a period beginning in 1898 by the age of large oak trees killed by inundation in 1966.

After the above analysis was made, two large oak trees on the shore of the lake were examined by C. W. Hendry and E. W. Bishop of the Florida Board of Conservation (personal commun., May 1969). The trees' ages were subsequently estimated by C. H. Coulter, State Forester, Florida Forest Service (personal commun., May 1969). One tree 15 feet in circumference, estimated to be about 125 years old at death, was killed in the 1948 flood which reached a level of 94.5 feet. The other, still living, is 19.3 feet in circumference, estimated to be about 150 years old, and stands with its base at an altitude of about 97 feet. Some of this tree's roots were washed by the lake at the 96.53-foot flood level.

COOPERATION AND ACKNOWLEDGMENT

This atlas was prepared by the U.S. Geological Survey, under the direction of Clyde S. Conover, district chief, Water Resources Division, as part of a continuing cooperative program with the Division of Geology, Florida Board of Conservation, and in joint cooperation with the Leon County Board of Commissioners and the city of Tallahassee. The photomosaic base map was furnished by the Florida State Road Department; topography was compiled by Antonio Jurado, U.S. Geological Survey.

HYDROLOGIC SETTING OF LAKE JACKSON

Lake Jackson occupies part of a natural closed depression about 7 miles north of Tallahassee, Florida (fig. 1). The lake receives its water from rainfall on the lake basin, an area of 43.2 square miles. Most of the water is supplied directly by rainfall on the lake but at times runoff from the land surface and seepage from the water-table aquifer add substantially to the lake. The lake rises abruptly with each individual rainstorm of consequence and tends to decline at other times.

Much of the rainfall on the land surface of the lake basin never reaches the lake because the soil of the basin is generally permeable and the rainfall is absorbed where it falls. Most of this absorbed water is stored as soil moisture and is consumed by natural vegetation which covers the land extensively. Part of the absorbed rainfall percolates to the water table. A small amount of rainfall simply wets the land surface and returns directly to the atmosphere by evaporation.

Several small lakes and ponds in the lake basin temporarily store water which eventually evaporates or leaks downward to an underlying aquifer. During unusually wet periods these lakes and ponds sometimes spill small amounts of water into Lake Jackson. Intense rainstorms produce substantial surface-water runoff which enters Lake Jackson during and immediately after the storm period. Small rivulets, fed by ground water or by drainage from the small lakes and ponds, flow into Lake Jackson during unusually wet periods.

Lake Jackson loses water by evaporation from the open-water surface, by transpiration from aquatic plants growing in the lake, and by leakage through the lake bottom. Evaporation and transpiration vary daily and seasonally but, per unit area, both are almost constant on a yearly basis; the volume of water removed from the lake by evaporation and transpiration varies with the surface area involved at the time of concern. The lake surface varies with the lake level as shown in figure 2. The topographic map of the Lake Jackson area indicates that the lake must rise to a level somewhat below the 110 foot contour to spill water which would discharge into the Ochlockonee River basin. E. W. Bishop (personal commun., 1969) estimates that the spill point is at about altitude 105 feet.

Most of the water leaking from the lake probably moves through sinkholes leading to a confined limestone aquifer underlying Lake Jackson and the surrounding area. In the vicinity of the lake the potentiometric level of the confined limestone aquifer is always substantially below the level of the lake; thus, under the natural conditions presently existing, the lake always can leak water to the confined limestone aquifer,but never can receive water from that aquifer. Leakage from the lake may change greatly if new sinkholes form and remain open, or if existing sinkholes become periodically plugged or unplugged. The available record of lake level does not indicate pronounced variations in leakage since 1950, but some variations undoubtedly have occurred in the past and probably will occur in the future. A more detailed description of the hydrology of Lake Jackson is contained in a report by Hughes (1967).

TABLE 1.—*Rainfall at Tallahassee, Quincy, and Monticello, Fla. for months when total rainfall recorded at any one station was 15 inches or greater during period 1886–1967.*

Date		Station rainfall (inches)		
Year	Month	Tallahassee	Quincy	Monticello
1898	Aug.	15.43	–	–
1900	June	16.47	–	–
1907	Dec.	12.78	–	15.64
1916	July	15.02	–	14.21
1923	June	9.51	15.59	9.58
1924	Sept.	23.85	19.23	20.22
1928	April	11.68	14.76	22.19
1948	March*	18.60	20.35	23.66
	July	17.88	11.24	11.67
1949	July	15.50	8.03	7.16
1957	Sept.	20.32	15.26	23.35
1964	July	20.12	10.87	17.58

*Includes rainfall on April 1, 1948.

TABLE 2.—*Partial time distribution of 24-hour rainfalls in excess of 5 inches recorded at Tallahassee, Fla. from 1932 to 1968.*

Year	Date	Maximum 24-hour rainfall (inches)	Maximum concentration for indicated period (inches)			Ratio of 6-hour to 24-hour rainfall
			1-hour	2-hour	6-hour	
1958	April 9–10	5.53	–	–	1.86	0.34
1959	March 5–6	6.00	0.89	1.35	3.05	.51
1962	Mar. 31–Apr. 1	7.16	1.54	2.63	4.83	.67
1964	Feb. 27–28	5.60	.56	1.05	2.80	.50
	July 17–18	8.94	3.23	4.96	6.16	.69
	Oct. 14–15	5.95	.73	1.14	2.41	.41
	Dec. 3–4	9.26	2.15	3.35	5.23	.56
1965	June 14–15	5.29	2.03	2.50	3.97	.75
1966	June 9–10	6.75	–	–	–	–
	Sept. 18–19	5.49	.77	1.27	2.51	.46
1968	Sept. 8	6.52	4.83	5.66	6.52	1.00

TABLE 3.—*Maximum and minimum monthly rainfall (in inches) recorded at Tallahassee, Fla. from 1886 to 1967.*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly
Maximum	11.28	12.22	16.48	12.91	12.36	16.47	20.12	15.43	23.85	12.27	12.64	12.78	104.18
Year	1915	1914	1948	1912	1890	1900	1964	1898	1924	1959	1947	1907	1964
Minimum	0.21	0.45	0.18	0.11	(T)	1.16	1.28	2.54	0.67	0.00	0.03	0.00	30.98
Year	1957	1911	1908	1903	1965	1944	1918	1916	1931	1904	1931	1889	1954

(T) Trace

Note.—Table 3 taken from Florida Division of Water Survey and Research Paper No. 11 and modified to include subsequent maxima and minima reported by U.S. Weather Bureau

AVAILABLE HYDROLOGIC DATA

The U.S. Geological Survey has maintained a water-level gage on Lake Jackson since March 1950 (fig. 3). The maximum level of record for the lake was 96.53 feet above mean sea level on June 18, 1966; however, the lake level was within a few hundredths of a foot of the maximum level several days in June and again in August of 1966.

The 1966 flood level of Lake Jackson resulted largely from rainfall which occurred from January 1, 1964, to April 30, 1965. During this 16-month period, the lake rose a total of 8.4 feet. Rainfall in the general area of the lake averaged about 122 inches for the same period. The greatest recorded rise of the lake for a single storm occurred on Dec. 3–4, 1964, when the lake rose 1.1 feet in 24 hours; the greatest recorded rise for a 12-month period occurred from July 1, 1964, to June 30, 1965, when the lake rose 6.6 feet.

The second highest known level of Lake Jackson—independent of the 1966 flood event—occurred in 1948. Information furnished by the Florida State Road Department indicates that the lake reached a level of about 94.5 feet in August 1948. This rise apparently resulted largely from rainfall in 1947 and 1948 but details of the rise were not recorded.

Rainfall has not been measured at Lake Jackson but long-term rainfall records (Florida State Board of Conservation, 1954; U.S. Weather Bureau, 1953–68) are available for four stations within 30 miles of the lake. The rainfall station nearest the lake is at Tallahassee where rainfall has been recorded since 1886 (fig. 4). Monthly rainfall data for Tallahassee are complete for all years except 1888, 1889, and 1892, which are complete for 11 months. Total rainfall for the 11-month period was 64.34 inches in 1888 (December missing), 42.34 inches in 1889 (July missing), and 46.56 inches in 1892 (November missing). Estimates of the total rainfall for these years are based on the assumption that for the months when no record was obtained rainfall was equal to the average monthly rainfall.

Yearly rainfall at Tallahassee averages 57.32 inches, based on 77 years complete record ending with 1965. The maximum yearly rainfall for Tallahassee was 104.18 inches in 1964; the maximum rainfall for a 12-month period was 104.46 inches from July 1964 to June 1965. The maximum monthly rainfall for Tallahassee was 23.85 inches in September 1924; other outstanding monthly rainfalls for Tallahassee and other stations are given in table 1. The maximum rainfall recorded at Tallahassee within a 24-hour period was 9.26 inches on Dec. 3-4, 1964; the time distribution of selected 24-hour rainfalls at Tallahassee is indicated by data in table 2. The record maximum and minimum monthly rainfalls for Tallahassee are summarized in table 3.

At Quincy, Fla., which is about 15 miles west of Lake Jackson, rainfall was recorded as early as 1897, but prior to 1917 the record is too incomplete to be useful. The yearly rainfall for Quincy is shown in figure 5. For a period of 49 years—from 1917 to 1965—yearly rainfall averaged 55.33 inches. Maximum yearly rainfall recorded was 83.61 inches in 1964; maximum rainfall for a 12-month period was 95.34 inches from July 1964 to June 1965.

At Monticello, Fla., which is about 27 miles east of Lake Jackson, rainfall has been recorded since 1904,but the record is incomplete for several years prior to 1920 (fig. 6). The monthly rainfall record for Monticello was complete for only 11 months in 1904 (January missing), 1905 (September missing), 1950 (March missing), and only 8 months in 1943 (January through April missing). Total rainfall recorded for these part-year periods was 38.85 inches in 1904, 55.13 inches in 1905, 31.70 inches in 1943, and 34.42 inches in 1950. Estimates of yearly rainfall for these years are based on records of rainfall at two nearby stations.

For 51 years of complete record from 1906 to 1965, rainfall at Monticello averaged 56.82 inches. Maximum yearly rainfall at Monticello was 88.12 inches in 1964; maximum rainfall for a 12-month period was 91.30 inches from February 1928 to January 1929. Second greatest rainfall for a 12-month period was 89.07 inches from July 1964 to June 1965.

Thomasville, Ga., is about 30 miles northeast of Lake Jackson. Rainfall at Thomasville was recorded as early as 1878. Except for the year 1879, however, the record of monthly rainfall is incomplete for years prior to 1892. Figure 7 shows the rainfall at Thomasville since that time. The record for 1949 is complete for only 11 months (October missing); total rainfall for the 11-month period was 41.62 inches. Yearly rainfall for 1949 was estimated on basis of records for nearby rainfall stations. For 73 years of complete record between 1892 and 1965, rainfall at Thomasville averaged 52.50 inches. Maximum yearly rainfall recorded there was 85.15 inches in 1964.

Rainfall on a sizable area immediately north and northeast of Lake Jackson is reflected in the flow of the Ochlockonee River, which has been measured near Havana, Fla., since 1927. Figure 8 shows the volume of calendar-year runoff expressed as the depth of water in inches over the drainage area of 1,140 square miles. Average yearly runoff for the period of record through 1966 was 12.2 inches.

ANALYSIS OF THE AVAILABLE DATA

The rise of Lake Jackson is definitely caused by rainfall on the lake basin but long-term records of rainfall at the lake are lacking for analysis. Seemingly, however, the extreme fluctuations of the lake result from rather long-term variations in rainfall which usually involve regional areas much larger than the lake's drainage basin. Thus the relative significance of at least the more pronounced and markedly different rises of the lake can be appraised by analysis of the hydrologic data for neighboring areas.

Analysis of the rainfall record of Tallahassee (table 4) shows that far more rain fell during the eras associated with the 1966 and 1948 flood levels of the lake than at any other time since rainfall record began in 1886. If the rainfall at Tallahassee was uniformly representative of rainfall at Lake Jackson the 1966 and 1948 flood levels are the greatest and second greatest levels of the lake, respectively, since at least 1886.

Hydrologic data for other areas near Lake Jackson indicate for varying periods of time that rainfall recorded at Tallahassee was representative of rainfall over an area broad enough to include Lake Jackson. For example, more rain fell at Quincy during the eras associated with the 1966 and 1948 flood levels of Lake Jackson than at any other time since 1917. The same relation between rainfalls of the different eras is indicated by the average of rainfall at Quincy and Monticello since 1920 and by the flow of the Ochlockonee River near Havana since 1927. Similarities of rainfall variations at Thomasville and Tallahassee (fig. 9) indicate that rainfall recorded at Tallahassee adequately represented rainfall at Lake Jackson since 1892, the beginning of record at Thomasville. (Note particularly that for years prior to 1917—when other supporting data are lacking—no unusually wet period occurred at Thomasville that is not reflected in similar degree by rainfall at Tallahassee.)

The 1966 and 1948 flood levels of Lake Jackson are the greatest and second greatest levels of that lake, respectively, since at least 1886 based on the foregoing analysis. This is confirmed partly by the age of large oak trees growing near the shoreline of the lake, for the oak tree cannot survive prolonged inundation of its roots. When the lake rises to some new high level, inundated trees are killed without exception because the lake recedes slowly. Thus the maximum tree age is the minimum possible time since flooding last occurred at or above the base level of the tree involved.

The 1966 flood of Lake Jackson left many dead oak trees of various sizes and ages ringing the lake. The age of two such trees selected as representing the largest killed was determined to be 46 years and 68 years (written commun., R. L. Phipps, U.S. Geological Survey, 1969). Consequently the confirmation provided by the age of the selected trees begins in 1898.

As previously mentioned, two larger and older trees were found after the above determination was made. The tree killed by the 94.5-foot flood of 1948 was about 125 years old at that time, and a nearby living tree, base at about 97 feet, whose roots were washed by the lake at the 96.53 flood level, was about 150 years old in 1969. These ages would place the germination date of the larger trees at about 1820.

RECURRENCE INTERVAL

In the natural sequence of flood events, the recurrence interval of a given flood is the average interval of time between recurring floods equal to or greater than the given flood. A distinction must be made between the apparent recurrence interval and the true recurrence interval. The apparent recurrence interval is necessarily determined by the pertinent flood data obtainable. The apparent recurrence interval of the greatest known flood is commonly assumed equal in years to the time span of the available data, and that of the second greatest known flood is assumed equal to one-half the time span, and so on for the lower ranking floods. The apparent recurrence interval is the true recurrence interval only if the flood record truly represents the full spectrum of possible flood events.

The apparent recurrence interval can be a reliable estimate of the true recurrence interval for floods having recurrence intervals that are short relative to the time span of the flood record. The reliability of the apparent recurrence interval decreases as the recurrence interval approaches the time span of the flood record. The apparent recurrence interval of high ranking floods may change appreciably as future floods occur, increasing or decreasing with time depending on the relative magnitudes of the known past floods and the eventual future floods. For example, the 1948 flood level of 94.5 feet at Lake Jackson was the highest level since at least 1820 until it was surpassed in 1965; hence, the apparent recurrence interval for flooding at that level—being at least 144 years in 1964—was suddenly reduced about 72 years by flooding in 1965.

Lake Jackson has reached the level of 96.53 feet only once since about 1820. Accordingly, the apparent recurrence interval for flooding at this level is presently (1969) at least 149 years; the true recurrence interval may be greater or less than 149 years. No upper limit can be given for the true recurrence interval, but the lower limit probably is about 100 years.

TABLE 4.—*Comparison of outstanding rainfalls recorded at Tallahassee, Fla., for selected periods of from 1 to 10 successive calendar years from 1886 to 1966.*

Number of years in period	First ranking rainfall		Second ranking rainfall		Third ranking rainfall	
	Yearly average (inches)	Inclusive years	Yearly average (inches)	Inclusive years	Yearly average (inches)	Inclusive years
1	104.2	1964	83.4	1948	75.6	1924
2	91.5	1964–65	82.4	1947–48	65.5	1911–12
3	86.0	1964–66	75.3	1946–48	65.0	1900–02
4	80.0	1963–66	70.6	1945–48	64.0	1899–1903
5	74.6	1962–66	69.6	1944–48	60.2	1898–1903
7	69.6	1960–66	65.5	1942–48	60.1	1897–1903
10	69.4	1957–66	62.8	1939–48	59.8	1894–1903

Note.—If, for independent periods within the same decade, more than one rainfall was outstandingly great, only the maximum rainfall was considered in ranking the rainfalls for the different eras involved.

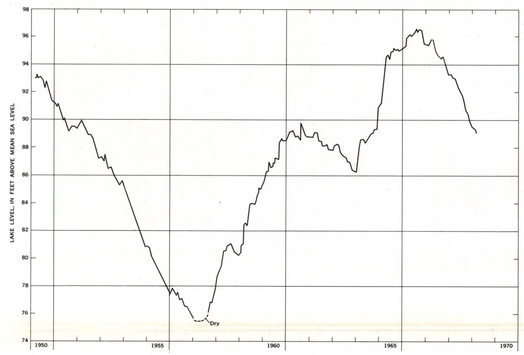


FIGURE 2.—*Relation between water level and surface area of Lake Jackson, Fla.*

FIGURE 3.—*Monthend water level of Lake Jackson, Fla.*

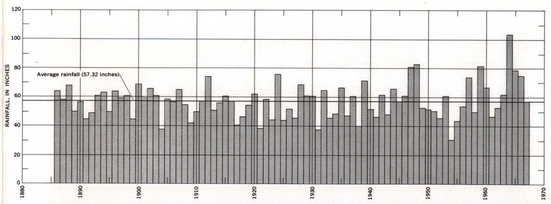


FIGURE 4.—*Yearly rainfall at Tallahassee, Fla.*

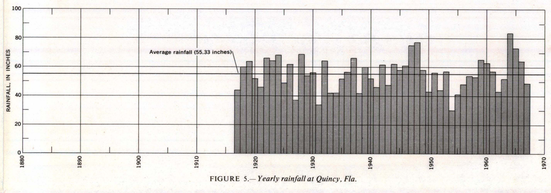


FIGURE 5.—*Yearly rainfall at Quincy, Fla.*

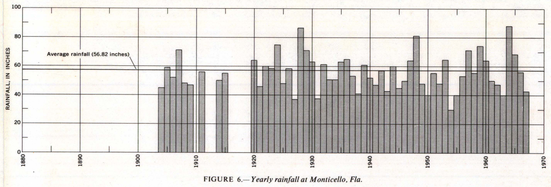


FIGURE 6.—*Yearly rainfall at Monticello, Fla.*

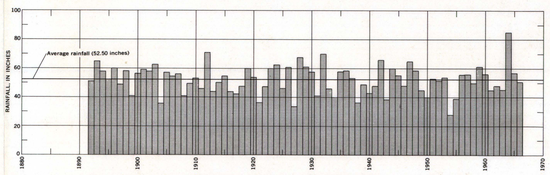


FIGURE 7.—*Yearly rainfall at Thomasville, Ga.*

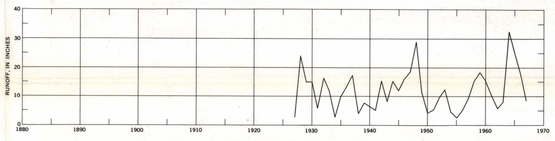


FIGURE 8.—*Yearly runoff of Ochlockonee River near Havana, Fla.*

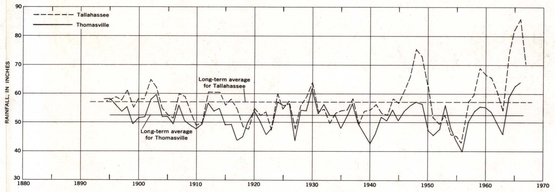


FIGURE 9.—*Three-year moving average of rainfall at Tallahassee, Fla. and Thomasville, Ga.*

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By
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1969

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