Final Report

CHEMICAL AND TROPHIC STATE CHARACTERISTICS OF FLORIDA LAKES IN RELATION TO REGIONAL GEOLOGY

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ABSTRACT

A limnological survey of 165 Florida lakes was conducted between September 1979 and August 1980 to determine chemical and trophic state characteristics. A wide range of limnological conditions was found. Mean pH ranged from 4.1 to 9.2 and mean total alkalinity concentrations ranged from 0 to 204 mg/l as $CaCO_3$. Mean specific conductance ranged from 11 to 5600 µmhos/cm. Total hardness concentrations averaged between 2 and 730 mg/l as $CaCO_3$ and calcium hardness concentrations averaged between 1 and 215 mg/l as $CaCO_3$. Mean total nitrogen concentrations ranged from 63 to 4600 mg/m^3 and total phosphorus concentrations averaged between 3 and 834 mg/m^3. Mean chlorophyll a concentrations ranged from 0.5 to 157 mg/m^3 and Secchi disc transparency averaged between 0.1 and 8.1 m. Lake trophic states ranged from ultra-oligotrophic to hyper-eutrophic. As a group, however, Florida lakes can be characterized as productive, soft-water lakes. Over 75% of the sampled lakes had total alkalinity concentrations below 40 mg/l as $CaCO_3$ and total hardness concentrations below 75 mg/l as $CaCO_3$. Total phosphorus concentrations ranged above 10 mg/m^3 in over 75% of the study lakes. Consequently, most of Florida's lakes are either mesotrophic (42%) or eutrophic (35%). Similar to the findings of regional limnology studies in other parts of the world, there is a strong relationship between the mineral composition of Florida's freshwater lakes and the surface geology and physiography.

INTRODUCTION

The State of Florida has over 7,700 natural and artificial lakes (Florida Board of Conservation 1969). These lakes, which range in size from small 0.4 ha ponds to the 181,000 ha Lake Okeechobee, are an extremely valuable natural resource because they provide habitat for a diverse flora and fauna as well as water for many of man's domestic, industrial, agricultural, and recreational activities. During the last 80 years, however, development activities have caused changes in the quality of many lakes. Unfortunately, these changes have often been undesirable. For example, the disposal of domestic, industrial, and agricultural wastes as well as increased urbanization have greatly increased plant nutrient inputs to many lakes. This nutrient enrichment or cultural eutrophication has caused the development of excessive growths of aquatic macrophytes and plankton algae. For the foreseeable future, however, the development of Florida will probably continue at a very rapid rate. With an expanding population and rapid economic growth, demands for water will increase. To meet these demands and minimize environmental damage, Florida'a lakes will have to be intensively managed.

The practical management of Florida's lakes, however, is complicated by their phycical, chemical, and biological diversity. Therefore, good management can occur only if the general limnological capabilities and potentials of the lakes are understood. Previous research has provided information on the mechanisms involved in the formation and destruction of lake basins (Sellards 1914; Cooke 1939; Stubbs 1940; Parker and Cooke 1944; Pirkle and Brooks 1959) as well as general information on the chemical and biological characteristics of select Florida lakes (Collins and Howard 1927; Carr 1934; Harkness and Pierce 1940; Pierce 1941; Reid 1950; Black and Brown 1951; Odum 1953; McLane 1955; Moody 1957). In addition, limnological research has documented the impact of cultural eutrophication on a number of Florida lakes (Reid 1964; Huffstutler 1965; Holcomb 1968, 1969; Duchrow 1970, 1971; Shannon 1970; Duchrow and Starling 1972; Shannon and Brezonik 1972; Holcomb and Starling 1973; Joyner 1974; Cowell et al. 1975; Nordlie 1976; Goolsby and McPherson 1978; Milleson 1978). Despite all this work, however, the limnological capabilities and potentials of the Florida lakes, as a group, remain poorly understood. This has occurred primarily because the factors influencing the productivity and species composition of lakes in different regions of Florida have not been studied.

Although there are a multitude of factors which can influence the productivity and species composition of lakes, limnological research (Moyle 1954, 1956; Sakamoto 1966; Dillon and Rigler 1974; Jones and Bachmann 1976; Larsen and Mercier 1976) has shown water chemistry is often the single most important factor. For any particular region, the mineral composition of freshwaters is largely determined by atmospheric precipitation (Gibbs 1970) and surface geology (Naumann 1932; Deevey 1940; Moyle 1954, 1956; Bachmann 1965; Jones and Bachmann 1978). In Florida, there have been statewide studies on water quality in streams which have shown a relationship between surface water chemistry and surface geology (Odum 1953; Kaufman 1975a, 1975b, 1975c, 1975d;

Slack and Kaufman 1975), but there have been no statewide limnological studies to determine if such a relationship exists in lakes. Because information about the edaphic influence on the mineral composition of lake water is important for separating lake types and for determining the limnological capabilities and potentials of lakes, this study was designed to determine the chemical composition and trophic state characteristics of Florida lakes located in different physiographic regions. The primary purpose was to determine if there were regional differences in chemical composition which might be of some biological importance.

DESCRIPTION OF STUDY AREA

A. Location

The State of Florida, which has an area of approximately 152,000 km^2 (Pride and Crooks 1962), is located on the southeast corner of the North American continent between latitudes 24°30' N and 31° N and longitudes 80° W and 87°30' W. Florida is bordered on the east by waters of the Atlantic Ocean, on the south by waters of the Straits of Florida and on the west by waters of the Gulf of Mexico. To the north, Florida is bordered by Alabama and Georgia.

B. Climate

General climatic conditions range from a zone of transition between temperate and subtropical conditions in northern Florida to tropical conditions in the Florida Keys (Bradley 1975). Mean annual temperatures range from 18-20 C in the northern areas to 22-25 C in south Florida. Summer temperatures generally average in the high 20s but can range over 38 C. Thundershowers, however, can drop temperatures 6-12 C in a short period of time. Minimum winter temperatures generally average from 4 C to 9 C in north Florida and from 10 C to 15 C in south Florida. Strong cold fronts, however, can drop temperatures throughout Florida below 0 C.

Atmospheric precipitation in the form of rain is the major source of water in Florida (Hughes et al. 1971). Rainfall generally averages around 135 cm/yr but varies from 102 cm/yr in the Florida keys to more than 163 cm/yr in southeast and northwest Florida (Figure 1). This rainfall, however, tends to be highly seasonal (Figure 2). Rainfall is normally greatest between June and September when summer thunderstorms and hurricanes occur. These storms generally provide over half of the annual rainfall (Bradley 1975). Winter tends to be the season with the least rainfall (Bradley 1975). Large seasonal and annual variations, however, characterize rainfall throughout Florida; thus, droughts and floods are common (Bradley 1975). Because mean annual evaporation rates vary from 117 cm/yr to 137 cm/yr (Kohler et al. 1959), droughts can be very severe. In addition to seasonal and annual variations in the quantity of rainfall, the chemical quality of the rainfall can vary (Irwin and Kirkland 1980). On the average, sodium, chloride, and calcium tend to be the dominant ions, but Florida's rainfall also has relatively high concentrations of total nitrogen and total phosphorus (Table A).

Table A. Mean and range values for selected chemical parameters in Florida rainfall (From Irwin and Kirkland 1980).

Parameter	Mean	Range
pH	***	4.7-8.8
Specific Conductance (μmhos/cm)	32	20-66
Calcium (mg/l)	2.1	1.1-3.4
Sodium (mg/l)	1.7	0.5-4.4
Chloride (mg/l)	3.2	1.1-7.9
Iron (μg/l)	***	40-340
Total Nitrogen (mg/l)	1.1	0.5-2.4
Total Phosphorus (mg/l)	0.10	.03-.30

C. Geology

Florida is part of the eastern Gulf of Mexico sedimentary basin (Puri and Vernon 1964). Pressler (1947) has divided this basin into two sedimentary provinces; the North Gulf Coast and the Florida

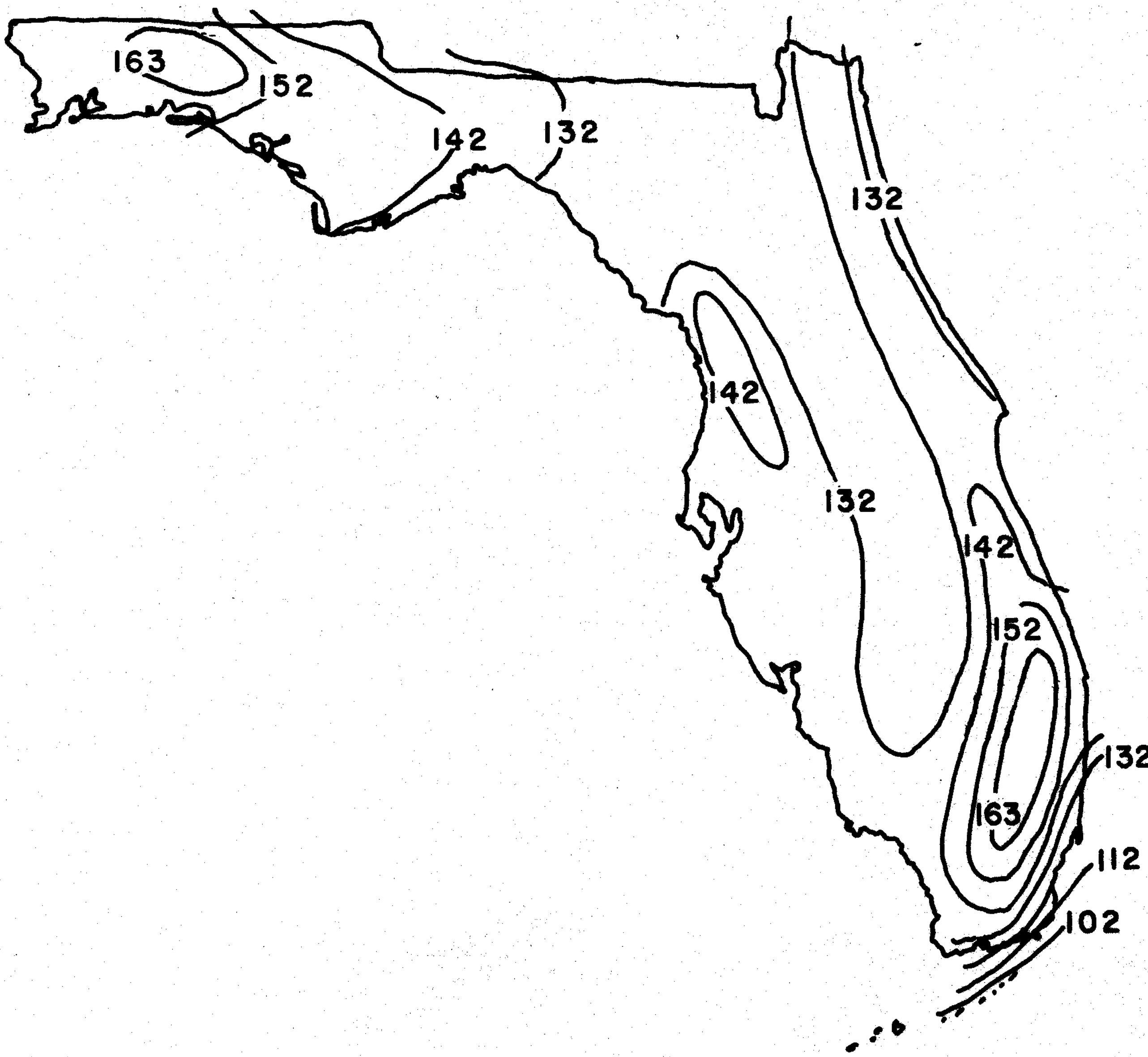

Figure 1. Mean annual rainfall (cm) in Florida. Modified from Hughes et al. (1971).

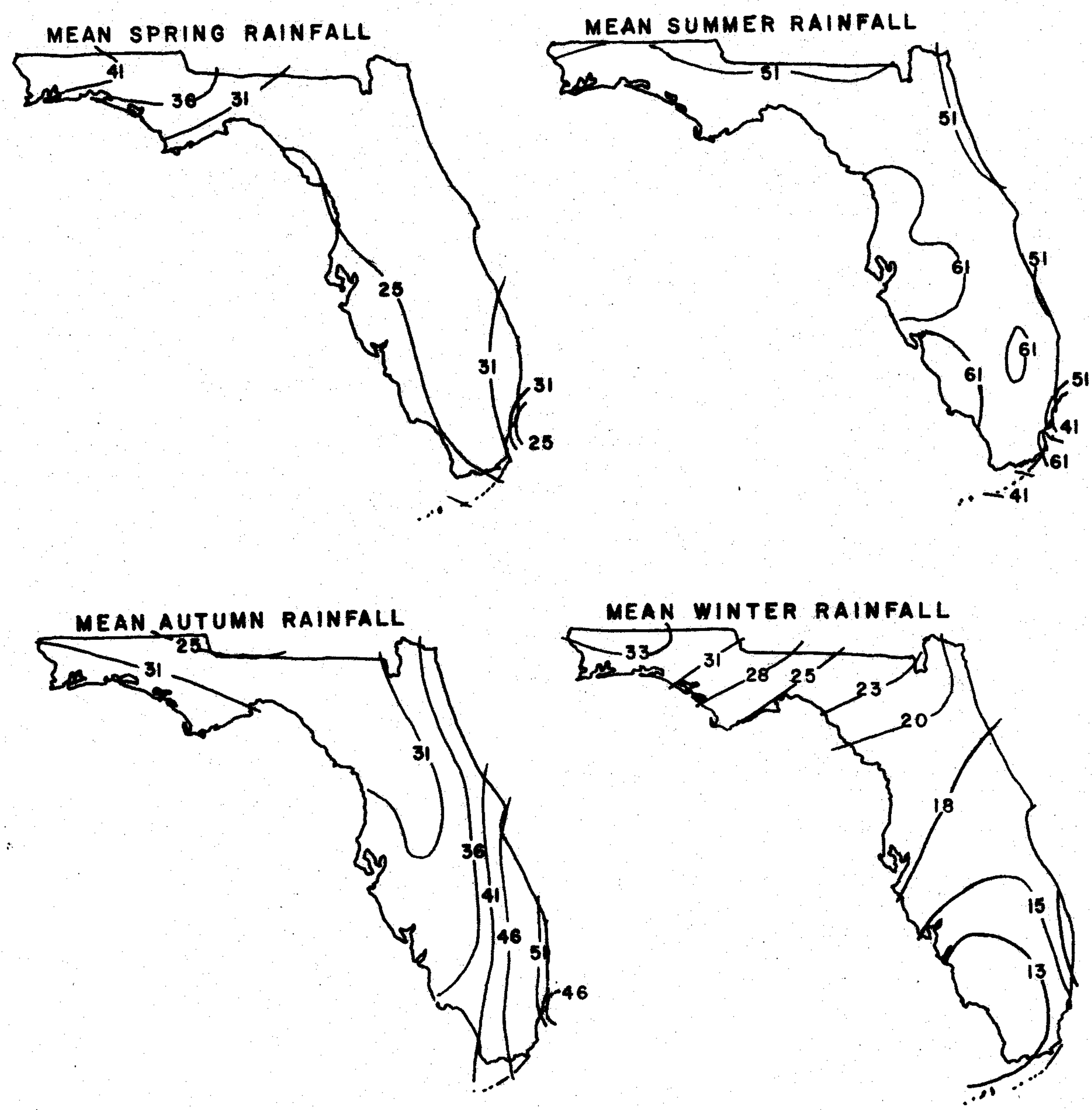

Figure 2. Mean seasonal rainfall (cm) in Florida. Modified from Hughes et al. (1971).

Peninsula. The North Gulf Coast sedimentary province, which includes all of Florida north of a line drawn between Levy and Nassau Counties, consists mainly of clastic sediments (Puri and Vernon 1964). The Florida Peninsula sedimentary province, which includes the Floridan Plateau of which present-day peninsular Florida is a part, consists mainly of carbonates and anhydrites (Puri and Vernon 1964).

Present-day surface geology in Florida is shown in Figure 3. This geology has been strongly influenced by the rise and fall of sea level. From the Cretaceous to the end of the Oligocene, sediments containing calcium and magnesium carbonates were deposited throughout much of Florida (Puri and Vernon 1964). Only in western Florida, where streams deposited clastics, were non-calcareous sediments deposited. Sedimentary deposits consisted of essentially pure calcium carbonate until late Tertiary times. After the Oligocene, streams began to encroach from the mainland and deposit large amounts of clastic sediments over calcareous sediments (Puri and Vernon 1964). During the Miocene, sediments containing large amounts of phosphorite, allapulgite, and kaolin were deposited (Puri and Vernon 1964). During the last geological period, the Pliestocene, deposits consisted mostly of sand (Puri and Vernon 1964). Deposits during the Recent have largely been alluviums, freshwater marls, peats and muds, and phosphorus enriched estuarine deposits (Puri and Vernon 1964).

D. Topography

The State of Florida lies in the Coastal Plain Province, a major physiographic division of the United States (Fenneman 1938). Topography, which has been described in detail by Matson and Sanford (1913), Fenneman

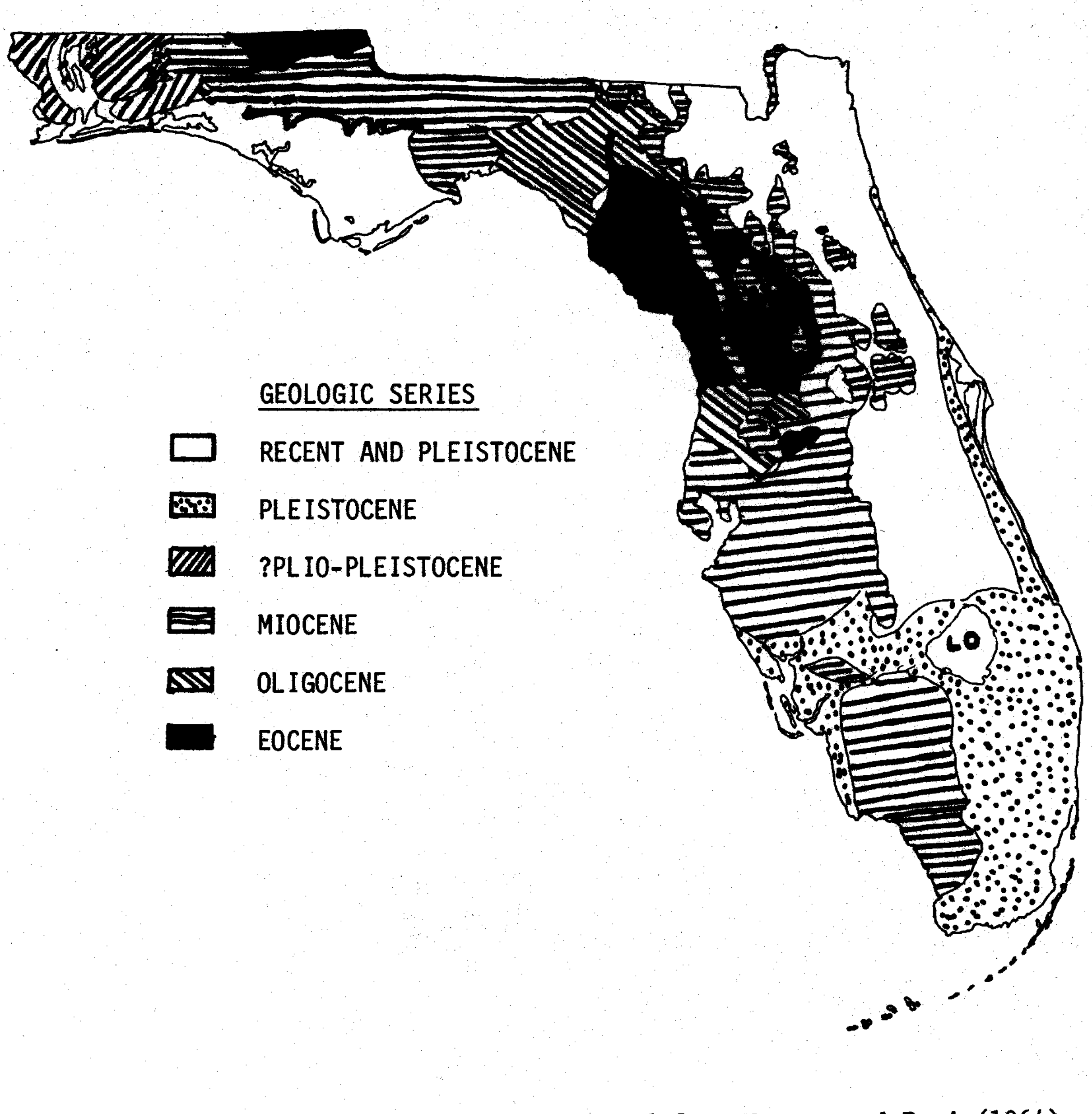

Figure 3. Geologic map of Florida. Modified from Vernon and Puri (1964). LO = Lake Okeechobee.

(1938), Cooke (1945), White (1958, 1970), and Puri and Vernon (1964), is relatively flat with elevations ranging from sea level to a high of approximately 105 m. Nearly 7% or 9,800 km^2 of Florida's total surface area is water (Pride and Crooks 1962). Florida also has over 13,000 km of coastline and no inland point in Florida is further than 113 km from saltwater.

Florida can be divided into three major physiographic zones: the Northern, Central, and Southern zones (Figure 4; Puri and Vernon 1964; White 1970). The Northern physiographic zone is distinguished by a region of continuous high ground which forms a broad upland in north Florida. Most of the Northern zone is above the piezometric surface (White 1970); therefore the region is characterized by features of dry highland or dead zone karst. Dry sinkholes, springheads, and beds of former broad shallow lakes abound and there are many lakes which periodically drain dry (White 1970). The Central physiographic zone is characterized by discontinuous highlands (White 1970). These highlands form subparallel ridges and are generally separated by broad valleys. The ridges are generally above the piezometric surface while the valley floors are generally below it (White 1970). Sinkhole lakes are common on the ridges, while broad shallow lakes are common on the valley floors. The Southern physiographic zone is characterized by large expanses of wetlands (Puri and Vernon 1964; White 1970). The entire area is generally below the piezometric level, but other than Lake Okeechobee, the region contains few lakes. Each major physiographic region, however, can be divided into additional distinct subdivisions of variable character (Figure 4).

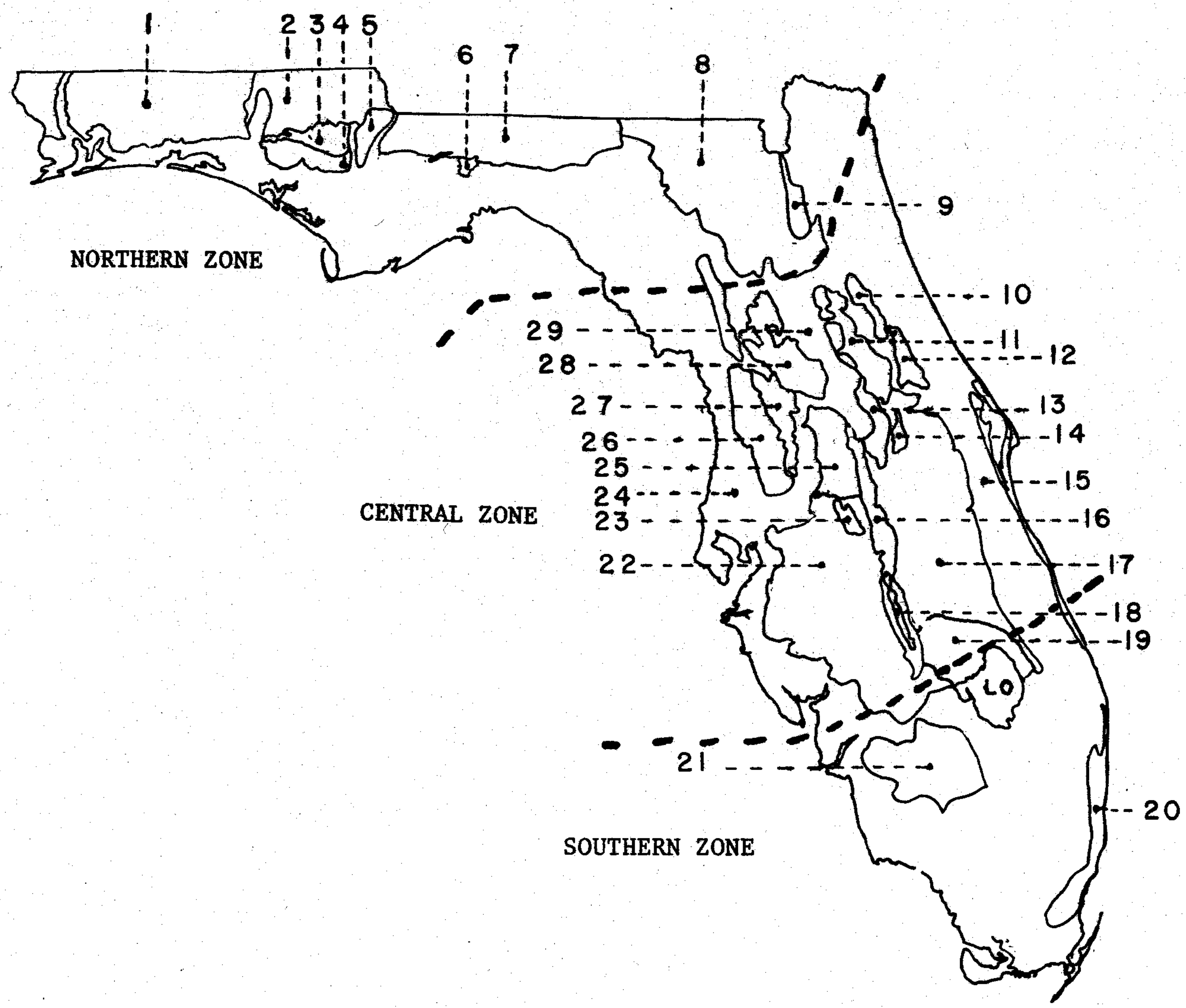

Figure 4. Physiographic map of Florida. Modified from Puri and Vernon (1964) and White (1970). Regions are: 1) Western Highlands; 2) Marianna Lowlands; 3) New Hope Ridge; 4) Greenhead Slope; 5) Grand Ridge; 6) Lake Munson Hills; 7) Tallahassee Hills; 8) Northern Highlands; 9) Trail Ridge; 10) Crescent City Ridge; 11) Marion Upland; 12) Deland Ridge; 13) Mount Dora Ridge; 14) Orlando Ridge; 15) Eastern Valley; 16) Lake Wales Ridge; 17) Osceola Plain; 18) Intraridge Valley; 19) Okeechobee Plain; 20) Atlantic Coastal Ridge; 21) Immokalee Rise; 22) Polk Upland; 23) Winter Haven Ridge; 24) Gulf Coastal Lowlands; 25) Lake Upland; 26) Brooksville Ridge; 27) Tsala Apopka Plain; 28) Sumter Upland; 29) Central Valley. LO = Lake Okeechobee.

METHODS

A. Sampling Methods

Between September 1, 1979 and August 30, 1980, surface water (0.5 m) samples were collected by boat on three occasions from 165 lakes located throughout Florida (Table 1). Lakes thought to be representative of Florida's physiographic regions were selected for study. At each lake, water samples were collected at three midlake locations in acid-cleaned nalgene bottles. On larger lakes, like Lake Okeechobee, samples were collected from near-shore waters. All samples were placed on ice and transported by truck to the laboratory at Gainesville, Florida for analysis.

B. Physical Measurements

Water clarity at each lake was measured at each sampling site by use of a 20 cm black and white Secchi disc. Water temperatures were measured in the deepest area of each lake at 1 m intervals from the surface to the bottom by use of a Yellow Springs Instrument Company Model 51A oxygen-temperature meter. All temperature measurements are listed in Appendix A.

C. Chemical Measurements

The following chemical analyses were made on unfiltered water samples. Specific conductance was measured by use of a Yellow Springs Instrument Company Model 31 conductivity bridge. An Orion Model 601A pH meter was used to measure pH. Total and phenol alkalinity was determined by titration with 0.02 N sulfuric acid (A.P.H.A. 1976). Endpoint determination was made by use of an Orion 601A pH meter and phenolphthalein and bromcresol green-methyl red indicators. Total

Table 1. Florida lakes sampled between September 1979 and August 1980. Numbers in parenthesis after each lake type indicate: (1) Lakes with streams flowing into them; (2) Lakes with streams flowing out of them; (3) Lakes with streams flowing both in and out of them; (4) Lakes that are landlocked (From Florida Board of Conservation 1969).

LAKE	TYPE	COUNTY	LOCATION	PHYSIOGRAPHIC REGION
Lake Agnes	Natural(4)	Polk	T27S R25E S4	Winter Haven Ridge
Alligator Lake	Natural(1)	Columbia	T4S R17E S5	Northern Highlands
Alligator Lake	Natural(3)	Osceola	T26S R31E S28	Osceola Plain
Lake Apopka	Natural(3)	Lake/Orange	T22S R26E S1	Central Valley
Lake Arbuckle	Natural(3)	Polk	T32S R29E S10	Osceola Plain
Ariana Lake	Natural(2)	Polk	T28S R25E S3	Winter Haven Ridge
Lake Arietta	Natural(2)	Polk	T27S R25E S28	Winter Haven Ridge
Lake Ashby	Natural(3)	Volusia	T18S R32E S14	Eastern Valley
Lake Baldwin	Natural(3)	Orange	T22S R30E S16	Orlando Ridge
Bear Lake	Impoundment(3)	Santa Rosa	T4N R26W S10	Western Highlands
Blue Cypress Lake	Natural(3)	Indian River	T32S R36E	Eastern Valley
Lake Broward	Natural(2)	Putnam	T11S R27E S29	Crescent City Ridge
Lake Buffam	Natural(1)	Polk	T31S R26E S12	Polk Upland
Lake Butler	Natural(3)	Orange	T23S R28E S18	Mount Dora Ridge
Lake Butler	Natural(3)	Union	T5S R20E S30	Northern Highlands
Carr Lake	Natural(3)	Leon	T2N R1W S13	Tallahassee Hills
Charles' Bay (Smith Lake)	Natural(3)	Washington	T4N R14W S19	Marianna Lowlands
Cherry Lake	Natural(4)	Madison	T3N R9E S34	Tallahassee Hills
Lake Clinch	Natural(4)	Polk	T31S R28E S31	Polk Upland

Table 1. (cont.)

LAKE	TYPE	COUNTY	LOCATION	PHYSIOGRAPHIC REGION
Compass Lake	Natural(2)	Jackson	T2N R12W S1	New Hope Ridge
Lake Conway	Natural(3)	Orange	T23S R30E S19	Orlando Ridge
Corn Landing Lake	Natural(4)	Franklin	T6S R2W S16	Gulf Coastal Lowlands
Crescent Lake	Natural(2)	Lake	T23S R25E S12	Lake Upland
Crescent Lake	Natural(3)	Flagler/Putnam	T12S R28E S20	Eastern Valley
Crews Lake	Natural(3)	Pasco	T24S R18E S20	Gulf Coastal Lowlands
Lake Crosby	Natural(1)	Bradford	T6S R21E S25	Northern Highlands
Crystal Lake	Natural(4)	Washington	T1N R15W S25	Greenhead Slope
Cypress Lake	Natural(3)	Osceola	T28S R30E S1	Osceola Plain
Dead Lake	Impoundment(3)	Calhoun/Gulf	T4S R9W S18	Gulf Coastal Lowlands
Lake Deaton	Natural(3)	Sumter	T19S R23E S14	Sumter Upland
Deer Point Lake	Impoundment(3)	Bay	T2S R14W S36	Gulf Coastal Lowlands
Lake Dexter	Natural(3)	Volusia/Lake	T16S R28E S15	St. Johns River Offset
Lake Dias	Natural(3)	Volusia	T15S R30E S29	Eastern Valley
Dinner Lake	Natural(4)	Highlands	T34S R29E S17	Lake Wales Ridge
Lake Disston	Natural(3)	Flagler	T14S R29E S17	Eastern Valley
Lake Dora	Natural(3)	Lake	T19S R26E S33	Central Valley
Lake Dorr	Natural(3)	Lake	T17S R27E S21	Marion Upland
Lake Down	Natural(3)	Orange	T23S R28E S8	Mount Dora Ridge
Dunford Pond	Natural(4)	Washington	T2N R14W S30	Greenhead Slope
Eagle Lake	Natural(2)	Polk	T29S R25E S1	Winter Haven Ridge
Lake Eaton	Natural(3)	Marion	T14S R24E S23	Central Valley

Table 1. (cont.)

LAKE	TYPE	COUNTY	LOCATION	PHYSIOGRAPHIC REGION
Lake Ellen	Natural(1)	Wakulla	T4S R2W S23	Gulf Coastal Lowlands
Lake Eustis	Natural(3)	Lake	T19S R26E S17	Central Valley
Lake Fairview	Natural(4)	Orange	T22S R29E S10	Orlando Ridge
Gap Pond	Natural(1)	Washington	T2N R13W S30	Greenhead Slope
Lake Geneva	Natural(3)	Clay	T8S R23E S29	Northern Highlands
Lake Gentry	Natural(3)	Osceola	T27S R31E S8	Osceola Plain
Lake George	Natural(3)	Volusia/Putnam	T14S R27E S3	St. Johns River Offset
Lake Gibson	Natural(3)	Polk	T27S R23E S25	Polk Upland
Lake Griffin	Natural(3)	Lake	T27S R25E S18	Central Valley
Hampton Lake	Natural(3)	Bradford	T7S R21E S26	Northern Highlands
Lake Harney	Natural(3)	Seminole/Volusia	T20S R32E S13	Eastern Valley
Lake Harris	Natural(3)	Lake	T19S R25E S26	Central Valley
Lake Hart	Natural(3)	Orange	T24S R31E S22	Osceola Plain
Lake Hatchineha	Natural(3)	Polk/Osceola	T28S R29E S19	Osceola Plain
Lake Howard	Natural(3)	Polk	T28S R26E S30	Winter Haven Ridge
Lake Huntley	Natural(3)	Highlands	T37S R30E S5	Lake Wales Ridge
Hurricane Lake	Impoundment(3)	Okaloosa	T5N R25W S7	Western Highlands
Lake Iamonia	Natural(3)	Leon	T3N R1E S23	Tallahassee Hills
Lake Iola	Natural(2)	Pasco	T24S R20E S15	Brooksville Ridge
Lake Istokpoga	Natural(3)	Highlands	T36S R30E S24	Okeechobee Plain
Lake Jackson	Natural(2)	Highlands	T34S R28E S25	Intraridge Valley
Lake Jackson	Natural(1)	Leon	T2N R1W S34	Tallahassee Hills

Table 1. (cont.)

LAKE	TYPE	COUNTY	LOCATION	PHYSIOGRAPHIC REGION
Lake Jackson	Natural(2)	Walton	T6N R21W S27	Western Highlands
Lake Jessamine	Natural(3)	Orange	T23S R29E S14	Orlando Ridge
Lake Jessup	Natural(3)	Seminole	T20S R30E S25	St. Johns River Offset
Johns Lake	Natural(3)	Lake/Orange	T22S R26E S25	Lake Wales Ridge
Lake Josephine	Natural(3)	Highlands	T35S R29E S28	Intraridge Valley
Juniper Bay	Impoundment(3)	Walton	T3N R19W S10	Western Highlands
Karick Lake	Impoundment(3)	Okaloosa	T5N R24W S33	Western Highlands
Lake Kerr	Natural(4)	Marion	T13S R25E S21	Marion Upland
Kingsley Lake	Natural(3)	Clay	T6S R23E S22	Trail Ridge
Lake Kissimmee	Natural(3)	Osceola	T30S R31E S27	Osceola Plain
Lawne Lake	Natural(3)	Orange	T22S R29E S20	Osceola Plain
Lake Lindsey	Natural(4)	Hernando	T21S R19E S25	Brooksville Ridge
Little Crooked Lake	Natural(3)	Polk	T31S R27E S23	Polk Upland
Little Red Water Lake	Natural(3)	Highlands	T34S R28E S12	Intraridge Valley
Lochloosa Lake	Natural(3)	Alachua	T11S R22E S20	Central Valley
Lake Lotela	Natural(3)	Highlands	T33S R28E S26	Lake Wales Ridge
Lake Louisa	Natural(3)	Lake	T23S R26E S17	Lake Upland
Lake Louise	Natural(2)	Suwannee	T2S R14E S13	Northern Highlands
Lake Lowery	Natural(4)	Polk	T27S R26E S23	Polk Upland
Lowry Lake	Natural(3)	Clay	T7S R23E S33	Trail Ridge
Lake Maggiore	Natural(3)	Pinellas	T31S R16E	Gulf Coastal Lowlands
Magnolia Lake	Natural(3)	Clay	T8S R23E S5	Trail Ridge

Table 1. (cont.)

LAKE	TYPE	COUNTY	LOCATION	PHYSIOGRAPHIC REGION
Lake Maitland	Natural(3)	Orange	T21S R30E	Orlando Ridge
Lake Manatee	Impoundment(3)	Manatee	T34S R20E S32	Gulf Coastal Lowlands
Lake Margaret	Natural(4)	Putnam	T12S R27E S19	Crescent City Ridge
Lake Marian	Natural(3)	Osceola	T30S R33E S18	Osceola Plain
Lake Marion	Natural(3)	Polk	T28S R28E S8	Lake Wales Ridge
Lake Mary Jane	Natural(3)	Orange	T24S R31E S23	Osceola Plain
Lake McKenzie	Natural(3)	Calhoun	T1N R11W S2	New Hope Ridge
Merial Lake	Natural(1)	Bay	T1S R14W S19	Greenhead Slope
Merritts Mill Pond	Impoundment(3)	Jackson	T5N R9W S32	Marianna Lowlands
Lake Minnehaha	Natural(3)	Lake	T22S R25E S36	Lake Upland
Lake Minneola	Natural(3)	Lake	T22S R25E S13	Lake Upland
Lake Miona	Natural(3)	Sumter	T18S R23E S22	Sumter Upland
Mirrow Lake	Natural(4)	Calhoun	T2N R11W S33	New Hope Ridge
Lake Monroe	Natural(3)	Seminole/Volusia	T19S R30E S19	St. Johns River Offset
Moon Lake	Natural(4)	Pasco	T25S R17E S28	Gulf Coastal Lowlands
Mountain Lake	Natural(3)	Hernando	T23S R20E S16	Brooksville Ridge
Lake Munson	Natural(3)	Leon	T1S R1W S26	Lake Munson Hills
Mystic Lake	Natural(4)	Madison	T1N R9E S17	Tallahassee Hills
Newnans Lake	Natural(3)	Alachua	T10S R21E S17	Central Valley
Ocean Pond	Natural(4)	Baker	T3S R19E S17	Northern Highlands
Ocheesee Pond	Natural(3)	Jackson	T3N R7W S18	Grand Ridge
Lake Okahumpka	Natural(3)	Sumter	T19S R23E S21	Sumter Upland

Table 1. (cont.)

LAKE	TYPE	COUNTY	LOCATION	PHYSIOGRAPHIC REGION
Lake Okeechobee	Natural(3)	Okeechobee/Martin Glades/Palm Beach/ Hendry	T38S R35E	Okeechobee Plain
Orange Lake	Natural(3)	Alachua	T12S R21E S11	Central Valley
Osborne Lake	Natural(3)	Palm Beach	T44S R43E S32	Atlantic Coastal Ridge
Otter Lake	Natural(1)	Wakulla	T5S R2W S27	Gulf Coastal Lowlands
Oyster Lake	Natural(1)	Walton	T3S R20W S3	Gulf Coastal Lowlands
Lake Padgett	Natural(4)	Pasco	T26S R18E S24	Gulf Coastal Lowlands
Palestine Lake (South Prong Pond)	Natural(4)	Union	T4S R19E S27	Northern Highlands
Lake Panasoffkee	Natural(3)	Sumter	T19S R22E S33	Tsala Apopka Plain
Lake Parker	Natural(3)	Polk	T28S R24E S8	Polk Upland
Lake Pasadena	Natural(4)	Pasco	T25S R21E S8	Brooksville Ridge
Pate Pond	Natural(3)	Washington	T3N R15W S4	Marianna Lowlands
Lake Pierce	Natural(1)	Polk	T29S R28E S9	Lake Wales Ridge
Lake Placid	Natural(3)	Highlands	T37S R30E S19	Intraridge Valley
Lake Poinsett	Natural(3)	Brevard	T25S R35E S4	Eastern Valley
Red Beach Lake	Natural(2)	Highlands	T35S R29E S15	Lake Wales Ridge
Reedy Lake	Natural(2)	Polk	T31S R28E S34	Lake Wales Ridge
Lake Rosalie	Natural(3)	Polk	T29S R29E S27	Osceola Plain
Round Lake	Natural(4)	Jackson	T3N R12W S24	New Hope Ridge
Lake Rousseau	Impoundment(3)	Levy/Marion/Citrus	T16S R17E S36	Gulf Coastal Lowlands
Lake Rowell	Natural(3)	Bradford	T7S R21E S1	Northern Highlands

Table 1. (cont.)

LAKE	TYPE	COUNTY	LOCATION	PHYSIOGRAPHIC REGION
Lake Sampson	Natural(3)	Bradford	T6S R21E S34	Northern Highlands
Santa Fe Lake	Natural(3)	Alachua	T9S R22E	Northern Highlands
Lake Sebring	Natural(3)	Highlands	T34S R28E S14	Intraridge Valley
Sellers Lake	Natural(3)	Marion/Lake	T16S R27E S7	Marion Upland
Lake Seminole	Impoundment(3)	Gadsden/Jackson	T4N R7W S15	Marianna Lowlands
Lake Seminole	Impoundment(3)	Pinellas	T30S R15E S22	Gulf Coastal Lowlands
Smith Lake	Natural(2)	Marion	T16S R23E S27	Sumter Upland
Lake Stanley	Natural(2)	Walton	T3N R19W S22	Western Highlands
Lake Stella	Natural(3)	Putnam	T12S R27E S25	Crescent City Ridge
Sun Lake	Impoundment(3)	Holmes	T3N R15W S13	Marianna Lowlands
Lake Susan	Natural(3)	Lake	T23S R25E S1	Lake Upland
Suwannee Lake	Impoundment(3)	Suwannee	T2S R14E S20	Northern Highlands
Lake Talquin	Impoundment(3)	Gadsden/Leon	T1N R3W S27	Tallahassee Hills
Lake Tarpon	Natural(3)	Pinellas	T27S R16E S33	Gulf Coastal Lowlands
Lake Thonotosassa	Natural(3)	Hillsborough	T28S R20E S11	Gulf Coastal Lowlands
Tiger Lake	Natural(3)	Polk	T30S R29E S1	Osceola Plain
Tigertail	Barrow Pit(4)	Broward	T50S R42E S33	Atlantic Coastal Ridge
Lake Tohopekaliga	Natural(3)	Osceola	T27S R30E S5	Osceola Plain
East Lake Tohopekaliga	Natural(3)	Osceola	T25S R30E S35	Osceola Plain
Townsend Pond (Koon Lake)	Natural(4)	Lafayette	T5S R12E S21	Gulf Coastal Lowlands
Lake Trafford	Natural(3)	Collier	T46S R28E S35	Immokalee Rise
Tsala Apopka Lake (Hernando Pool)	Natural(3)	Citrus	T18S R19E S13	Tsala Apopka Plain

Table 1. (cont.)

LAKE	TYPE	COUNTY	LOCATION	PHYSIOGRAPHIC REGION
Turkey Pen Pond	Natural(4)	Calhoun	T2N R11W S24	New Hope Ridge
Lake Underhill	Natural(4)	Orange	T22S R30E S32	Orlando Ridge
Upper Myakka Lake	Natural(3)	Sarasota	T37S R20E S10	Gulf Coastal Lowlands
Lake Victor	Impoundment(3)	Holmes	T5N R17W S12	Marianna Lowlands
Lake Virginia	Natural(3)	Orange	T22S R30E S8	Orlando Ridge
Lake Wales	Natural(4)	Polk	T30S R27E S1	Lake Wales Ridge
Lake Washington	Natural(3)	Brevard	T27S R36E S8	Eastern Valley
Watertown Lake	Natural(4)	Columbia	T3S R17E S34	Northern Highlands
Lake Wauberg	Natural(4)	Alachua	T11S R20E	Central Valley
Lake Weir	Natural(2)	Marion	T17S R24E S8	Sumter Upland
Lake Weohyakapka	Natural(3)	Polk	T31S R29E S3	Osceola Plain
Western Lake	Natural(3)	Walton	T3S R19W S16	Gulf Coastal Lowlands
Wildcat Lake	Natural(3)	Lake	T15S R27E S30	Marion Upland
Lake Wimico	Natural(3)	Gulf	T8S R9W S5	Gulf Coastal Lowlands
Lake Winnemissett	Natural(4)	Volusia	T17S R30E S13	Deland Ridge
Lake Yale	Natural(3)	Lake	T18S R26E S20	Central Valley

and calcium hardness concentrations were determined by titration with HexaVer chelating reagent (Hach Chemical Company 1975). ManVer hardness indicator and CalVer calcium indicator (Hach Chemical Company 1975) were used for endpoint determination. Calcium concentrations were calculated from calcium hardness concentrations while magnesium concentrations were estimated from the difference between total and calcium hardness concentrations. Chloride concentrations were determined by titration with 0.0141 N mercuric nitrate. Diphenylcarbazone was used for endpoint determination (A.P.H.A. 1976). Silica concentrations were determined by using the heteropoly blue method (A.P.H.A. 1976) and total iron concentrations were determined by using the ferrozine method (Hach Chemical Company 1975). Total phosphorus concentrations were determined by using the procedures of Murphy and Riley (1962) with a persulfate digestion (Menzel and Corwin 1965). Total nitrogen concentrations were determined by using a modified Kjeldahl technique described by Nelson and Sommers (1975).

The following chemical analyses were made on water which was filtered through a Gelman type A-E glass fiber filter. Sulfate concentrations were determined by use of a turbidimetric method with SulfaVer IV sulfate reagent (Hach Chemical Company 1975). Color was determined by use of the platinum-cobalt method and Nessler tubes (A.P.H.A. 1976). Sodium and potassium concentrations were determined by flame photometry (A.P.H.A. 1976). Results of all mineral analyses were expressed in meq/l. With few exceptions, the balance between positive and negative ions (as meq/l) in each lake was within the range found acceptable by Golterman (1969). Results from individual analyses are found in Appendix B.

D. Biological Measurements

The concentration of plankton algae in each lake was estimated by measuring chlorophyll a concentrations. For chlorophyll a analysis, a measured volume of lake water was filtered through a Gelman type A-E glass fiber filter. Filters were stored over dessicant and frozen until analyses could be completed. Chlorophyll a concentrations were determined by using the methods of Richards with Thompson (1952) and Yentsch and Menzel (1963). Chlorophyll a values were calculated by using the equations of Parsons and Strickland (1963). Corrections for phaeophytin were not made. Results of individual analyses are listed in Appendix B.

RESULTS AND DISCUSSION

A. Chemical and Trophic State Characteristics of Lakes Located in Northern Physiographic Zone.

1. Western Highlands: The Western Highlands is a gently sloping plateau located in portions of Escambia, Santa Rosa, Okaloosa, Walton, and Holmes counties (Figure 4). This region is a remnant of the continuous highlands which once stretched across north Florida. Throughout the region, numerous streams dissect the plateau. The eastern portion of the Western Highlands is composed largely of fossiliferous marl from the Chipola Formation while the western portion consists mostly of sands, gravels, and clays from the Citronelle Formation (Vernon and Puri 1964). The region has very few natural lakes and these exist primarily in the eastern portion of the highlands. In this study, 6 lakes including 2 natural (Lake Jackson and Lake Stanley) and 4 artificial (Bear Lake, Hurricane Lake, Juniper Bay and Lake Karick) lakes were sampled. Data for these lakes are presented in Table 2.

Based on the collected data, the lakes of the Western Highlands can be characterized as acidic, soft-water lakes. Mean pH values ranged from 4.5 to 6.4 and mean total alkalinity concentrations ranged from 2 to 9 mg/l as $CaCO_3$. Mean total hardness concentrations ranged from 2.1 to 10 mg/l as $CaCO_3$ and mean calcium hardness concentrations ranged from 0.7 to 4.6 mg/l as $CaCO_3$. In general, the artificial lakes had lower average values than the natural lakes, which are located in the Chipola Formation. The only exception was Lake Karick, which was being artificially limed

Table 2.. Means of limnological parameters measured in lakes located in the Western Highlands. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Bear Lake	4.5 (3.6-5.8)	2 (0-3)	0 (0-0)	16 (14-18)	2.6 (2.0-3.0)	0.7 (0.5-1.0)	2.3 (2.1-2.7)	0.2 (0.1-0.3)	2.9 (2.5-3.3)
Hurricane Lake	5.7 (5.5-5.9)	3 (2-3)	0 (0-0)	14 (13-16)	2.3 (2.0-2.5)	1.1 (1.0-1.5)	2.0 (1.7-2.4)	0.2 (0.1-0.3)	2.6 (2.3-3.0)
Lake Jackson	6.4 (6.2-6.6)	4 (4-5)	0 (0-0)	19 (18-22)	4.8 (4.5-5.1)	2.9 (2.5-3.5)	1.8 (1.6-2.3)	0.4 (0.2-0.6)	2.6 (2.3-2.8)
Juniper Bay	5.5 (5.3-5.8)	2 (1-3)	0 (0-0)	13 (12-13)	2.1 (1.8-2.5)	1.2 (0.9-1.5)	1.8 (1.5-2.1)	0.2 (0.2-0.2)	2.1 (1.8-2.5)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 · Pt)	SECCHI (m)
Bear Lake	6.8 (0-12.8)	0.7 (0.1-1.0)	709 (460-1200)	337 (175-508)	15.5 (5.2-33.0)	10.9 (2.3-25.1)	30 (10-35)	1.6 (1.4-2.0)
Hurricane Lake	5.6 (0-13.6)	0.7 (0.3-0.9)	415 (234-634)	317 (175-475)	11.1 (5.0-15.5)	2.7 (1.4-4.1)	16 (10-20)	3.5 (2.9-4.3)
Lake Jackson	4.6 (0-9.8)	0.2 (0.1-0.4)	120 (81.1-167)	359 (292-417)	13.7 (6.5-21.5)	2.8 (1.7-4.6)	10 (5-15)	2.7 (1.7-3.3)
Juniper Bay	4.6 (0-10)	0.2 (0.0-0.5)	758 (125-1200)	388 (333-450)	19.7 (16.2-26.7)	7.5 (4.1-10.2)	17 (10-20)	2.4 (1.8-3.3)

Table 2. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Karick Lake	6.0 (5.6-6.7)	9 (2-21)	0 (0-0)	28 (13-50)	10 (3.0-21)	4.6 (1.5-10)	2.0 (1.7-2.3)	0.3 (0.1-0.5)	2.6 (2.0-3.0)
Lake Stanley	6.1 (5.8-6.3)	3 (2-4)	0 (0-0)	20 (18-26)	4.2 (3.5-5.0)	2.4 (2.0-3.5)	2.8 (2.4-3.1)	0.3 (0.1-0.5)	3.1 (3.0-3.5)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Karick Lake	6.5 (2.8-11)	1.0 (0.4-1.6)	427 (295-583)	239 (66.6-375)	19.0 (6.3-46.3)	3.8 (2.6-4.7)	20 (10-25)	2.9 (2.1-3.5)
Lake Stanley	4.7 (0-9.7)	0.2 (0.1-0.3)	59.4 (42.0-86.9)	346 (267-395)	11.1 (6.7-18.6)	3.3 (1.5-6.2)	8 (5-10)	2.5 (1.9-3.0)

Table 3. Mean percentage of major cations and anions in lakes located in the Western Highlands.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Bear Lake	8	20	56	2	13	0	55	32
Hurricane Lake	14	17	57	3	21	0	49	30
Lake Jackson	31	20	42	5	33	0	38	30
Juniper Lake	16	12	51	3	19	0	50	31
Karick Lake	30	35	28	2	47	0	35	19
Lake Stanley	23	16	56	4	23	0	40	37

and fertilized to enhance fish production (Mr. Norman Young, Florida Game and Fresh Water Fish Commission, personal communication).

Mineral content of lakes in this region is extremely low (Table 2). Mean specific conductance ranged from 13 to 28 µmhos/cm. In nearly all the lakes, the dominant cation was sodium and the dominant anions were sulfate and chloride (Table 3). Exceptions include Lake Karick, which was being limed, and Lake Jackson which received surface inputs from the fossiliferous marl deposits of the Chipola Formation. Based on criteria established by Gibbs (1970) and a comparison of chemical analyses on Florida rainfall (Table A), atmospheric precipitation seems to be the dominant mechanism controlling the chemical composition of the lakes. Surface geology does not greatly influence lake water chemistry, largely because surface and subsurface flows come from sandy, non-calcereous soils.

Table 4 shows some of the general characteristics of oligotrophic, mesotrophic, and eutrophic lakes. For the lakes sampled in this study

Table 4. Generalized trophic state classification standards. Compressed from Likens (1975).

Trophic Status	Total Phosphorus (mg/m^3)	Total Nitrogen (mg/m^3)	Chlorophyll *a* (mg/m^3)
Oligotrophic	0-10	1-600	0-3
Mesotrophic	10-30	500-1100	2-15
Eutrophic	>30	>1000	>15

(Table 2), mean total phosphorus values ranged from 11.1 to 19.7 mg/m^3, which is in the range reported for mesotrophic lakes. Mean total nitrogen

Table 5. Means of limnological parameters measured in lakes located in the Western Highlands. Numbers in parentheses are the minimum and maximum values measured. Period of record 1967-1973. Data from Holcomb (1968,1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Bear Lake	5.2 (4.7-5.6)	5.8 (4.6-7.5)	2.3 (1.0-5.0)	0.0 (0.0-0.0)	30 (20-44)	4.8 (2.0-11)	0.9 (0.0-3.8)	0.3 (0.1-0.6)	1.5 (0.9-1.9)
Karick Lake	5.3 (4.9-5.5)	5.6 (4.8-6.8)	3.1 (1.0-7.0)	0.0 (0.0-0.0)	29 (20-40)	4.8 (3.0-8.0)	0.5 (0.0-0.9)	0.3 (0.0-0.4)	1.6 (1.3-1.9)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
0.3 (0.0-0.9)	2.7 (2.5-3.0)	0.2 (0.0-1.5)	2.0 (1.9-2.1)	0.543 (0.190-0.800)	0.356 (0.060-0.800)	6.0 (0.0-12.8)	5 (5-5)	5.1 (3.2-7.0)
0.4 (0.1-0.9)	3.2 (2.8-4.0)	0.2 (0.0-0.8)	1.5 (0.6-2.3)	1.23 (0.510-2.23)	0.206 (0.040-0.710)	8.3 (6.4-10.7)	40 (30-50)	5.7 (3.8-10)

values, however, ranged between 239 and 388 mg/m^3 which is in the range reported for oligotrophic lakes. Chlorophyll a values ranged from an average of 2.7 mg/m^3, an oligotrophic characteristic, to 10.9 mg/m^3, a mesotrophic characteristic. Based on these data and similar long-term data collected by the Florida Game and Fresh Water Fish Commission on Bear Lake and Lake Karick (Table 5), the lakes of the Western Highlands probably should be classified as oligo-mesotrophic lakes.

2. Marianna Lowlands: The Marianna Lowlands are located in Holmes, Jackson, and Washington counties. This area encompasses 5,000 km^2 of lowland formed by stream and solution processes (Figure 4; Puri and Vernon 1964). The geology of the region is dominated by limestone of the Crystal River Formation and Marianna Limestone (Puri and Vernon 1964). Sand and clay, however, cover these limestone formations in many areas (Puri and Vernon 1964).

The region is generally well-drained. Numerous natural springs occur in this region, but there are few natural lakes. In this study, 6 lakes, including 1 natural (Pate Pond), and 5 artificial (Charles' Bay, Merritts Mill Pond, Lake Seminole, Sun Lake, and Lake Victor) lakes were sampled. Data are presented in Table 6.

With the exception of Merritts Mill Pond, an alkaline (mean pH 8.1), hard-water (mean total alkalinity 96 mg/l as $CaCO_3$; mean total hardness 104 mg/l as $CaCO_3$; mean calcium hardness 97 mg/l as $CaCO_3$,) spring-fed lake, the lakes of the Marianna Lowlands can be characterized as acidic, soft-water lakes. Mean pH values ranged from 4.5 to 6.8 and mean total alkalinity values ranged from 0 to 20 mg/l as $CaCO_3$. Mean total hardness concentrations ranged from 2.3 to 20 mg/l as $CaCO_3$ and calcium

Table 6. Means of limnological parameters measured on lakes located in the Marianna Lowlands. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Charles' Bay	5.0 (4.7-5.2)	2 (1-4)	0 (0-0)	11 (10-11)	2.4 (2.0-3.0)	1.3 (0.9-2.0)	1.4 (1.3-1.8)	0.2 (0-0.3)	1.7 (1.3-2.0)
Merritts Mill Pond	8.1 (7.6-8.5)	96 (93-99)	0 (0-2)	191 (185-198)	104 (98-109)	97 (90-100)	1.9 (1.4-2.2)	0.2 (0.1-0.3)	3.6 (3.5-4.0)
Pate Pond	4.6 (4.5-4.7)	0 (0-1)	0 (0-0)	20 (18-22)	2.6 (2.1-3.0)	1.4 (1.0-2.0)	1.9 (1.6-2.1)	0.2 (0.1-0.3)	2.5 (2.0-3.3)
Lake Seminole	6.8 (6.6-7.0)	20 (15-26)	0 (0-0)	66 (53-72)	20 (18-23)	16 (13-20)	5.8 (3.4-7.8)	1.4 (1.1-1.7)	3.3 (2.5-4.0)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Charles' Bay	4.7 (0-11)	0.3 (0-0.9)	736 (424-1200)	473 (431-553)	13.7 (0.3-34.8)	2.5 (1.1-4.8)	45 (30-70)	1.5 (1.0-1.7)
Merritts Mill Pond	7.6 (0-17)	6.4 (6.1-6.8)	6.6 (0-15)	1500 (919-1900)	19.3 (17.0-21.5)	1.1 (0.1-5.6)	2 (0-5)	BOTTOM (***-***)
Pate Pond	4.6 (0-8.6)	0.3 (0.1-0.4)	103 (88-114)	297 (237-396)	14.1 (8.6-30.6)	5.7 (2.4-12.8)	36 (15-60)	1.7 (1.3-2.5)
Lake Seminole	10 (5.4-17)	6.4 (5.7-7.0)	517 (276-1300)	514 (338-600)	43.6 (31.0-75.4)	10.6 (8.2-14.3)	20 (10-30)	0.5 (0.3-0.7)

Table 6. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Sun Lake	5.3 (5.0-5.5)	2 (1-2)	0 (0-0)	15 (15-17)	2.3 (2.0-2.5)	1.4 (1.0-2.0)	2.0 (1.8-2.3)	0.4 (0.3-0.5)	2.8 (2.3-3.5)
Lake Victor	5.7 (5.1-7.0)	6 (2-9)	0 (0-0)	25 (22-27)	8.7 (7.5-10)	5.8 (4.5-7.0)	1.8 (1.6-2.3)	0.5 (0.4-0.6)	2.9 (2.5-3.3)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Sun Lake	5.4 (0-14)	0 (0-0.1)	47 (25-59)	420 (392-460)	13.5 (6.0-21.5)	2.0 (1.0-3.6)	10 (5-15)	BOTTOM (***-***)
Lake Victor	4.8 (0-11)	0.4 (0.1-0.9)	258 (52-372)	294 (217-350)	12.4 (5.0-20.2)	2.8 (1.8-4.5)	15 (10-20)	2.7 (2.1-3.5)

Table 7. Mean percentage of major cations and anions in lakes located in the Marianna Lowlands.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Charles' Bay	19	15	44	3	21	0	53	26
Merrits Mill Pond	89	6	4	0	87	1	7	5
Pate Pond	20	16	57	4	4	0	55	41
Lake Seminole	46	10	36	5	57	0	30	13
Sun Lake	20	11	61	7	16	0	50	35
Lake Victor	42	21	29	4	40	0	33	27

hardness concentrations averaged 1.3 to 16 mg/l as $CaCO_3$. As reflected by the low average specific conductance values (range 11-66 µmhos/cm), the concentrations of sodium (1.4-5.8 mg/l), potassium (0.2-1.4 mg/l), chloride (1.7-3.3 mg/l) and sulfate (4.6-10 mg/l) were also low.

In Merritts Mill Pond, calcium was the dominant cation and bicarbonate was the dominant anion (Table 7.). This is typical of hard-water lakes of the bicarbondate type (Hutchinson 1957) and of Florida springs (Ferguson et al. 1947). The ionic composition of other lakes in the Marianna Lowlands, however, is variable (Table 7). In Pate Pond and Sun Lake, impermeable clays and sands isolate the lakes from the underlying limestone, thus sodium, sulfate, and chloride ions derived from atmospheric precipitation are dominant. In Charles' Bay, Lake Seminole, and Lake Victor the influence of surface geology is greater thus the ionic composition is mixed.

Based on criteria listed in Table 4 and data in Table 7, the trophic status of the lakes in the Marianna Lowlands would probably be characterized as oligo-mesotrophic or mesotrophic. With the exception of Merritts Mill Pond, mean total nitrogen values (297-514 mg/m^3) in these lakes were in the range reported for oligotrophic lakes. Total nitrogen, however, averaged 1500 mg/m^3 in Merritts Mill Pond, which is characteristic of eutrophic lakes. Mean total phosphorus values (13.5-43.6 mg/m^3) were characteristic of mesotrophic lakes. Only turbid Lake Seminole had an average phosphorus value (43.6 mg/m^3) in the eutrophic category. Algal biomass as measured by chlorophyll a concentrations was very low in Charles' Bay (mean chlorophyll a of 2.5 mg/m^3), Merritts Mill Pond (mean chlorophyll a of 1.1 mg/m^3), Sun Lake (mean chlorophyll a of 2.0 mg/m^3), and Lake Victor (mean chlorophyll a of 2.8 mg/m^3), thus suggesting the lakes are oligotrophic. All of these lakes, however, had maximum algal chlorophyll levels in the range reported for mesotrophic lakes and Merritts Mill Pond had substantial growths of submerged aquatic macrophytes. This suggests these lakes are best classified as oligo-mesotrophic or mesotrophic.

3. New Hope Ridge: The New Hope Ridge is a narrow, gently sloping plateau located in portions of Bay, Calhoun, Jackson, and Washington counties (Figure 4). The region is a remnant portion of the highlands which once stretched completely across north Florida. The geology of the region is dominated by sands of the Fort Preston Formation (Vernon and Puri 1964). As is typical of other regions in Florida dominated by this formation (Puri and Vernon 1964; White 1970), the New Hope Ridge contains numerous sinkhole lakes. Five of these lakes (Compass Lake, Lake McKenzie, Mirrow Lake, Round Lake, and Turkey Pen Pond) were sampled. Data are presented in Table 8.

From the data collected in this study, the lakes of the New Hope Ridge can be chemically characterized as acidic, soft-water lakes of extremely low mineral content. Mean pH values ranged from 4.7 to 6.3 and total alkalinity values averaged between 1 and 4 mg/l as $CaCO_3$. Total hardness concentrations averaged below 7 mg/l as $CaCO_3$, and mean calcium concentrations ranged between 1.2 and 4.7 mg/l as $CaCO_3$. Mean specific conductance ranged between 16 and 25 μmhos/cm. With the exception of Round Lake (several local residents have reported the presence of a small spring) sodium was the dominant cation and sulfate was the dominant anion (Table 9). The low salinity and mean ionic composition of the study lakes strongly suggest atmospheric precipitation

Table 8. Means of limnological parameters measured in lakes located on the New Hope Ridge. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Compass Lake	5.2 (5.1-5.4)	2 (1-2)	0 (0-0)	18 (17-18)	2.6 (1.5-3.5)	2.9 (2.0-3.5)	1.6 (1.0-2.1)	0.3 (0.2-0.4)	3.1 (3.0-3.3)
Lake McKenzie	4.7 (4.6-4.7)	1 (1-1)	0 (0-0)	16 (15-20)	1.5 (1.0-2.0)	1.2 (0.8-1.5)	1.7 (1.4-2.0)	0.1 (0-0.2)	2.0 (1.8-2.3)
Mirrow Lake	4.9 (4.8-4.9)	1 (0.6-1.0)	0 (0-0)	16 (16-16)	2.3 (1.6-3.0)	1.9 (1.3-3.0)	1.7 (1.2-2.3)	0.2 (0.1-0.3)	1.9 (1.8-2.3)
Round Lake	6.3 (6.1-6.5)	4 (4-5)	0 (0-0)	25 (25-26)	6.4 (5.5-7.0)	4.7 (3.5-6.0)	1.9 (1.4-2.3)	0.4 (0.4-0.6)	3.2 (3.0-3.3)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Compass Lake	6.3 (2.8-10)	0.1 (0-0.2)	42 (34-53)	163 (114-229)	5.7 (0.8-15.5)	0.7 (0.4-1.0)	1 (0-3)	4.9 (4.0-6.4)
Lake McKenzie	5.7 (2.8-9.9)	0.1 (0-0.1)	26 (18-35)	176 (150-217)	3.5 (0.6-6.4)	1.0 (0.6-1.3)	9 (5-15)	5.3 (4.0-6.5)
Mirrow Lake	5.4 (2.8-12)	0 (0-0)	21 (8.5-38)	110 (75-158)	3.4 (0.9-8.7)	0.8 (0.6-1.1)	3 (0-10)	7.1 (5.5-9.0)
Round Lake	6.6 (3.5-11)	0.1 (0-0.1)	93 (41-176)	169 (108-208)	5.4 (0-10.1)	0.8 (0.7-1.1)	0 (0-0)	4.7 (4.0-5.2)

Table 8. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Turkey Pen Pond	4.7 (4.6-4.7)	1 (0-1)	0 (0-0)	19 (18-19)	2.0 (1.4-2.5)	1.2 (1.0-1.5)	1.7 (1.5-2.2)	0.2 (0.1-0.3)	2.0 (1.8-2.3)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Turkey Pen Pond	6.2 (3.1-11)	0.1 (0-0.3)	15 (9.5-21)	68 (35-133)	5.2 (2.4-9.8)	0.6 (0.3-0.8)	1 (0-2.5)	4.7 (3.3-6.4)

Table 9. Mean percentage of major cations and anions in lakes located on the New Hope Ridge.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Compass Lake	45	0	53	6	13	0	52	35
Lake McKenzie	23	5	68	3	10	0	61	29
Mirrow Lake	30	7	58	4	9	0	51	30
Round Lake	42	15	36	5	28	0	44	29
Turkey Pen Pond	20	12	62	4	5	0	66	29

is the dominant mechanism determining the chemical composition of lakes on the New Hope Ridge.

Data on trophic state characteristics (Table 8) shows the study lakes on the New Hope Ridge are highly oligotrophic. Mean total nitrogen values ranged between 68 and 176 mg/m^3. Mean total phosphorus concentrations ranged between 3.4 and 5.7 mg/m^3. Chlorophyll a concentrations averaged between 0.6 and 1 mg/m^3 and water clarity averaged between 4.7 and 7.1 m. These data are very similar to the total nitrogen (220 mg/m^3), total phosphorus (5 mg/m^3), chlorophyll a (0.6 mg/m^3) and water clarity (12.8 m) values reported for Lake Tahoe, Nevada by the U. S. Environmental Protection Agency (1978a). This suggests the lakes on the New Hope Ridge are among the most oligotrophic lakes found in the United States.

4. Greenhead Slope: The Greenhead Slope (Figure 4) is located in Washington and Bay counties. Like the New Hope Ridge and the Western Highlands, this region is a remnant of the once continuous northern highlands. Vernon and Puri (1964) suggest sands of the Jackson Bluff Formation dominate the regional geology. Throughout the region, there are numerous sinkhole lakes. In this study, 4 natural lakes (Crystal Lake, Dunford Pond, Gap Pond, and Merial Lake) were studied. Data are presented in Table 10. Additional data for Porter Pond (Table 11) were obtained from the Florida Game and Fresh Water Fish Commission.

Lakes on the Greenhead Slope are characterized as acidic, soft-water lakes of low mineral content. Mean pH (Table 10) ranged from 4.7 to 5.7. Total alkalinity values averaged from 1 to 2 mg/l as $CaCO_3$. Mean total hardness concentrations ranged from 2.0 to 2.5 mg/l as $CaCO_3$ while

Table 10. Means of limnological parameters measured in lakes located on the Greenhead Slope. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Crystal Lake	5.7 (5.6-5.9)	2 (1-2)	0 (0-0)	13 (13-14)	2.5 (2.1-3.0)	1.8 (1.5-2.5)	1.8 (1.5-2.2)	0.2 (0.1-0.2)	2.1 (1.8-2.5)
Dunford Pond	5.0 (4.9-5.1)	1 (1-1)	0 (0-0)	15 (14-15)	2.1 (1.6-3.0)	1.6 (1.0-2.0)	1.7 (1.5-1.9)	0.2 (0.1-0.2)	2.2 (2.0-2.8)
Gap Pond	5.1 (5.1-5.2)	1 (1-1)	0 (0-0)	13 (12-14)	2.0 (1.6-2.5)	1.6 (0.8-2.5)	1.7 (1.5-2.0)	0.2 (0.1-0.3)	2.1 (1.8-2.5)
Merial Lake	4.7 (4.5-4.8)	1 (0-1)	0 (0-0)	19 (17-21)	2.1 (1.6-2.6)	1.5 (1.0-2.5)	2.0 (1.7-2.4)	0.2 (0.1-0.3)	2.6 (2.3-3.0)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Crystal Lake	4.6 (0-12)	0.5 (0.2-0.6)	12 (5.9-18)	119 (93-141)	6.3 (3.1-10.0)	0.5 (0.2-0.7)	0 (0-0)	8.1 (7.0-9.6)
Dunford Pond	4.8 (0-8.9)	0 (0-0)	25 (18-39)	220 (183-282)	7.1 (3.9-10.3)	0.8 (0.6-1.2)	6 (0-15)	5.0 (5.0-5.0)
Gap Pond	7.1 (0-15)	0 (0-0)	40 (26-51)	308 (244-383)	12.2 (5.0-32.6)	1.5 (1.0-2.2)	4 (0-10)	4.5 (4.3-4.6)
Merial Lake	6.3 (3.0-9.6)	0.2 (0.1-0.2)	18 (12-25)	64 (0-167)	6.0 (2.6-8.2)	0.5 (0.3-0.6)	0 (0-2.5)	3.2 (3.0-3.7)

Table 11. Means of limnological parameters measured in Porter Pond between 1967 and 1968. Numbers in parentheses are the minimum and maximum values measured. Data from Holcomb (1968, 1969), Duchrow and (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Porter Pond	4.9 (4.0-6.7)	5.0 (4.2-6.4)	0.8 (0-2)	0 (0-0)	30 (19-40)	2.3 (2.0-3.0)	0.4 (0-0.7)	0.3 (0.1-0.4)	1.0 (0-1.6)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m³)	COLOR (mg/1 Pt)	SECCHI (ft)
0.2 (0-0.5)	2.2 (1.8-2.5)	1.9 (0-4.0)	0.8 (0.7-0.8)	0.190 (0.020-0.490)	0.149 (0.020-0.490)	0.6 (0-1.1)	3 (0-5)	7.6 (1.8-18)

Table 12. Mean percentage of major cations and anions in lakes located on the Greenhead Slope.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Crystal Lake	28	10	59	3	17	0	51	31
Dunford Pond	25	10	61	3	11	0	54	34
Gap Pond	26	7	62	4	9	0	65	26
Merial Lake	21	9	65	4	4	0	61	35

calcium hardness concentrations averaged between 1.5 and 1.8 mg/1 as $CaCO_3$. Mean specific conductance ranged from 13 to 19 μmhos/cm. Data for Porter Pond (Table 11) are similar.

In all lakes, mineral analyses (Table 12) showed sodium was the dominant cation and sulfate followed by chloride were the dominant anions. Similar to New Hope Ridge lakes, the low salinity and chemical composition of the lakes located on the Greenhead Slope suggest the chemical composition of these lakes is largely determined by atmospheric precipitation.

As a group, lakes on the Greenhead Slope can be characterized as oligotrohpic. With the exception of Gap Pond and Porter Pond, which are relatively shallow lakes, mean total phosphorus values (Table 10) averaged below 10 mg/m^3. Mean total nitrogen concentrations ranged from 64 to 308 mg/m^3. In all the lakes, chlorophyll a concentrations averaged between 0.5 and 1.5 mg/m^3. These low algal levels coupled with low average color values (0-6 mg/1 as Pt) result in high water transparency. Mean Secchi disc readings ranged from 3.2 to 8.1 m.

5. Grand Ridge: The Grand Ridge, which is located in Calhoun and Jackson counties, is a remnant high area left by the Chipola and Apalachicola Rivers when they dissected the original northern highlands (Figure 4). Regional geology is dominated by sands of the Fort Preston Formation (Vernon and Puri 1964), but unlike other regions within this geologic formation, the Grand Ridge has very few lakes. Consequently, only one lake, Ocheesee Pond, was sampled. Data are presented in Table 13.

Ocheesee Pond, similar to other sand-hill lakes in western Florida,

Table 13. Means of limnological parameters measured in lakes located on the Grand Ridge. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Ocheesee Pond	5.6 (5.6-5.7)	3 (2-3)	0 (0-0)	16 (15-16)	3.2 (3.4-4.0)	2.3 (1.5-3.0)	1.6 (1.1-2.0)	0.2 (0.2-0.3)	3.0 (2.8-3.3)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Ocheesee Pond	5.4 (2.8-11)	0.1 (0-0.3)	170 (98-245)	328 (255-374)	8.7 (3.9-16.3)	2.6 (1.7-3.5)	9 (5-10)	3.3 (2.2-4.0)

Table 14. Mean percentage of major cations and anions in lakes located on the Grand Ridge.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Ocheesee Pond	31	13	48	4	21	0	45	34

is an acid, soft-water lake of low mineral content. Mean pH was 5.6 and mean total alkalinity was 3 mg/l as $CaCO_3$. Total and calcium hardness concentrations (Table 13) averaged less than 4 mg/l as $CaCO_3$ and mean specific conductance was 16 μmhos/cm. Sulfate and chloride were the dominant anions (Table 14). Sodium was the dominant cation (48%) but calcium also contributed significantly to the ionic composition of Ocheesee Pond (Table 14). Based on the ionic composition and low mineral content (Gibbs 1970), atmospheric precipitation probably is the dominant mechanism controlling surface water chemistry in Ocheesee Pond.

Ocheesee Pond probably can be characterized as an oligotrophic lake. Total nitrogen concentrations averaged 328 mg/m^3 and total phosphorus concentrations averaged 8.7 mg/m^3. Chlorophyll _a_ concentrations averaged 2.6 mg/m^3 and Secchi disc readings averaged 3.3 m. Though the average values are characteristic of oligotrophic lakes, examination of the maximum measured total phosphorus and chlorophyll _a_ values suggests Ocheesee Pond is not as oligotrophic as other sand-hill lakes in western Florida and may actually be an oligo-mesotrophic lake.

6. _Tallahassee Hills_: The Tallahassee Hills (Figure 4) are a 40 km wide strip of uplands located in Gadsen, Jefferson, Leon, Liberty and Madison counties. The upland extends from the Withlacoochee River on the east westward to the Apalachicola River. The geology in the eastern portion of the uplands is dominated by the yellowish-red, clay-sands of the Miccosukee Formation (Vernon and Puri 1964). Deposits of the Hawthorn Formation, a phosphatic deposit, generally dominate the geology westward from the Ocholockonee River (Vernon and Puri 1964). However, thick deposits

of clastics overlie the main geological formations in many areas. Where these deposits occur, there are often many lakes ranging from large shallow lakes to relatively deep sinkhole lakes. Five natural lakes (Carr Lake, Cherry Lake, Lake Iamonia, Lake Jackson, and Mystic Lake) and one artificial lake (Lake Talquin) were sampled during this study. Data are presented in Table 15. Additional data obtained from the Florida Game and Fresh Water Fish Commission are presented in Table 16.

As a group, the lakes in the Tallahassee Hills can be characterized as acidic, soft-water lakes of low mineral content. Mean pH values ranged from 5.6 to 6.7. Total alkalinity levels averaged between 4 and 12 mg/l as $CaCO_3$. Total hardness concentrations averaged between 5.2 and 19 mg/l as $CaCO_3$ while calcium hardness concentrations averaged between 2.5 and 10 mg/l as $CaCO_3$.

Unlike lakes located on the New Hope Ridge and the Greenhead Slope, chemical composition of lakes in the Tallahassee Hills was mixed (Table 17). Because calcium and magnesium occur in roughly the same proportions as sodium (Table 17) and mean specific conductance values (16-71 μmhos/cm) are generally higher than values found in lakes to the west, the geology of this region probably influences the water chemistry of these lakes at least as much as atmospheric precipitation.

Based on data collected in this study (Table 15) and the criteria given in Table 4, the trophic status of most of the lakes in the Tallahassee Hills can be classified as oligo-mesotrophic or mesotrophic. Total nitrogen values averaged between 287 and 746 mg/m^3. Total phosphorus values, with the exception of Lake Talquin, averaged between 6.8 and 27.2 mg/m^3 and chlorophyll a values averaged between 3.7 and 10

Table 15. Means of limnological parameters measured in lakes located in the Tallahassee Hills. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (μmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Carr Lake	6.1 (5.9-6.3)	4 (3-5)	0 (0-0)	16 (13-17)	5.2 (4.5-6.0)	2.5 (1.5-3.0)	1.2 (0-2.2)	0.1 (0.1-0.2)	2.7 (2.3-3.0)
Cherry Lake	5.9 (5.5-6.2)	2 (1-4)	0 (0-0)	45 (43-46)	9.3 (9.0-9.5)	5.2 (4.5-6.0)	4.4 (3.8-4.8)	0.6 (0.5-0.6)	6.8 (6.5-7.0)
Lake Iamonia	5.6 (5.4-6.2)	3 (3-4)	0 (0-0)	18 (15-20)	4.8 (4.0-6.0)	2.2 (2.0-2.5)	1.6 (0.2-2.7)	0.2 (0.2-0.3)	3.2 (2.8-3.5)
Lake Jackson	6.5 (6.4-6.7)	5 (4-9)	0 (0-0)	26 (23-34)	7.4 (6.0-10.5)	4.6 (3.5-7.5)	2.0 (0.9-2.6)	0.3 (0.2-0.4)	3.3 (3.3-3.5)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Carr Lake	4.5 (0-10)	0.1 (0-0.1)	294 (239-416)	440 (333-618)	14.6 (10.7-22.6)	7.3 (1.0-21.7)	15 (10-20)	2.0 (1.9-2.0)
Cherry Lake	8.7 (6.0-14)	0.2 (0-0.6)	69 (31-126)	287 (211-383)	27.2 (17.6-36.4)	5.4 (1.5-9.6)	4 (0-10)	2.3 (1.3-3.6)
Lake Iamonia	4.4 (0-14)	1.0 (0.2-1.5)	511 (59-1200)	433 (350-591)	6.8 (3.9-12.2)	7.8 (4.2-21.0)	29 (25-40)	2.2 (1.5-2.9)
Lake Jackson	4.1 (0-11)	0.2 (0.1-0.2)	68 (39-92)	439 (374-583)	15.9 (13.7-18.0)	3.9 (2.2-4.8)	9 (5-10)	4.0 (4.0-4.0)

Table 15. (cont.)

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (μmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Mystic Lake	6.7 (6.5-6.8)	10 (8-11)	0 (0-0)	31 (27-37)	12 (9.5-13)	8.0 (6.5-9.0)	2.2 (0.8-3.0)	0.1 (0.1-0.1)	4.0 (3.5-4.5)
Lake Talquin	6.2 (5.9-6.7)	12 (5-20)	0 (0-0)	71 (36-104)	19 (9.0-28)	10 (3.0-16)	7.0 (4.1-10)	1.9 (1.5-2.4)	10 (6.0-15)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Mystic Lake	4.2 (0-11)	0.1 (0.1-0.2)	266 (198-397)	549 (422-634)	12.2 (3.2-19.5)	3.7 (2.1-8.9)	13 (5-25)	BOTTOM (***-***)
Lake Talquin	7.5 (3.3-14)	6.5 (3.9-9.0)	1200 (1100-1400)	746 (616-883)	114.5 (28.1-212.2)	10.0 (1.9-29.5)	73 (60-100)	0.5 (0.2-0.8)

Table 16. Means of limnological parameters measured in lakes located in the Tallahassee Hills. Numbers in parentheses are the minimum and maximum values measured. Period or record 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971) Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/l)	PHENOL ALKALINITY (mg/l)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/l)	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)
Jackson	7.0 (6.4-7.3)	6.8 (6.2-7.2)	4.3 (2.0-8.0)	0.0 (0.0-0.0)	33 (28-36)	6.5 (6.0-7.0)	1.6 (1.0-3.5)	0.5 (0.4-0.6)	2.1 (1.6-3.2)
Miccosukee	6.5 (6.1-6.9)	6.7 (6.2-7.3)	5.2 (2.0-8.0)	0.0 (0.0-0.0)	38 (32-50)	7.5 (6.0-9.0)	2.0 (1.1-4.4)	0.6 (0.5-0.8)	2.5 (1.7-3.2)
Talquin	6.7 (6.4-7.4)	6.8 (6.3-7.3)	8.3 (4.0-12)	0.0 (0.0-0.0)	67 (42-88)	15 (14-16)	8.8 (2.1-33)	1.0 (0.6-1.4)	5.2 (3.7-7.7)

POTASSIUM (mg/l)	CHLORIDE (mg/l)	SULFATE (mg/l)	SILICA (mg/l)	TOTAL IRON (mg/l)	TOTAL PHOSPHATE (mg/l)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l Pt)	SECCHI (ft)
0.7 (0.4-1.0)	2.0 (2.0-2.0)	0.2 (0.0-1.0)	- -	0.125 (0.100-0.150)	0.108 (0.070-0.160)	3.1 (1.1-4.8)	- -	7.0 (4.6-11)
0.7 (0.0-1.2)	3.5 (3.0-4.0)	0.08 (0.0-0.5)	- -	0.270 (0.070-0.470)	0.085 (0.010-0.140)	3.6 (1.6-6.4)	- -	5.1 (2.7-9.3)
1.0 (0.8-1.4)	9.0 (7.0-11)	1.5 (0.0-4.5)	- -	0.380 (0.190-0.570)	0.238 (0.010-0.410)	5.7 (3.2-9.6)	- -	3.5 (2.3-4.8)

Table 17. Mean percentage of major cations and anions in lakes located in the Tallahassee Hills.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Carr Lake	30	32	30	2	31	0	38	30
Cherry Lake	26	21	49	4	11	0	43	46
Lake Iamonia	23	27	27	3	27	0	37	37
Lake Jackson	37	24	35	3	38	0	29	33
Mystic Lake	47	21	28	1	49	0	22	29
Lake Talquin	25	23	39	6	36	0	23	42

mg/m^3. Lake Talquin, however, probably should be classified as a eutrophic lake as total phosphorus concentrations averaged over 100 mg/m^3 (Table 15). This results primarily because the Ochlockonee River drains the phosphorus deposits of the Hawthorn Formation. In addition to the high phosphorus values, chlorophyll a concentrations were measured up to 29.5 mg/m^3 (Table 15) which is decidedly eutrophic. The low average chlorophyll a values (10 mg/m^3) measured in Lake Talquin most likely result from the high turbidity or rapid flushing rates of this lake.

7. Lake Munson Hills: The Lake Munson Hills (Figure 4) are located in Leon County south of the Tallahassee Hills. The region has an area of about 104 km^2. Geology of the region is dominated by sands overlying Suwannee Limestone (Vernon and Puri 1964). In the western portion of this region, there are numerous circular sinkhole lakes. In this study, only one lake, Lake Munson, was sampled. Data are presented in Table 18.

Lake Munson is an alkaline, hard-water lake of relatively high mineral content. Mean lake pH was 7.7 but ranged up to 9.6. Total alkalinity averaged 58 mg/l as $CaCO_3$. Mean total hardness and mean calcium hardness concentrations averaged 60 and 44 mg/l as $CaCO_3$ respectively. Lake specific conductance averaged 187 μmhos/cm, but ranged up to 240 μmhos/cm. Calcium and magnesium (Table 19) were the dominant cations and bicarbonate and carbonate were the dominant anions. This is similar to many of the world's hard-water lakes (Hutchinson 1957). Lake Munson's chemical composition and quality, however, are probably not typical of other lakes in this region because the lake receives inputs of

Table 18. Means of limnological parameters measured in lakes located in the Lake Munson Hills. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Munson	7.7 (7.2-9.6)	58 (35-73)	10 (0-34)	187 (115-240)	60 (37-74)	44 (27-56)	16 (8.8-20)	2.8 (1.8-3.6)	18 (9.5-23)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL <u>a</u> (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Munson	8.2 (3.0-15)	6.9 (3.2-9.9)	472 (246-899)	2900 (2100-3800)	622 (40.9-1200)	145 (68.3-255)	51 (20-100)	0.4 (0.3-0.6)

Table 19. Mean percentage of major cations and anions in lakes located in the Lake Munson Hills.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Munson	45	16	35	4	42	21	9	28

treated domestic wastes from the City of Tallahassee.

Because the lake receives large inputs of plant nutrients from Tallahassee (U.S. Environmental Protection Agency 1978b), the lake is highly eutrophic. Total nitrogen and total phosphorus concentrations averaged 2900 and 622 mg/m^3 respectively. Chlorophyll a concentrations averaged 145 mg/m^3 but ranged up to 255 mg/m^3. Consequently, lake water clarity was extremely low (mean Secchi disc 0.4 m) as is typical of most eutrophic lakes with heavy algal blooms.

8. Northern Highlands: The Northern Highlands (Figure 4) is a large plateau located in Hamilton, Suwannee, Columbia, Baker, Union Bradford, Clay, Putnam and Alachua counties. Generally, the topography is flat, but along the peripheral zone, gentle hills appear. The region's geology is largely dominated by deposits of clastics, but along the periphery, major deposits of the phosphatic Hawthorn Formation and Suwannee Limestone occur (Puri and Vernon 1964; Vernon and Puri 1964; White 1970). In Clay and Putnam counties, clays cap the Hawthorn and limestone deposits. Here, a karstic landscape has developed and the area contains many mulitform solution depressions. Many of these depressions contain lakes. In this study, 13 lakes including one artificial lake (Suwannee Lake) were studied. Data are presented in Table 20. Additional data were obtained from the Florida Game and Fresh Water Fish Commission (Table 21), Shannon (1970)(Table 22), and Shannon and Brezonik (1972).

Inspection of the data reveals water quality in the Northern Highlands is highly variable, but much of this variation can

Table 20. Means of limnological parameters measured in lakes located on the Northern Highlands. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Alligator Lake	7.4 (6.9-9.9)	38 (33-42)	4 (0-12)	110 (86-142)	46 (36-59)	37 (27-46)	6.7 (3.5-11)	1.1 (0.5-1.8)	8.3 (5.8-13)
Lake Butler	6.0 (5.8-6.2)	3 (0-4)	0 (0-0)	47 (44-53)	12 (12-13)	7.4 (6.5-8.5)	4.9 (3.7-6.0)	0.5 (0.3-0.7)	7.7 (7.0-8.5)
Lake Crosby	5.7 (5.6-5.9)	2 (2-3)	0 (0-0)	42 (38-45)	9.1 (8.0-10)	5.3 (4.5-7.0)	4.7 (3.7-5.6)	0.2 (0.1-0.2)	7.0 (6.5-7.3)
Lake Geneva	6.4 (6.3-6.6)	3 (3-3)	0 (0-0)	52 (50-54)	11 (11-12)	6.1 (6.0-6.5)	6.7 (5.6-7.9)	0.4 (0.2-0.6)	8.9 (8.8-9.3)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL $\underline{a}$ (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Alligator Lake	7.7 (2.5-13)	2.4 (1.6-3.8)	254 (139-370)	1700 (711-2300)	384.2 (62.3-877)	50.4 (16.5-96.8)	35 (30-40)	0.5 (0.4-0.6)
Lake Butler	7.3 (4.9-12)	0.6 (0.3-0.8)	235 (162-378)	437 (283-718)	23.9 (14.0-30.2)	11.3 (1.3-32.0)	63 (30-100)	1.3 (0.8-1.6)
Lake Crosby	7.5 (4.5-14)	0.5 (0.1-0.8)	176 (109-261)	420 (343-500)	17.3 (7.8-28.5)	4.5 (2.1-9.0)	30 (15-40)	1.9 (1.5-2.4)
Lake Geneva	9.3 (6.6-13)	0.2 (0-0.4)	15.1 (12.5-18.9)	198 (88-283)	12.8 (2.2-27.9)	2.3 (1.0-3.3)	3 (0-5)	3.3 (2.8-4.0)

Table 20. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Hampton Lake	5.5 (5.4-5.8)	2 (2-2)	0 (0-0)	50 (45-55)	11 (10-11)	6.0 (5.0-9.0)	5.7 (4.6-6.4)	0.3 (0.2-0.4)	8.6 (8.0-9.0)
Lake Louise	6.4 (6.3-6.6)	5 (4-6)	0 (0-0)	46 (40-53)	12 (11-13)	8.8 (7.0-10)	4.1 (3.4-4.7)	0.2 (0.1-0.3)	7.8 (7.3-8.3)
Ocean Pond	4.1 (3.5-5.0)	0 (0-1)	0 (0-0)	35 (32-38)	5.9 (5.5-6.0)	2.7 (2.0-4.0)	4.1 (3.1-4.9)	0.1 (0.1-0.2)	6.3 (5.8-7.0)
Palestine Lake	5.0 (4.9-5.1)	1 (0.2-1)	0 (0-0)	34 (31-39)	6.4 (6.0-6.5)	3.1 (2.5-4.0)	4.2 (2.9-5.1)	0.1 (0.1-0.2)	5.9 (5.5-6.3)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Hampton Lake	7.4 (6.4-9.6)	0.2 (0-0.3)	95.3 (51.5-136)	410 (192-566)	13.0 (5.7-23.3)	5.7 (2.6-9.8)	30 (15-40)	2.2 (1.3-2.9)
Lake Louise	4.4 (0-9.5)	0.2 (0.1-0.3)	78.9 (63.5-103)	632 (467-739)	22.9 (16.8-33.3)	6.5 (3.9-9.5)	42 (35-50)	1.8 (1.6-2.0)
Ocean Pond	6.3 (3.8-12)	2.8 (1.9-3.3)	278 (173-338)	222 (158-352)	22.9 (11.4-37.0)	3.3 (1.8-6.4)	50 (15-75)	1.1 (0.8-1.5)
Palestine Lake	5.6 (4.4-9.1)	1.0 (0.4-1600)	123 (90.6-172)	286 (183-431)	20.2 (11.9-25.3)	3.6 (1.7-4.7)	37 (20-60)	1.1 (0.8-1.5)

Table 20. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Lake Rowell	7.4 (7.2-7.8)	24 (17-32)	0 (0-0)	203 (136-250)	66 (50-75)	56 (40-68)	18 (12-24)	0.9 (0.6-1.1)	9.2 (9.0-9.5)
Lake Sampson	6.9 (6.8-7.2)	10 (8-12)	0 (0-0)	124 (97-160)	37 (34-43)	30 (26-38)	12 (9.8-16)	0.7 (0.5-0.9)	8.4 (7.8-9.0)
Santa Fe Lake	6.0 (5.8-6.4)	3 (2-4)	0 (0-0)	49 (46-52)	10 (9.0-11)	5.3 (5.0-6.0)	6.8 (5.9-8.3)	0.3 (0.1-0.4)	9.7 (9.3-10)
Suwannee Lake	6.6 (6.3-7.4)	8 (8-10)	0 (0-0)	38 (38-40)	12 (12-13)	8.8 (8.0-10)	3.0 (1.9-3.7)	0.4 (0.3-0.5)	5.7 (5.5-5.8)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m³)	TOTAL N (mg/m³)	TOTAL P (mg/m³)	CHLOROPHYLL a (mg/m³)	COLOR (mg/l Pt)	SECCHI (m)
Lake Rowell	82 (44-103)	3.3 (1.5-4.6)	180 (74.9-297)	718 (581-854)	65.6 (41.3-77.8)	12.4 (3.0-21.8)	47 (30-70)	0.8 (0.6-1.0)
Lake Sampson	43 (33-59)	1.5 (0.5-3.1)	155 (37.2-220)	522 (333-700)	33.8 (12.3-62.2)	3.4 (2.2-4.9)	67 (25-90)	2.0 (1.3-2.6)
Santa Fe Lake	6.6 (4.6-9.6)	0.1 (0-0.1)	83.5 (60.9-101)	358 (246-467)	16.3 (4.5-36.1)	5.4 (4.0-7.0)	33 (30-40)	2.2 (1.8-2.6)
Suwannee Lake	5.5 (0-12)	0.7 (0.2-1.4)	96.1 (80.9-111)	979 (633-1200)	58.5 (38.0-81.5)	21.0 (5.7-45.0)	20 (15-25)	1.3 (0.7-2.2)

Table 20. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Watertown Lake	7.9 (7.4-9.1)	78 (73-87)	2 (0-7)	163 (150-185)	78 (73-85)	66 (63-72)	6.8 (6.0-7.4)	2.9 (2.8-3.0)	8.0 (7.3-8.5)

	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Watertown Lake	5.3 (0-10)	1.8 (0.2-3.1)	70.2 (51.2-93.2)	615 (519-766)	29.5 (22.5-38.1)	18.6 (14.2-26.5)	23 (10-30)	1.9 (1.4-2.8)

Table 21. Means of limnological parameters measured in lakes located on the Northern Highlands. Numbers in parentheses are the minimum and maximum values measured. Period or record 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Alligator	7.4 (6.4-8.6)	7.1 (6.5-7.9)	45 (20-66)	1.6 (0.0-8.0)	154 (75-189)	43 (43-43)	14 (7.4-20)	2.4 (1.7-3.0)	10 (4.2-13)
Altho	6.0 (5.0-7.0)	5.9 (5.1-7.1)	3.1 (2.0-7.0)	0.0 (0.0-0.0)	61 (45-72)	8.8 (8.0-10)	1.9 (1.4-2.6)	0.9 (0.5-1.0)	5.1 (4.7-5.6)
Brooklyn	4.9 (4.4-5.2)	5.4 (4.6-6.0)	0.9 (0.0-4.0)	0.0 (0.0-0.0)	37 (28-56)	3.5 (3.0-4.0)	0.7 (0.6-0.8)	0.5 (0.4-0.6)	2.4 (2.2-2.7)
Butler	5.6 (4.9-6.4)	5.8 (5.1-6.4)	2.3 (1.0-4.0)	0.0 (0.0-0.0)	51 (37-62)	8.0 (8.0-8.0)	2.2 (1.8-2.8)	0.8 (0.6-0.9)	3.3 (2.7-3.7)

LAKE	POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
Alligator	1.7 (0.3-2.7)	15 (15-15)	3.5 (1.0-6.5)	*** ***	0.410 (0.410-0.410)	2.99 (1.00-3.90)	38 (8.6-87)	*** ***	3.3 (1.8-4.8)
Altho	0.4 (0.0-0.6)	8.3 (4.5-10)	2.8 (0.4-4.0)	0.4 (0.1-0.6)	0.223 (0.160-0.340)	0.148 (0.050-0.640)	0.5 (0.0-1.6)	55 (50-60)	4.4 (2.0-5.6)
Brooklyn	0.2 (0.1-0.2)	7.0 (4.5-9.5)	3.2 (3.0-3.5)	*** ***	0.015 (0.010-0.020)	0.028 (0.010-0.040)	1.3 (0.0-2.1)	*** ***	12 (8.9-15)
Butler	0.5 (0.4-0.6)	3.8 (3.5-4.0)	2.8 (1.0-5.0)	*** ***	0.405 (0.380-0.430)	0.078 (0.060-0.100)	2.8 (0.0-4.8)	*** ***	3.3 (2.8-4.3)

Table 21. (cont.).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (µmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Geneva	6.2 (5.6-6.5)	6.2 (5.8-6.4)	4.3 (1.0-20)	0.0 (0.0-0.0)	60 (47-90)	7.0 (6.0-8.0)	1.7 (1.4-1.8)	0.9 (0.8-1.0)	4.3 (4.0-4.8)
Ocean Pond	4.8 (4.2-5.6)	5.0 (4.2-5.6)	2.6 (0.0-17)	0.0 (0.0-0.0)	45 (25-57)	5.3 (4.0-6.0)	1.0 (0.8-1.2)	0.5 (0.3-0.7)	3.2 (2.4-3.9)
Palestine	4.6 (4.1-5.3)	5.0 (4.5-5.5)	2.0 (0.0-8.0)	0.0 (0.0-0.0)	40 (31-46)	5.0 (5.0-5.0)	1.1 (0.9-1.4)	0.7 (0.5-0.8)	2.7 (2.4-3.2)
Sampson	7.1 (6.6-7.8)	6.9 (6.4-7.4)	10 (4.0-19)	0.0 (0.0-0.0)	141 (86-189)	38 (32-43)	11 (6.7-16)	1.8 (1.0-2.7	10 (5.8-17)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m³)	COLOR (mg/1 Pt)	SECCHI (ft)
0.5 (0.4-0.8)	7.8 (7.0-8.5)	6.0 (5.5-6.5)	*** ***	0.030 (0.020-0.040)	0.025 (0.010-0.040)	1.0 (0.0-1.6)	*** ***	11 (7.2-15)
0.1 (0.0-0.2)	5.4 (4.0-7.0)	1.9 (0.0-4.0)	2.5 (1.7-3.3)	0.340 (0.240-0.430)	0.139 (0.040-0.390)	2.0 (1.3-3.2)	120 (120-120)	3.5 (2.0-6.0)
0.2 (0.1-0.2)	4.0 (3.5-4.5)	1.5 (0.0-4.0)	*** ***	0.240 (0.230-0.250)	0.063 (0.040-0.100)	4.0 (3.2-4.8)	*** ***	2.8 (2.1-3.3)
1.0 (0.7-1.3)	6.8 (6.0-7.5)	26 (13-42)	*** ***	0.150 (0.090-0.210)	0.128 (0.070-0.220)	7.2 (3.2-9.6)	*** ***	3.8 (1.7-5.3)

Table 21. (cont.).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/l)	PHENOL ALKALINITY (mg/l)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/l)	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)
Watertown	7.4 (7.0-7.6)	7.3 (6.4-8.1)	52 (34-75)	0.0 (0.0-0.0)	148 (105-190)	37 (35-38)	11 (0.0-19)	7.9 (2.4-25)	5.3 (2.3-7.6)

POTASSIUM (mg/l)	CHLORIDE (mg/l)	SULFATE (mg/l)	SILICA (mg/l)	TOTAL IRON (mg/l)	TOTAL PHOSPHATE (mg/l)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l Pt)	SECCHI (ft)
3.9 (2.5-6.9)	8.6 (7.2-10)	6.7 (0.0-25)	1.3 (1.2-1.3)	0.180 (0.080-0.230)	0.174 (0.010-0.360)	15.5 (4.8-32.1)	20 (20-20)	3.9 (2.3-7.3)

Table 22. Means of limnological parameters measured in lakes located on the Northern Highlands. Numbers in parentheses are the minimum and maximum values measured. Period of record 1979-1970. Data from Shannon (1970).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN (mg/1)	AMMONIA NITROGEN (mg/1)
Adaho	37 (26-47)	2.2 (1.4-3.5)	0.9 (0.8-1.0)	4.9 (3.2-6.5)	0.2 (0.1-0.4)	0.027 (0.010-0.041)	0.717 (0.450-0.880)	0.417 (0.030-0.360)
Alice	552 (445-634)	59 (17-88)	13 (11-16)	19 (16-23)	2.1 (0.5-5)	0.900 (0.520-1.800)	0.503 (0.370-0.770)	0.070 (0.000-0.260)
Altho	53 (46-55)	4.0 (1.8-7.5)	1.0 (0.8-1.2)	7.3 (7.0-7.5)	0.4 (0.2-0.5)	0.023 (0.010-0.030)	0.593 (0.540-0.620)	0.063 (0.040-0.100)
Anderson-Cue	38 (35-40)	1.7 (0.9-2.6)	0.7 (0.7-0.8)	3.5 (2.0-5.0)	0.3 (0.1-0.5)	0.019 (0.008-0.032)	0.278 (0.210-0.340)	0.140 (0.000-0.440)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Adaho	0.077 (0.000-0.200)	5.3 (2.5-7.6)	336 (250-398)	0.9 (0.6-1.1)
Alice	0.023 (0.000-0.090)	4.4 (2.1-6.9)	26 (16-31)	1.5 (1.2-2.0)
Altho	0.017 (0.000-0.040)	5.9 (5.5-6.5)	134 (98-160)	1.4 (1.2-1.7)
Anderson-Cue	0.092 (0.010-0.180)	3.2 (1.7-5.8)	3 (0-9)	3.7 (1.8-5.4)

Table 22. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN (mg/1)	AMMONIA NITROGEN (mg/1)
Beville's Pond	40 (37-41)	2.7 (2.0-3.2)	0.8 (0.7-0.9)	6.1 (2.9-8.0)	0.5 (0.1-0.8)	0.087 (0.071-0.100)	0.653 (0.460-0.820)	0.090 (0.060-0.150)
Brooklyn	30 (26-35)	2.1 (1.2-3.0)	0.7 (0.5-1.0)	3.2 (2.0-4.6)	0.2 (0.1-0.4)	0.011 (0.010-0.012)	0.280 (0.240-0.300)	0.027 (0.000-0.080)
Clear Water	40 (38-42)	2.0 (1.3-3.2)	0.7 (0.7-0.8)	4.9 (4.2-5.5)	0.2 (0.1-0.3)	0.012 (0.010-0.017)	1.320 (0.440-2.970)	0.040 (0.020-0.050)
Cooter Pond	60 (51-70)	5.8 (4.3-8.6)	1.2 (1.0-1.4)	5.0 (4.5-5.6)	1.9 (0.8-3.0)	0.165 (0.120-0.235)	1.263 (0.630-1.660)	0.120 (0.030-0.230)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Beville's Pond	0.090 (0.000-0.270)	23.7 (11.3-44.6)	182 (132-207)	2.1 (1.4-3.1)
Brooklyn	0.080 (0.000-0.220)	1.9 (1.8-2.1)	4 (3-7)	4.3 (3.4-5.8)
Clear Water	0.017 (0.000-0.050)	2.3 (1.9-2.6)	21 (15-32)	2.4 (1.0-4.6)
Cooter Pond	0.040 (0.000-0.080	22.6 (9.2-39.4)	83 (68-99)	0.9 (0.6-1.2)

Table 22. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN (mg/1)	AMMONIA NITROGEN (mg/1)
Cowpen	46 (38-53)	2.3 (1.7-2.9)	0.9 (0.8-1.0)	5.0 (4.0-7.0)	0.4 (0.1-0.6)	0.010 (0.010-0.010)	0.247 (0.110-0.350)	0.037 (0.020-0.050)
Elizabeth	48 (40-53)	3.7 (1.8-6.8)	1.0 (0.9-1.2)	5.2 (5.0-5.4)	0.4 (0.1-0.6)	0.036 (0.030-0.047)	0.810 (0.610-0.940)	0.023 (0.000-0.040)
Gallilee	38 (34-43)	2.3 (1.8-2.9)	0.8 (0.7-0.9)	4.5 (3.0-5.6)	0.3 (0.1-0.4)	0.014 (0.010-0.022)	0.360 (0.320-0.410)	0.017 (0.000-0.030)
Geneva	49 (42-58)	2.6 (1.7-3.7)	0.9 (0.8-1.0)	5.4 (4.0-7.2)	0.5 (0.2-0.6)	0.016 (0.005-0.039)	0.350 (0.220-0.500)	0.030 (0.000-0.050)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Cowpen	0.007 (0.000-0.020)	1.6 (1.5-1.6)	5 (2-11)	4.7 (4.3-5.5)
Elizabeth	0.103 (0.030-0.190)	8.0 (4.2-12.8)	237 (217-261)	0.6 (0.5-0.7)
Gallilee	0.010 (0.000-0.020)	1.9 (1.5-2.4)	12 (8-17)	3.4 (2.4-4.1)
Geneva	0.072 (0.000-0.380)	1.4 (0.9-1.9)	10 (6-20)	3.1 (3.0-3.5)

Table 22. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)	POTASSIUM (mg/l)	TOTAL PHOSPHATE (mg/l)	TOTAL ORGANIC NITROGEN (mg/l)	AMMONIA NITROGEN (mg/l)
Hickory Pond	46 (39-52)	3.5 (1.2-7.0)	7.8 (7.0-8.5)	6.0 (5.5-6.4)	0.7 (0.2-0.9)	0.027 (0.020-0.032)	0.700 (0.630-0.750)	0.063 (0.000-0.110)
Little Santa Fe	54 (51-56)	4.5 (0.8-10.5)	0.8 (0.3-1.2)	5.6 (1.9-7.8)	0.3 (0.1-0.4)	0.015 (0.010-0.026)	0.613 (0.540-0.690)	0.157 (0.000-0.440)
McCloud	34 (31-38)	1.7 (0.8-3.4)	0.7 (0.6-0.9)	4.0 (2.4-5.2)	0.2 (0.1-0.3)	0.017 (0.010-0.024)	0.303 (0.140-0.500)	0.043 (0.000-0.110)
Meta	93 (79-108)	7.8 (2.1-11.0)	1.2 (1.0-1.4)	4.9 (3.7-6.1)	1.1 (0.1-2.7)	0.030 (0.030-0.030)	0.807 (0.610-0.990)	0.240 (0.050-0.460)

	NITRATE NITROGEN (mg/l)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l pt)	SECCHI (m)
Hickory Pond	0.053 (0.010-0.130)	7.6 (5.7-10.1)	62 (37-77)	1.8 (1.2-2.4)
Little Santa Fe	0.120 (0.000-0.330)	4.5 (2.9-5.8)	149 (98-209)	1.5 (1.2-1.8)
McCloud	0.022 (0.010-0.050)	2.4 (1.0-4.7)	4 (0-10)	4.8 (2.7-5.8)
Meta	0.073 (0.010-0.190)	3.3 (2.4-4.3)	25 (18-29)	2.2 (1.5-3.4)

Table 22. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN, (mg/1)	AMMONIA NITROGEN (mg/1)
Mize	53 (49-57)	3.4 (2.6-4.0)	0.9 (0.9-1.0)	6.7 (5.1-8.0)	0.3 (0.1-0.5)	0.113 (0.040-0.180)	0.848 (0.570-1.090)	0.310 (0.050-0.980)
Moss Lee	43 (41-44)	2.3 (1.3-3.6)	0.9 (0.9-1.0)	6.2 (5.5-7.0)	0.4 (0.1-0.6)	0.036 (0.030-0.047)	0.770 (0.580-0.890)	0.063 (0.000-0.150)
Santa Fe	53 (44-52)	9.6 (2.2-15)	0.9 (0.7-1.1)	8.1 (7.0-10.0)	0.367 (0.150-0.500)	0.021 (0.010-0.030)	0.498 (0.410-0.570)	0.097 (0.000-0.290)
Santa Rosa	37 (36-39)	1.4 (0.9-2.2)	0.7 (0.6-0.7)	4.1 (2.5-5.7)	0.3 (0.1-0.4)	0.011 (0.010-0.014)	0.187 (0.180-0.200)	0.087 (0.000-0.230)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Mize	0.133 (0.000-0.560)	33.9 (6.4-65.7)	433 (134-715)	0.5 (0.2-0.9)
Moss Lee	0.120 (0.010-0.340)	8.1 (3.8-16.2)	98 (71-140)	1.4 (1.2-1.5)
Santa Fe	0.048 (0.000-0.200)	5.6 (4.2-7.7)	59 (31-95)	2.3 (1.7-3.7)
Santa Rosa	0.083 (0.000-0.240)	1.7 (0.6-2.6)	2 (0-5)	6.4 (5.2-7.3)

Table 22. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)	POTASSIUM (mg/l)	TOTAL PHOSPHATE (mg/l)	TOTAL ORGANIC NITROGEN (mg/l)	AMMONIA NITROGEN (mg/l)
Still Pond	38 (36-40)	2.5 (1.2-3.8)	0.9 (0.8-0.9)	5.3 (5.0-5.8)	0.2 (0.1-0.3)	0.013 (0.010-0.018)	0.627 (0.580-0.710)	0.030 (0.000-0.060)
Suggs	46 (43-50)	2.1 (1.2-3.6)	0.9 (0.8-1.0)	5.0 (3.3-6.6)	0.2 (0.1-0.3)	0.036 (0.020-0.060)	0.693 (0.540-0.810)	0.118 (0.000-0.290)
Lake Swan	44 (38-47)	2.1 (1.3-2.5)	0.9 (0.9-1.0)	5.4 (4.1-7.1)	0.5 (0.2-0.7)	0.011 (0.005-0.019)	0.268 (0.180-0.330)	0.018 (0.000-0.070)
Wall	42 (40-45)	1.8 (1.3-2.5)	0.8 (0.7-0.8)	5.1 (3.4-6.9)	0.3 (0.1-0.5)	0.025 (0.020-0.030)	0.670 (0.620-0.740)	0.123 (0.000-0.300)

	NITRATE NITROGEN (mg/l)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l pt)	SECCHI (m)
Still Pond	0.007 (0.000-0.010)	3.1 (2.3-4.3)	26 (16-34)	2.0 (0.9-3.3)
Suggs	0.058 (0.000-0.260)	3.4 (2.0-5.0)	281 (210-340)	0.9 (0.9-1.1)
Lake Swan	0.008 (0.000-0.040)	1.6 (0.9-2.0)	6 (0-10)	3.2 (2.4-3.7)
Wall	0.040 (0.000-0.120)	5.1 (3.8-7.1)	151 (97-196)	1.4 (1.1-1.8)

Table 22. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)	POTASSIUM (mg/l)	TOTAL PHOSPHATE (mg/l)	TOTAL ORGANIC NITROGEN (mg/l)	AMMONIA NITROGEN (mg/l)
Winnott	41 (36-47)	2.3 (1.5-3.2)	0.7 (0.7-0.8)	4.5 (2.5-6.1)	0.4 (0.1-0.6)	0.023 (0.020-0.030)	0.563 (0.320-0.830)	0.097 (0.010-0.250)
Unnamed Twenty-five	93 (75-119)	18 (11-31)	0.5 (0.4-0.7)	1.7 (1.4-2.0)	0.2 (0.1-0.3)	0.028 (0.020-0.035)	0.733 (0.610-0.800)	0.037 (0.000-0.080)

	NITRATE NITROGEN (mg/l)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/l pt)	SECCHI (m)
Winnott	0.087 (0.000-0.260)	2.6 (0.8-4.1)	23 (16-28)	3.4 (2.2-4.0)
Unnamed Twenty-five	0.013 (0.000-0.040)	3.5 (1.7-6.5)	36 (23-57)	1.5 (1.1-2.0)

Table 23. Mean percentage of major cations and anions in lakes located on the Northern Highlands.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Alligator Lake	58	15	23	2	52	13	14	20
Lake Butler	31	19	45	3	12	0	36	52
Lake Crosby	27	19	52	1	11	0	40	50
Lake Geneva	23	20	55	2	12	0	38	50
Hampton Lake	26	20	52	2	9	0	35	56
Lake Louise	41	15	42	1	24	0	22	54
Ocean Pond	18	20	58	1	3	0	41	56
Palestine Lake	20	21	57	1	5	0	39	56
Lake Rowell	52	10	37	1	20	0	69	11
Lake Sampson	47	11	41	1	15	0	67	18
Santa Fe Lake	21	19	58	1	12	0	29	58
Suwannee Lake	45	18	33	3	38	0	26	36
Watertown Lake	68	12	15	4	77	5	6	12

be attributed to variations in the regional geology. In the eastern karstic zone, the lakes (Anderson-Cue, Brooklyn, Clearwater, Cowpen, Gallilee , Geneva, McCloud, Santa Rosa, Swan and Winnot) can be characterized as clear, acidic, soft-water lakes of low mineral content. Mean water clarity ranged from 3.1 m to 6.4 m. Available pH data indicates mean pH ranged from 4.9 to 6.4. Shannon and Brezonik (1972) in their study of this region's limnology found the median pH to be 5.8, the median alkalinity to be 2.8 mg/l as $CaCO_3$, the median conductivity to be 48 μmhos/cm and the median calcium concentration to be 3.0 mg/l. As can be seen by the data for Lake Geneva (Table 23), sodium was the dominant cation and chloride followed by sulfate were the dominant anions in the lakes. This chemical composition reflects the importance of atmospheric precipitation as a major mechanism determining surface water chemistry. As a group, the lakes in this region can also be characterized as oligotrophic or oligo-mesotrophic. Mean chlorophyll a concentrations averaged below 3 mg/m^3 in all the study lakes which indicates the lakes are oligotrophic, but high phosphorus concentrations (see Lake Geneva; Table 20) were occasionally measured which suggests the lake may occasionally show the characteristics of oligo-mesotrophic lakes.

Outside the eastern karstic zone, there is a group of lakes (Adaho, Altho, Butler, Crosby, Elisabeth, Hampton, Hickory Pond, Little Santa Fe, Louise, Moss Lee, Ocean Pond, Palestine, Santa Fe, Still Pond, Suggs, and Wall) located in clastic deposits from the Recent which can be characterized as colored, acid, soft-water lakes. Water clarity, as measured by a Secchi disc, averaged between 0.6 m and 2.2 m. The low to moderate water clarity readings result largely from high color levels. Mean color values ranged from 26 to 336 mg/l as Pt. Mean pH values averaged between 4.1 and 6.0 and mean total alkalinity concentrations averaged between 0 and 5 mg/l as $CaCO_3$. Shannon and Brezonik (1972) report a median pH of 5.7 and a median alkalinity of 2.4 mg/l as $CaCO_3$. Conductivity was low, averaging between 35 and 54 μmhos/cm. Calcium concentrations averaged between 1 and 5 mg/l and sodium concentrations averaged between 4 and 8 mg/l. In this group of lakes (Table 23), sodium was generally the dominant cation and chloride the dominant anion. This results because most of the lakes receive the bulk of their water from atmospheric precipitation or from surface/subsurface runoff, which comes from sandy, low-calcareous soils. The trophic status of these lakes can be characterized as mesotrophic. Total phosphorus values averaged between 10 and 30 mg/m^3 (Tables 20, 21, and 22) largely because surface inflows pass through sands that are slightly enriched with phosphorus. Chlorophyll a concentrations averaged between 3.3 and 11 mg/m^3.

A third distinct group of lakes in the Northern Highlands consists of lakes located in the phosphatic Hawthorn Formation. This includes Beville's Pond, Cooter Pond, Lake Mize, and Suwannee Lake. Similar to lakes located in deposits from the Recent, these lakes can be characterized as colored, acid, soft-water lakes of low mineral content. Mean conductivity ranged between 38 and 60 μmhos/cm. Mean pH averaged less than 7 and calcium concentrations averaged between 3 and 6 mg/l. Color values averaged between 20 and 433 mg/l as Pt. Dissimilar to the lakes located in deposits from the Recent, the lakes on the Hawthorn Formation

Table 21. Means of limnological parameters measured in lakes located on the Northern Highlands. Numbers in parentheses are the minimum and maximum values measured. Period or record 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (µmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Alligator	7.4 (6.4-8.6)	7.1 (6.5-7.9)	45 (20-66)	1.6 (0.0-8.0)	154 (75-189)	43 (43-43)	14 (7.4-20)	2.4 (1.7-3.0)	10 (4.2-13)
Altho	6.0 (5.0-7.0)	5.9 (5.1-7.1)	3.1 (2.0-7.0)	0.0 (0.0-0.0)	61 (45-72)	8.8 (8.0-10)	1.9 (1.4-2.6)	0.9 (0.5-1.0)	5.1 (4.7-5.6)
Brooklyn	4.9 (4.4-5.2)	5.4 (4.6-6.0)	0.9 (0.0-4.0)	0.0 (0.0-0.0)	37 (28-56)	3.5 (3.0-4.0)	0.7 (0.6-0.8)	0.5 (0.4-0.6)	2.4 (2.2-2.7)
Butler	5.6 (4.9-6.4)	5.8 (5.1-6.4)	2.3 (1.0-4.0)	0.0 (0.0-0.0)	51 (37-62)	8.0 (8.0-8.0)	2.2 (1.8-2.8)	0.8 (0.6-0.9)	3.3 (2.7-3.7)

LAKE	POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
Alligator	1.7 (0.3-2.7)	15 (15-15)	3.5 (1.0-6.5)	*** ***	0.410 (0.410-0.410)	2.99 (1.00-3.90)	38 (8.6-87)	*** ***	3.3 (1.8-4.8)
Altho	0.4 (0.0-0.6)	8.3 (4.5-10)	2.8 (0.4-4.0)	0.4 (0.1-0.6)	0.223 (0.160-0.340)	0.148 (0.050-0.640)	0.5 (0.0-1.6)	55 (50-60)	4.4 (2.0-5.6)
Brooklyn	0.2 (0.1-0.2)	7.0 (4.5-9.5)	3.2 (3.0-3.5)	*** ***	0.015 (0.010-0.020)	0.028 (0.010-0.040)	1.3 (0.0-2.1)	*** ***	12 (8.9-15)
Butler	0.5 (0.4-0.6)	3.8 (3.5-4.0)	2.8 (1.0-5.0)	*** ***	0.405 (0.380-0.430)	0.078 (0.060-0.100)	2.8 (0.0-4.8)	*** ***	3.3 (2.8-4.3)

Table 21. (cont.).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Geneva	6.2 (5.6-6.5)	6.2 (5.8-6.4)	4.3 (1.0-20)	0.0 (0.0-0.0)	60 (47-90)	7.0 (6.0-8.0)	1.7 (1.4-1.8)	0.9 (0.8-1.0)	4.3 (4.0-4.8)
Ocean Pond	4.8 (4.2-5.6)	5.0 (4.2-5.6)	2.6 (0.0-17)	0.0 (0.0-0.0)	45 (25-57)	5.3 (4.0-6.0)	1.0 (0.8-1.2)	0.5 (0.3-0.7)	3.2 (2.4-3.9)
Palestine	4.6 (4.1-5.3)	5.0 (4.5-5.5)	2.0 (0.0-8.0)	0.0 (0.0-0.0)	40 (31-46)	5.0 (5.0-5.0)	1.1 (0.9-1.4)	0.7 (0.5-0.8)	2.7 (2.4-3.2)
Sampson	7.1 (6.6-7.8)	6.9 (6.4-7.4)	10 (4.0-19)	0.0 (0.0-0.0)	141 (86-189)	38 (32-43)	11 (6.7-16)	1.8 (1.0-2.7	10 (5.8-17)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m³)	COLOR (mg/1 Pt)	SECCHI (ft)
0.5 (0.4-0.8)	7.8 (7.0-8.5)	6.0 (5.5-6.5)	*** ***	0.030 (0.020-0.040)	0.025 (0.010-0.040)	1.0 (0.0-1.6)	*** ***	11 (7.2-15)
0.1 (0.0-0.2)	5.4 (4.0-7.0)	1.9 (0.0-4.0)	2.5 (1.7-3.3)	0.340 (0.240-0.430)	0.139 (0.040-0.390)	2.0 (1.3-3.2)	120 (120-120)	3.5 (2.0-6.0)
0.2 (0.1-0.2)	4.0 (3.5-4.5)	1.5 (0.0-4.0)	*** ***	0.240 (0.230-0.250)	0.063 (0.040-0.100)	4.0 (3.2-4.8)	*** ***	2.8 (2.1-3.3)
1.0 (0.7-1.3)	6.8 (6.0-7.5)	26 (13-42)	*** ***	0.150 (0.090-0.210)	0.128 (0.070-0.220)	7.2 (3.2-9.6)	*** ***	3.8 (1.7-5.3)

Table 21. (cont.).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Watertown	7.4 (7.0-7.6)	7.3 (6.4-8.1)	52 (34-75)	0.0 (0.0-0.0)	148 (105-190)	37 (35-38)	11 (0.0-19)	7.9 (2.4-25)	5.3 (2.3-7.6)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
3.9 (2.5-6.9)	8.6 (7.2-10)	6.7 (0.0-25)	1.3 (1.2-1.3)	0.180 (0.080-0.230)	0.174 (0.010-0.360)	15.5 (4.8-32.1)	20 (20-20)	3.9 (2.3-7.3)

Table 22. Means of limnological parameters measured in lakes located on the Northern Highlands. Numbers in parentheses are the minimum and maximum values measured. Period of record 1979-1970. Data from Shannon (1970).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN. (mg/1)	AMMONIA NITROGEN (mg/1)
Adaho	37 (26-47)	2.2 (1.4-3.5)	0.9 (0.8-1.0)	4.9 (3.2-6.5)	0.2 (0.1-0.4)	0.027 (0.010-0.041)	0.717 (0.450-0.880)	0.417 (0.030-0.360)
Alice	552 (445-634)	59 (17-88)	13 (11-16)	19 (16-23)	2.1 (0.5-5)	0.900 (0.520-1.800)	0.503 (0.370-0.770)	0.070 (0.000-0.260)
Altho	53 (46-55)	4.0 (1.8-7.5)	1.0 (0.8-1.2)	7.3 (7.0-7.5)	0.4 (0.2-0.5)	0.023 (0.010-0.030)	0.593 (0.540-0.620)	0.063 (0.040-0.100)
Anderson-Cue	38 (35-40)	1.7 (0.9-2.6)	0.7 (0.7-0.8)	3.5 (2.0-5.0)	0.3 (0.1-0.5)	0.019 (0.008-0.032)	0.278 (0.210-0.340)	0.140 (0.000-0.440)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Adaho	0.077 (0.000-0.200)	5.3 (2.5-7.6)	336 (250-398)	0.9 (0.6-1.1)
Alice	0.023 (0.000-0.090)	4.4 (2.1-6.9)	26 (16-31)	1.5 (1.2-2.0)
Altho	0.017 (0.000-0.040)	5.9 (5.5-6.5)	134 (98-160)	1.4 (1.2-1.7)
Anderson-Cue	0.092 (0.010-0.180)	3.2 (1.7-5.8)	3 (0-9)	3.7 (1.8-5.4)

Table 22. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN (mg/1)	AMMONIA NITROGEN (mg/1)
Beville's Pond	40 (37-41)	2.7 (2.0-3.2)	0.8 (0.7-0.9)	6.1 (2.9-8.0)	0.5 (0.1-0.8)	0.087 (0.071-0.100)	0.653 (0.460-0.820)	0.090 (0.060-0.150)
Brooklyn	30 (26-35)	2.1 (1.2-3.0)	0.7 (0.5-1.0)	3.2 (2.0-4.6)	0.2 (0.1-0.4)	0.011 (0.010-0.012)	0.280 (0.240-0.300)	0.027 (0.000-0.080)
Clear Water	40 (38-42)	2.0 (1.3-3.2)	0.7 (0.7-0.8)	4.9 (4.2-5.5)	0.2 (0.1-0.3)	0.012 (0.010-0.017)	1.320 (0.440-2.970)	0.040 (0.020-0.050)
Cooter Pond	60 (51-70)	5.8 (4.3-8.6)	1.2 (1.0-1.4)	5.0 (4.5-5.6)	1.9 (0.8-3.0)	0.165 (0.120-0.235)	1.263 (0.630-1.660)	0.120 (0.030-0.230)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Beville's Pond	0.090 (0.000-0.270)	23.7 (11.3-44.6)	182 (132-207)	2.1 (1.4-3.1)
Brooklyn	0.080 (0.000-0.220)	1.9 (1.8-2.1)	4 (3-7)	4.3 (3.4-5.8)
Clear Water	0.017 (0.000-0.050)	2.3 (1.9-2.6)	21 (15-32)	2.4 (1.0-4.6)
Cooter Pond	0.040 (0.000-0.080	22.6 (9.2-39.4)	83 (68-99)	0.9 (0.6-1.2)

Table 22. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN (mg/1)	AMMONIA NITROGEN (mg/1)
Cowpen	46 (38-53)	2.3 (1.7-2.9)	0.9 (0.8-1.0)	5.0 (4.0-7.0)	0.4 (0.1-0.6)	0.010 (0.010-0.010)	0.247 (0.110-0.350)	0.037 (0.020-0.050)
Elizabeth	48 (40-53)	3.7 (1.8-6.8)	1.0 (0.9-1.2)	5.2 (5.0-5.4)	0.4 (0.1-0.6)	0.036 (0.030-0.047)	0.810 (0.610-0.940)	0.023 (0.000-0.040)
Gallilee	38 (34-43)	2.3 (1.8-2.9)	0.8 (0.7-0.9)	4.5 (3.0-5.6)	0.3 (0.1-0.4)	0.014 (0.010-0.022)	0.360 (0.320-0.410)	0.017 (0.000-0.030)
Geneva	49 (42-58)	2.6 (1.7-3.7)	0.9 (0.8-1.0)	5.4 (4.0-7.2)	0.5 (0.2-0.6)	0.016 (0.005-0.039)	0.350 (0.220-0.500)	0.030 (0.000-0.050)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Cowpen	0.007 (0.000-0.020)	1.6 (1.5-1.6)	5 (2-11)	4.7 (4.3-5.5)
Elizabeth	0.103 (0.030-0.190)	8.0 (4.2-12.8)	237 (217-261)	0.6 (0.5-0.7)
Gallilee	0.010 (0.000-0.020)	1.9 (1.5-2.4)	12 (8-17)	3.4 (2.4-4.1)
Geneva	0.072 (0.000-0.380)	1.4 (0.9-1.9)	10 (6-20)	3.1 (3.0-3.5)

Table 22. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN (mg/1)	AMMONIA NITROGEN (mg/1)
Hickory Pond	46 (39-52)	3.5 (1.2-7.0)	7.8 (7.0-8.5)	6.0 (5.5-6.4)	0.7 (0.2-0.9)	0.027 (0.020-0.032)	0.700 (0.630-0.750)	0.063 (0.000-0.110)
Little Santa Fe	54 (51-56)	4.5 (0.8-10.5)	0.8 (0.3-1.2)	5.6 (1.9-7.8)	0.3 (0.1-0.4)	0.015 (0.010-0.026)	0.613 (0.540-0.690)	0.157 (0.000-0.440)
McCloud	34 (31-38)	1.7 (0.8-3.4)	0.7 (0.6-0.9)	4.0 (2.4-5.2)	0.2 (0.1-0.3)	0.017 (0.010-0.024)	0.303 (0.140-0.500)	0.043 (0.000-0.110)
Meta	93 (79-108)	7.8 (2.1-11.0)	1.2 (1.0-1.4)	4.9 (3.7-6.1)	1.1 (0.1-2.7)	0.030 (0.030-0.030)	0.807 (0.610-0.990)	0.240 (0.050-0.460)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Hickory Pond	0.053 (0.010-0.130)	7.6 (5.7-10.1)	62 (37-77)	1.8 (1.2-2.4)
Little Santa Fe	0.120 (0.000-0.330)	4.5 (2.9-5.8)	149 (98-209)	1.5 (1.2-1.8)
McCloud	0.022 (0.010-0.050)	2.4 (1.0-4.7)	4 (0-10)	4.8 (2.7-5.8)
Meta	0.073 (0.010-0.190)	3.3 (2.4-4.3)	25 (18-29)	2.2 (1.5-3.4)

Table 22. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN, (mg/1)	AMMONIA NITROGEN (mg/1)
Mize	53 (49-57)	3.4 (2.6-4.0)	0.9 (0.9-1.0)	6.7 (5.1-8.0)	0.3 (0.1-0.5)	0.113 (0.040-0.180)	0.848 (0.570-1.090)	0.310 (0.050-0.980)
Moss Lee	43 (41-44)	2.3 (1.3-3.6)	0.9 (0.9-1.0)	6.2 (5.5-7.0)	0.4 (0.1-0.6)	0.036 (0.030-0.047)	0.770 (0.580-0.890)	0.063 (0.000-0.150)
Santa Fe	53 (44-52)	9.6 (2.2-15)	0.9 (0.7-1.1)	8.1 (7.0-10.0)	0.367 (0.150-0.500)	0.021 (0.010-0.030)	0.498 (0.410-0.570)	0.097 (0.000-0.290)
Santa Rosa	37 (36-39)	1.4 (0.9-2.2)	0.7 (0.6-0.7)	4.1 (2.5-5.7)	0.3 (0.1-0.4)	0.011 (0.010-0.014)	0.187 (0.180-0.200)	0.087 (0.000-0.230)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Mize	0.133 (0.000-0.560)	33.9 (6.4-65.7)	433 (134-715)	0.5 (0.2-0.9)
Moss Lee	0.120 (0.010-0.340)	8.1 (3.8-16.2)	98 (71-140)	1.4 (1.2-1.5)
Santa Fe	0.048 (0.000-0.200)	5.6 (4.2-7.7)	59 (31-95)	2.3 (1.7-3.7)
Santa Rosa	0.083 (0.000-0.240)	1.7 (0.6-2.6)	2 (0-5)	6.4 (5.2-7.3)

Table 22. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN (mg/1)	AMMONIA NITROGEN (mg/1)
Still Pond	38 (36-40)	2.5 (1.2-3.8)	0.9 (0.8-0.9)	5.3 (5.0-5.8)	0.2 (0.1-0.3)	0.013 (0.010-0.018)	0.627 (0.580-0.710)	0.030 (0.000-0.060)
Suggs	46 (43-50)	2.1 (1.2-3.6)	0.9 (0.8-1.0)	5.0 (3.3-6.6)	0.2 (0.1-0.3)	0.036 (0.020-0.060)	0.693 (0.540-0.810)	0.118 (0.000-0.290)
Lake Swan	44 (38-47)	2.1 (1.3-2.5)	0.9 (0.9-1.0)	5.4 (4.1-7.1)	0.5 (0.2-0.7)	0.011 (0.005-0.019)	0.268 (0.180-0.330)	0.018 (0.000-0.070)
Wall	42 (40-45)	1.8 (1.3-2.5)	0.8 (0.7-0.8)	5.1 (3.4-6.9)	0.3 (0.1-0.5)	0.025 (0.020-0.030)	0.670 (0.620-0.740)	0.123 (0.000-0.300)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Still Pond	0.007 (0.000-0.010)	3.1 (2.3-4.3)	26 (16-34)	2.0 (0.9-3.3)
Suggs	0.058 (0.000-0.260)	3.4 (2.0-5.0)	281 (210-340)	0.9 (0.9-1.1)
Lake Swan	0.008 (0.000-0.040)	1.6 (0.9-2.0)	6 (0-10)	3.2 (2.4-3.7)
Wall	0.040 (0.000-0.120)	5.1 (3.8-7.1)	151 (97-196)	1.4 (1.1-1.8)

Table 22. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)	POTASSIUM (mg/l)	TOTAL PHOSPHATE (mg/l)	TOTAL ORGANIC NITROGEN (mg/l)	AMMONIA NITROGEN (mg/l)
Winnott	41 (36-47)	2.3 (1.5-3.2)	0.7 (0.7-0.8)	4.5 (2.5-6.1)	0.4 (0.1-0.6)	0.023 (0.020-0.030)	0.563 (0.320-0.830)	0.097 (0.010-0.250)
Unnamed Twenty-five	93 (75-119)	18 (11-31)	0.5 (0.4-0.7)	1.7 (1.4-2.0)	0.2 (0.1-0.3)	0.028 (0.020-0.035)	0.733 (0.610-0.800)	0.037 (0.000-0.080)

	NITRATE NITROGEN (mg/l)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l pt)	SECCHI (m)
Winnott	0.087 (0.000-0.260)	2.6 (0.8-4.1)	23 (16-28)	3.4 (2.2-4.0)
Unnamed Twenty-five	0.013 (0.000-0.040)	3.5 (1.7-6.5)	36 (23-57)	1.5 (1.1-2.0)

Table 23. Mean percentage of major cations and anions in lakes located on the Northern Highlands.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Alligator Lake	58	15	23	2	52	13	14	20
Lake Butler	31	19	45	3	12	0	36	52
Lake Crosby	27	19	52	1	11	0	40	50
Lake Geneva	23	20	55	2	12	0	38	50
Hampton Lake	26	20	52	2	9	0	35	56
Lake Louise	41	15	42	1	24	0	22	54
Ocean Pond	18	20	58	1	3	0	41	56
Palestine Lake	20	21	57	1	5	0	39	56
Lake Rowell	52	10	37	1	20	0	69	11
Lake Sampson	47	11	41	1	15	0	67	18
Santa Fe Lake	21	19	58	1	12	0	29	58
Suwannee Lake	45	18	33	3	38	0	26	36
Watertown Lake	68	12	15	4	77	5	6	12

be attributed to variations in the regional geology. In the eastern karstic zone, the lakes (Anderson-Cue, Brooklyn, Clearwater, Cowpen, Gallilee , Geneva, McCloud, Santa Rosa, Swan and Winnot) can be characterized as clear, acidic, soft-water lakes of low mineral content. Mean water clarity ranged from 3.1 m to 6.4 m. Available pH data indicates mean pH ranged from 4.9 to 6.4. Shannon and Brezonik (1972) in their study of this region's limnology found the median pH to be 5.8, the median alkalinity to be 2.8 mg/l as $CaCO_3$, the median conductivity to be 48 μmhos/cm and the median calcium concentration to be 3.0 mg/l. As can be seen by the data for Lake Geneva (Table 23), sodium was the dominant cation and chloride followed by sulfate were the dominant anions in the lakes. This chemical composition reflects the importance of atmospheric precipitation as a major mechanism determining surface water chemistry. As a group, the lakes in this region can also be characterized as oligotrophic or oligo-mesotrophic. Mean chlorophyll a concentrations averaged below 3 mg/m^3 in all the study lakes which indicates the lakes are oligotrophic, but high phosphorus concentrations (see Lake Geneva; Table 20) were occasionally measured which suggests the lake may occasionally show the characteristics of oligo-mesotrophic lakes.

Outside the eastern karstic zone, there is a group of lakes (Adaho, Altho, Butler, Crosby, Elisabeth, Hampton, Hickory Pond, Little Santa Fe, Louise, Moss Lee, Ocean Pond, Palestine, Santa Fe, Still Pond, Suggs, and Wall) located in clastic deposits from the Recent which can be characterized as colored, acid, soft-water lakes. Water clarity, as measured by a Secchi disc, averaged between 0.6 m and 2.2 m. The low to moderate water clarity readings result largely from high color levels. Mean color values ranged from 26 to 336 mg/l as Pt. Mean pH values averaged between 4.1 and 6.0 and mean total alkalinity concentrations averaged between 0 and 5 mg/l as $CaCO_3$. Shannon and Brezonik (1972) report a median pH of 5.7 and a median alkalinity of 2.4 mg/l as $CaCO_3$. Conductivity was low, averaging between 35 and 54 µmhos/cm. Calcium concentrations averaged between 1 and 5 mg/l and sodium concentrations averaged between 4 and 8 mg/l. In this group of lakes (Table 23), sodium was generally the dominant cation and chloride the dominant anion. This results because most of the lakes receive the bulk of their water from atmospheric precipitation or from surface/subsurface runoff, which comes from sandy, low-calcareous soils. The trophic status of these lakes can be characterized as mesotrophic. Total phosphorus values averaged between 10 and 30 mg/m^3 (Tables 20, 21, and 22) largely because surface inflows pass through sands that are slightly enriched with phosphorus. Chlorophyll a concentrations averaged between 3.3 and 11 mg/m^3.

A third distinct group of lakes in the Northern Highlands consists of lakes located in the phosphatic Hawthorn Formation. This includes Beville's Pond, Cooter Pond, Lake Mize, and Suwannee Lake. Similar to lakes located in deposits from the Recent, these lakes can be characterized as colored, acid, soft-water lakes of low mineral content. Mean conductivity ranged between 38 and 60 µmhos/cm. Mean pH averaged less than 7 and calcium concentrations averaged between 3 and 6 mg/l. Color values averaged between 20 and 433 mg/l as Pt. Dissimilar to the lakes located in deposits from the Recent, the lakes on the Hawthorn Formation are all eutrophic. Total phosphorus values (Table 20 and 22) averaged well above 30 mg/m^3 as a result of natural phosphorus inputs originating from the highly phosphatic sands of the Hawthorn Formation. Consequently, the lakes support high levels of plankton algae with mean chlorophyll _a_ concentrations averaging between 21 and 34 mg/m^3.

Finally, there remains a group of lakes of variable water quality. This group includes Lake Alice, Alligator Lake, Lake Rowell, Lake Sampson, and Watertown Lake. With the exception of Watertown Lake, all of these lakes have received, either directly or indirectly, nutrient inputs from municipal treatment plants. Consequently, the lakes can be characterized as eutrophic. Mean total phosphorus values averaged over 30 mg/m^3. Thus, all of the lakes, with the exception of Lake Alice and Lake Sampson (which receives indirect inputs from Lake Rowell), experienced chlorophyll _a_ levels greater than 15 mg/m^3. Lake Alice, when sampled by Shannon (1970), was covered with water hyacinths, but today supports excessive growths of planktonic algae (personal observations). Watertown Lake, similar to Alligator Lake, is a hard-water lake. Mean total hardness averaged 78 mg/l as $CaCO_3$. This hardness, however, cannot be attributed to artificial inputs such as domestic wastes. Both Watertown Lake and Alligator Lake are located on deposits of limestone and are connected to the groundwater by limestone sinks (Holcomb 1968). This suggests there may be a group of hard-water lakes located along the periphery of the Northern Highlands, especially where Suwannee Limestone occurs.

9. _Trail Ridge_: The Trail Ridge (Figure 4) which is located in

portions of Baker, Bradford and Clay counties, is a relict marine littoral feature (White 1970). The ridge crowns the eastern edge of the Northern Highlands just north of the Northern Highlands' karstic zone. The geology of the region is dominated by sands of the Fort Preston Formation (Vernon and Puri 1964). Like other regions with this formation, the Trail Ridge has a karstic landscape filled with numerous sinkhole lakes. In this study, 3 lakes (Kingsley Lake, Lowry Lake, and Magnolia Lake) were sampled. Data are presented in Table 24.

Lowry Lake and Magnolia Lake can be characterized as acid, soft-water lakes. Both lakes had an average pH of 5.1. Total alkalinity averaged 1 mg/l as $CaCO_3$ and total hardness concentrations averaged 3.3 mg/l as $CaCO_3$. Mineral content in these lakes was very low as reflected by the mean specific conductance of 23 μmhos/cm. In both lakes, sodium was the dominant cation and chloride and sulfate were the dominant anions (Table 25). This, as with other sinkhole lakes, probably results because atmospheric precipitation is the dominant mechanism influencing water chemistry and all surface/subsurface inflows come from sandy, non-calcareous soils.

Kingsley Lake, however, is chemically different. The lake had a mean pH of 7.0 and an average total alkalinity of 10 mg/l as $CaCO_3$. Total hardness averaged 15 mg/l as $CaCO_3$ and mean specific conductance was 54 μmhos/cm. Calcium and magnesium, rather than sodium, were the dominant cations and bicarbonate occurred in roughly equal proportions with chloride (Table 25). These differences result largely from inputs of mineralized groundwater (Clark at al. 1964).

Although there are differences in water chemistry, the trophic

Table 24. Means of limnological parameters measured in lakes located on the Trail Ridge. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Kingsley Lake	7.0 (6.8-7.2)	10 (8-11)	0 (0-0)	54 (50-57)	15 (15-16)	13 (11-16)	5.0 (4.3-5.6)	0.2 (0.1-0.3)	7.0 (6.8-7.3)
Lowry Lake	5.1 (5.0-5.1)	1 (0.8-2)	0 (0-0)	23 (23-24)	3.3 (3.0-4.0)	1.1 (1.0-1.5)	2.7 (1.9-3.5)	0.1 (0-0.2)	4.3 (4.0-4.5)
Magnolia Lake	5.1 (5.0-5.2)	1 (1-1)	0 (0-0)	23 (22-24)	3.4 (3.0-4.0)	1.7 (1.0-2.0)	2.5 (1.4-3.2)	0.1 (0-0.2)	4.4 (4.3-4.5)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Kingsley Lake	7.7 (5.2-12)	0.5 (0.4-0.7)	36.8 (20.0-53.5)	279 (167-375)	10.9 (0.5-23.1)	2.0 (1.4-2.8)	6 (5-10)	4.2 (3.1-5.0)
Lowry Lake	5.1 (3.5-8.5)	1.8 (0.8-2.4)	16.4 (10.4-24.3)	91.0 (26.4-133)	13.0 (1.2-27.9)	2.0 (1.0-4.5)	1 (0-5)	3.8 (2.6-5.0)
Magnolia Lake	5.9 (3.3-10)	0.9 (0.5-1.3)	16.8 (11.5-20.9)	97.1 (0-200)	13.0 (0.3-33.1)	1.4 (0.7-2.8)	3 (0-5)	4.8 (3.8-5.5)

Table 25. Mean percentage of major cations and anions in lakes located on the Trail Ridge.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Kingsley Lake	48	10	41	1	35	0	29	36
Lowry Lake	12	24	63	1	9	0	42	48
Magnolia Lake	19	19	60	1	8	0	46	46

status of the Trail Ridge lakes is very similar. All the lakes studied can be characterized as oligotrophic or oligo-mesotrophic. Total nitrogen concentrations averaged between 91 and 279 mg/m^3 and chlorophyll a concentrations averaged between 1.4 and 2.0 mg/m^3. These values are well within the range characteristic of oligotrophic lakes (Table 4). In addition, water clarity was very high, ranging from an average of 3.8 to 4.8 m. Total phosphorus values, however, averaged between 10.9 and 13 mg/m^3 which is characteristic of mesotrophic lakes. Based on these results, however, lakes on the Trail Ridge are probably oligotrophic at best and oligo-mesotrophic at worst.

10. Gulf Coastal Lowlands: The Gulf Coastal Lowlands of northern Florida (Figure 4) consist of the low, poorly-drained lands which lie between the Gulf of Mexico and the scarp of the inland highlands. This physiographic region includes a number of geological formations (Figure 3; Vernon and Puri 1964). In western panhandle Florida, marine and estuarine sediments dominate (Vernon and Puri 1964). These deposits extend east to Wakulla County where sands of the Jackson Bluff Formation occur (Vernon and Puri 1964). In eastern Wakulla County, deposits from the St. Marks Formation (Vernon and Puri 1964) dominate. Suwannee Limestone is dominant in Taylor County and limestone of the Crystal River Formation is dominant in LaFayette and Dixie counties (Vernon and Puri 1964.) Along the coast where barrier sand dunes occur, there are numerous barrier lagoon lakes. Inland, in the poorly-drained areas, lakes are found in shallow depressions that occur in sandy soils.

In this study, 9 lakes (Corn Landing Lake, Dead Lake, Deer Point Lake, Lake Ellen, Otter Lake, Oyster Lake, Townsend Pond, Western Lake, and Lake Wimico were sampled. Data are presented in Table 26. Additional

Table 26. Means of limnological parameters measured in lakes located in the Gulf Coastal Lowlands of northern Florida. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Corn Landing Lake	7.0 (6.7-7.3)	27 (25-28)	0 (0-0)	199 (190-210)	41 (39-43)	30 (28-32)	27 (24-28)	1.3 (1.1-1.4)	44 (38-50)
Dead Lake	6.1 (5.6-6.7)	12 (3-28)	0 (0-0)	38 (21-61)	15 (6-28)	12 (4-22)	3.2 (2.1-9.6)	0.3 (0.1-0.4)	3.2 (2.8-3.5)
Deer Point Lake	6.8 (6.5-7.5)	23 (17-32)	0 (0-0)	60 (47-72)	25 (20-34)	19 (14-26)	4.1 (2.9-9.6)	0.3 (0.2-0.4)	4.5 (4.0-5.0)
Lake Ellen	4.9 (4.8-5.1)	1 (1-2)	0 (0-0)	23 (20-24)	4.9 (4.5-5.5)	2.8 (2.0-3.5)	2.6 (2.5-2.7)	0.2 (0.1-0.3)	3.5 (3.0-3.8)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Corn Landing Lake	12 (9.3-13)	1.4 (1.1-1.7)	172 (163-180)	574 (508-658)	13.0 (9.1-14.8)	2.8 (0.6-5.2)	82 (75-90)	1.3 (1.0-1.5)
Dead Lake	5.3 (0-12)	3.2 (2.4-3.9)	249 (128-464)	312 (158-445)	14.7 (7.8-37.3)	3.6 (1.5-8.0)	68 (40-90)	2.0 (0.7-3.0)
Deer Point Lake	6.0 (0-12)	3.8 (3.2-4.2)	192 (118-234)	184 (125-266)	8.9 (2.5-13.1)	1.9 (1.4-3.1)	62 (25-90)	2.1 (1.2-3.0)
Lake Ellen	5.4 (2.9-8.8)	0.4 (0-0.8)	207 (188-242)	319 (259-350)	11.9 (6.7-19.5)	3.2 (1.8-4.7)	97 (50-120)	1.5 (1.2-1.7)

Table 26. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Otter Lake	4.5 (4.2-6.2)	2 (0-7)	0 (0-0)	128 (32-290)	18 (3.0-44)	11 (1.5-29)	21 (2.8-51)	0.7 (0.1-1.6)	36 (4.5-91)
Oyster Lake	6.5 (6.3-7.3)	19 (9.0-32)	0 (0-0)	4300 (1800-9100)	523 (178-1800)	97 (34-205)	837 (310-1900)	37 (16-80)	1600 (538-3600)
Townsend Pond	5.1 (4.6-5.4)	3 (2-4)	0 (0-0)	23 (21-30)	6.3 (5.5-7.5)	3.7 (3.0-4.0)	2.6 (0.9-4.4)	0.1 (0.1-0.2)	3.4 (2.5-3.8)
Western Lake	6.6 (6.2-7.3)	21 (8-34)	0 (0-0)	5600 (1200-10000)	730 (126-1400)	130 (65-235)	1200 (200-2300)	51 (9.8-92)	2300 (1100-4300)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Otter Lake	11 (5.8-18)	1.4 (0.1-3.0)	209 (190-245)	493 (352-518)	28.7 (15.5-54.7)	2.9 (2.3-3.4)	222 (200-250)	0.9 (0.6-1.2)
Oyster Lake	135 (108-162)	1.3 (0.2-2.3)	250 (190-330)	548 (475-633)	34.0 (26.7-40.5)	4.0 (2.6-7.2)	208 (125-300)	0.9 (0.6-1.3)
Townsend Pond	3.5 (0-13)	0.3 (0.1-0.7)	241 (147-371)	633 (475-927)	8.8 (4.8-18)	5.6 (4.0-8.8)	117 (75-175)	1.3 (1.0-1.6)
Western Lake	186 (9.4-273)	3.1 (2.0-4.7)	196 (61-352)	289 (225-375)	5.7 (1.9-11.0)	1.2 (0.7-2.0)	141 (45-225)	1.7 (0.7-3.0)

Table 26. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Wimico	6.6 (6.2-7.2)	21 (13-28)	0 (0-0)	126 (71-250)	30 (18-43)	20 (10-27)	16 (4.1-43)	1.2 (0.8-2.1)	28 (5.0-83)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Wimico	8.3 (5.6-11)	5.1 (4.1-5.9)	871 (96-1700)	493 (323-675)	27.6 (17.7-38.5)	3.9 (2.8-6.2)	113 (75-175)	0.5 (0.2-0.6)

Table 27. Means of limnological parameters measured in lakes located in the Gulf Coastal Lowlands of northern Florida. Numbers in parentheses are the minimum and maximum values measured. Period of record 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Alligator Lake	7.2 (5.4-7.9)	7.7 (7.3-8.0)	89 (52-105)	0 (0-0)	363 (220-440)	115 (76-138)	41 (24-48)	5.1 (4.0-7.1)	21 (12-28)
Dead Lake	7.0 (6.4-8.1)	7.2 (7.1-7.5)	49 (37-61)	0 (0-0)	127 (103-50)	51 (45-56)	17 (14-21)	2.2 (1.5-3.4)	3.1 (2.0-4.5)
Deer Point Lake	6.9 (6.2-7.6)	7.0 (6.5-7.7)	22 (9-40)	0 (0-0)	87 (60-118)	20 (4.0-39)	7.6 (4.4-12)	1.3 (0.8-2.2)	4.6 (2.7-7.4)
Governor Hill	8.3 (8.0-8.6)	8.1 (6.7-8.8)	54 (45-66)	3 (0-9)	136 (118-173)	63 (51-72)	22 (19-27)	1.0 (0.6-1.2)	2.4 (1.8-2.8)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
6.1 (3.0-9.3)	31 (19-45)	28 (19-37)	8.3 (7.7-8.8)	0.353 (0.200-0.630)	0.954 (0.410-1.50)	24.9 (3.2-42.8)	75 (50-100)	2.1 (0.9-3.5)
0.4 (0.3-0.4)	2.8 (1.5-4.0)	0 (0-0)	- -	0.245 (0.220-0.270)	0.053 (0.020-0080)	0.6 (0-1.1)	- -	7.2 (4.9-9.5)
0.4 (0.0-0.6)	9.1 (6.0-14)	1.3 (0-3.0)	3.9 (3.8-3.9)	0.210 (0.120-0.310)	0.129 (0.020-0.470)	0.5 (0-2.1)	60 (40-80)	6.9 (4.8-12)
0.2 (0-1.1)	4.8 (3.0-6.5)	0.05 (0-0.4)	1.1 (0-2.2)	0.120 (0.070-0.200)	0.199 (0.010-1.00)	0.8 (0-2.1)	3 (0-5)	6.1 (3.5-8.0)

Table 28. Mean percentage of major cations and anions in lakes located in the Gulf Coastal Lowlands of Northern Florida.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Corn Landing Lake	30	11	58	2	27	0	12	61
Dead Lake	52	14	30	1	54	0	25	21
Deer Point Lake	56	17	26	1	64	0	18	18
Lake Ellen	25	19	51	2	11	0	47	41
Otter Lake	17	11	70	1	4	0	17	79
Oyster Lake	4	18	76	2	1	0	6	93
Townsend Lake (Koon Lake)	30	20	45	1	24	0	33	43
Western Lake	4	18	76	2	1	0	6	94
Lake Wimico	29	14	52	2	30	0	12	57

data (Table 27) were also obtained from the Florida Game and Fresh Water Fish Commission. From this data, it can be seen water quality in Florida's northern Gulf Coastal Lowlands is highly variable. This variability is not unexpected, however, as the region's geology is diverse; but, most of the variability in water quality seems attributable to the lake's water source. Consequently, patterns in the lake water chemistry can be discerned if the lakes are divided into groups based on the lake's water source.

A major lake grouping in the Gulf Coastal Lowlands is the barrier lagoon lakes. Though these lakes receive freshwater inputs via direct rainfall and surface runoff, saltwater inputs via breeches in the barrier sand dunes or saltwater intrusion are dominant. In this study, two of these lakes, Oyster Lake, and Western Lake, were sampled (Table 26). Mean pH was 6.5 in Oyster Lake and 6.6 in Western Lake. Total alkalinity averaged 20 mg/l as $CaCO_3$. Total hardness concentrations averaged 523 mg/l as $CaCO_3$ in Oyster Lake and 730 mg/l as $CaCO_3$ in Western Lake. Sulfate concentrations averaged 135 mg/l and 186 mg/l in Oyster Lake and Western Lake respectively. Sodium and chloride concentrations averaged 837 mg/l and 1600 mg/l respectively in Oyster Lake and 1200 mg/l and 2300 mg/l repectively in Western Lake. Mineral analyses (Table 28) showed sodium comprises over 75% of the measured cations and chloride comprises over 90% of the measured anions. From the data on Oyster Lake and Western Lake, the barrier lagoon lakes can be chemically characterized as slightly acidic, hard-water lakes of high mineral content. The overall chemistry of these lakes, however, can change as the proportion of freshwater inputs increases. The barrier lagoon lakes may freshen considerably with time and even support a freshwater fauna, as has happened in Western Lake (Staff, Grayton Beach State Park; personal communication). The lakes, however, can become highly saline in a short period of time if a storm should cause a breach in the barrier dunes or if deficiencies in rainfall result in increased saltwater intrusion.

A second major grouping of lakes in the Gulf Coastal Lowlands consists of those lakes that receive the majority of their water from direct rainfall and runoff from surrounding poorly drained, sandy soils. This lake type is represented by Lake Ellen and Townsend Pond (Table 26). In these lakes, pH averaged 4.9 and 5.1. Total alkalinity averaged less than 5 mg/1 as $CaCO_3$ and total hardness concentrations averaged less than 10 mg/1 as $CaCO_3$. Specific conductance averaged 23 μmhos/cm in each lake and the ionic composition was dominated by sodium, sulfate, and chloride (Table 28). Calcium and magnesium ions, however, were more prevalent in Townsend Pond than Lake Ellen (Table 28). This results primarily because Townsend Pond is located in a limestone region. Based on the data from Lake Ellen and Townsend Pond, lakes in this group can be chemically characterized as acid, soft-water lakes of low mineral content.

A third distinctive group of lakes in Florida's northern Gulf Coastal Lowlands is those lakes that receive a significant input of groundwater which has been in contact with underlying limestone formations. In this study, this group is represented by Dead Lake, Deer Point Lake, and Governor Hill Lake. Governor Hill Lake, which lies on limestone of the Crystal River Formation, receives nearly all of its water from limestone formations. Consequently, the lake's pH (mean field pH of 8.3) was high. Total alkalinity (Table 27) averaged 54 mg/1 as $CaCO_3$ and total hardness concentrations averaged 63 mg/1 as $CaCO_3$. Specific conductance averaged 136 μmhos/cm. In Dead Lake and Deer Point Lake, however, pH averaged 6.1 and 6.8 respectively. Mean total alkalinity ranged between 12 and 23 mg/l as $CaCO_3$ and mean total hardness ranged between 15 and 25 mg/l as $CaCO_3$. Specific conductance averaged 38 and 60 μmhos/cm respectively. These lower values result because water which has been in contact with limestone makes up a small percentage of each lake's total water budget. In all these lakes, however, the ionic composition (Table 28) was dominated by calcium, magnesium, and bicarbonate ions.

Finally, there is a group of lakes which exhibit chemical characteristics which are intermediate to those exhibited by the other lake types. This group includes Corn Landing Lake, Otter Lake, and Lake Wimico. Mean pH in this group ranged from 4.5 to 7.0. Total alkalinity averaged between 2 and 27 mg/l as $CaCO_3$ and mean total hardness concentrations averaged between 18 and 41 mg/l as $CaCO_3$. Mean specific conductance ranged from 126 to 199 μmhos/cm. In Otter Lake, sodium was the dominant cation and chloride was the dominant anion (Table 28). In Corn Landing Lake and Lake Wimico, sodium and chloride were the dominant ions but calcium, magnesium and bicarbonate ions were also common. Overall, this group of lakes can probably be best characterized as lakes of moderate mineral content.

Although the surface water chemistry of lakes located on the Gulf Coastal Lowlands in highly variable, the trophic status of these lakes is generally quite similar. Nearly all the lakes can be characterized as oligotrophic or oligo-mesotrophic. Mean total nitrogen concentrations ranged from 184 to 633 mg/m^3. Mean total phosphorus concentrations ranged from 5.7 to 34 mg/m^3. Although some of the measured total phosphorus values are in the range characteristic of eutrophic lakes, most of this phosphorus was associated with suspended sediments and thus probably unavailable for plant growth. This is reflected by low levels of planktonic algae. Mean chlorophyll a concentrations ranged from 1.2 mg/m^3 to 5.6 mg/m^3. Although planktonic algae are few, water clarity is moderate. Mean Secchi disc readings ranged from 0.5 m to 21 m. In Lake Wimico, a very shallow lake, the low water clarity readings are the result of high concentrations of suspended sediments. In the other lakes, high color values moderate water clarity.

B. Chemical and Trophic State Characteristics of Lakes Located in the Central and Southern Physiographic Zones.

1. Gulf Coastal Lowlands: The Gulf Coastal Lowlands of peninsular Florida (Figure 4), like the coastal lowlands of north Florida, are composed of the low lying lands located between the Gulf of Mexico and the inland highlands. Geology in this physiographic region is diverse. In Levy County and Citrus County, limestones of the Avon Park, Inglis, Williston and Crystal River Formations are dominant (Vernon and Puri 1964). In Hernando County and northern Pasco County, Suwannee Limestone is the dominant geologic formation. Sandy, chalky limestone of the St. Marks Formation is dominant in southern Pasco County, northern Pinellas County, and northwestern Hillsborough County (Vernon and Puri 1964). South of the St. Marks Formation, deposits of the Hawthorn and Bone Valley Formations, the principal phosphatic deposits in Florida, are dominant (Vernon and Puri 1964). Sand and clay deposits, however

cover the dominant geological formations in many areas. In these regions, numerous lakes can be found. Most natural lakes in the Gulf Coastal Lowlands, however, are found in southern Pasco County, northern Pinellas County, and northwestern Hillsborough County in association with deposits of the St. Marks Formation.

In this study, 10 lakes including 7 natural (Crews Lake, Lake Maggiore, Moon Lake, Lake Padgett, Lake Tarpon, Lake Thonotosassa, and Upper Myakka Lake) and 3 artificial (Lake Manatee, Lake Rousseau, and Lake Seminole) lakes were sampled. Data are presented in Table 29. Additional data from the Florida Game and Fresh Water Fish Commission are presented in Table 30. As can be seen from this data, water quality in the Gulf Coastal Lowlands is highly variable. Mean pH ranged from 6.7 to 8.8. Total alkalinity averaged between 8 and 110 mg/l as $CaCO_3$ and total hardness concentrations averaged between 18 and 282 mg/l as $CaCO_3$. Mean specific conductance ranged from 78 to 1000 μmhos/cm. Total phosphorus concentrations averaged between 12.7 and 834 mg/m^3 and chlorophyll a concentrations averaged between 2.3 and 66.8 mg/m^3. Much of this variability, however, is directly related to geological differences that occur in the Gulf Coastal Lowlands and in inland areas that drain into the Gulf Coastal Lowlands.

Lake Rousseau, a mainstream reservoir on the Withlacoochee River, can be chemically characterized as an alkaline, hard-water lake (Table 29). Measured pH averaged 7.3 and total alkalinity averaged 92 mg/l as $CaCO_3$. Total and calcium hardness concentrations averaged 110 and 95 mg/l as $CaCO_3$ respectively. As is typical of many hard-water lakes (Hutchinson 1957), calcium (79%) and bicarbonate (83%) ions dominated the mineral composition

Table 29. Means of limnological parameters measured in lakes located in the Gulf Coastal Lowlands of central Florida. Numbers in parentheses are the minimum and maximum values observed.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Crews Lake	7.1 (7.0-7.7)	21 (20-23)	0 (0-0)	76 (70-87)	30 (27-32)	25 (22-28)	5.1 (4.4-5.6)	1.1 (0.9-1.3)	10 (8.5-11)
Lake Maggiore	8.6 (8.4-8.9)	110 (85-127)	4 (0-9)	1000 (820-1200)	282 (239-318)	215 (209-215)	134 (99-190)	9.0 (7.5-12)	275 (217-365)
Lake Manatee	6.7 (6.5-7.3)	30 (16-53)	0 (0-0)	134 (115-160)	54 (48-62)	31 (27-35)	6.0 (4.9-6.9)	2.6 (2.4-3.1)	12 (10-13)
Moon Lake	6.7 (6.6-7.0)	8 (7-9)	0 (0-0)	78 (74-84)	18 (17-19)	14 (12-15)	8.9 (8.3-9.5)	0.6 (0.6-0.7)	16 (15-16)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Crews Lake	7.7 (4.1-15)	0.4 (0.1-0.7)	95.5 (81.5-118)	714 (458-916)	12.7 (9.8-15.9)	3.6 (2.5-4.7)	45 (30-60)	1.5 (1.3-1.7)
Lake Maggiore	107 (88-140)	13 (12-13)	174 (114-234)	2300 (1500-2800)	76.5 (57.4-103)	66.7 (20.9-107)	32 (25-45)	0.3 (0.2-0.4)
Lake Manatee	32 (21-40)	3.7 (1.5-6.1)	262 (165-371)	618 (425-841)	163 (82.6-218)	7.3 (1.2-14.1)	101 (60-150)	1.2 (0.9-1.7)
Moon Lake	10 (6.3-19)	0.1 (0.1-0.2)	36.0 (32.7-40.0)	662 (467-741)	13.6 (10.5-17.9)	3.4 (2.3-4.6)	28 (25-30)	2.7 (2.3-3.5)

Table 29. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Padgett	7.3 (6.9-8.1)	23 (12-29)	0 (0-0)	134 (130-144)	45 (43-47)	31 (30-32)	9.4 (8.4-11)	4.0 (3.8-4.3)	17 (16-18)
Lake Rousseau	7.3 (7.0-7.5)	92 (84-100)	0 (0-0)	209 (185-220)	110 (99-121)	95 (88-104)	4.1 (2.6-5.0)	0.3 (0.2-0.4)	6.3 (5.3-7.0)
Lake Seminole	8.8 (8.6-8.9)	90 (75-110)	3 (0-8)	404 (360-450)	126 (98-147)	93 (63-119)	37 (31-41)	6.2 (5.5-6.8)	66 (58-73)
Lake Tarpon	6.8 (6.7-7.5)	16 (7-28)	0 (0-0)	596 (550-620)	103 (96-110)	62 (60-65)	89 (75-105)	4.1 (3.7-4.9)	172 (154-198)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Padgett	16 (10-21)	0.2 (0.1-0.4)	20.9 (14.3-27.9)	530 (438-603)	14.1 (9.8-23.1)	2.4 (1.8-3.4)	15 (15-15)	3.6 (2.4-4.2)
Lake Rousseau	9.1 (0-17)	6.8 (5.8-7.7)	162 (57.4-332)	462 (358-716)	47.9 (16.2-65.8)	2.3 (0.4-6.1)	70 (20-150)	2.1 (1.1-2.6)
Lake Seminole	49 (42-55)	0.8 (0.2-1.4)	234 (110-365)	1900 (1700-2200)	122 (70.6-174)	64.9 (44.7-90.6)	27 (15-45)	0.3 (0.2-0.5)
Lake Tarpon	51 (44-61)	3.2 (0.1-6.9)	218 (53.3-312)	635 (475-883)	39.4 (22.1-60.6)	3.8 (1.4-6.7)	50 (50-50)	1.5 (1.1-2.0)

Table 29. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (μmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Thonotosassa	8.1 (7.8-9.0)	48 (43-53)	1 (0-4)	214 (190-260)	64 (58-71)	51 (48-55)	22 (18-24)	4.6 (4.3-5.0)	26 (23-29)
Upper Myaka Lake	7.6 (7.2-10.5)	41 (18-72)	18 (0-52)	201 (138-310)	80 (58-109)	53 (43-67)	8.8 (7.4-10)	1.7 (0.2-3.1)	16 (14-17)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Thonotosassa	30 (17-37)	0.8 (0.6-1.4)	158 (143-176)	1500 (1200-1800)	834 (576-1100)	66.8 (46.8-81.4)	82 (75-90)	0.7 (0.4-1.0)
Upper Myaka Lake	54 (28-90)	2.4 (1.0-4.8)	82.2 (17.6-157)	863 (791-1000)	207 (60.7-389)	6.7 (1.5-23.7)	99 (40-150)	1.3 (1.1-1.5)

Table 30. Means of limnological parameters measured in lakes located in the Gulf Coastal Lowlands of central Florida. Numbers in parentheses are the minimum and maximum values measured. Period of record 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/l)	PHENOL ALKALINITY (mg/l)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/l)	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)
Lake Maggiore	8.6 (8.0-9.2)	8.1 (7.2-9.2)	90 (65-116)	7 (0-25)	1000 (1000-1000)	377 (315-474)	81 (50-116)	28 (13-45)	174 (60-260)
Moon Lake	6.8 (6.2-6.9)	6.7 (6.3-7.2)	7 (6-9)	0 (0-0)	84 (60-95)	15 (12-18)	4.8 (3.5-6.2)	1.0 (0.7-1.2)	6.9 (5.6-8.0)
Lake Seminole	8.6 (8.2-8.9)	8.4 (7.7-9.0)	109 (78-165)	7 (0-18)	692 (329-1000)	220 (188-251)	51 (39-69)	9.4 (5.3-19)	37 (17-73)
Lake Tarpon	6.0 (5.1-7.0)	6.1 (5.4-6.7)	6 (2-12)	0 (0-0)	4250 (1000-11,100)	1425 (1267-1583)	55 (21-123)	117 (17-310)	1042 (177-2800)

POTASSIUM (mg/l)	CHLORIDE (mg/l)	SULFATE (mg/l)	SILICA (mg/l)	TOTAL IRON (mg/l)	TOTAL PHOSPHATE (mg/l)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l Pt)	SECCHI (ft)
12 (7.7-21)	436 (300-550)	93 (56-138)	4.5 (0.3-8.6)	0.213 (0.100-0.430)	0.643 (0.250-1.16)	189 (61.7-353)	35 (30-40)	0.8 (0.4-1.5)
0.7 (0.4-1.5)	12 (10-13)	5.5 (4.0-7.0)	0.5 (0.1-0.8)	0.080 (0.050-0.140)	0.195 (0.050-0.650)	1.4 (0-2.3)	15 (15-15)	6.5 (4.0-8.5)
7.6 (4.9-12)	106 (92-120)	42 (28-66)	- -	0.260 (0.200-0.320)	2.09 (0.540-3.40)	46.0 (21.4-69.5)	- -	1.3 (0.5-1.6)
41 (7.5-108)	4400 (3780-5020)	223 (54-780)	- -	0.315 (0.120-0.510)	0.188 (0.080-0.340)	3.0 (0-9.6)	- -	5.1 (3.3-7.8)

Table 30. (cont.).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Lake Thonotosassa	7.4 (6.5-8.0)	7.5 (7.1-8.0)	58 (37-96)	0 (0-0)	211 (149-260)	68 (47-88)	21 (13-29)	4.4 (3.2-7.0)	11 (7.6-15)
Townsend Pond	5.1 (4.7-5.5)	5.4 (4.8-6.1)	2 (1-3)	0 (0-0)	43 (26-73)	4.8 (4.0-7.0)	1.3 (0.9-1.6)	0.4 (0.1-0.6)	2.4 (1.7-3.7)
Webb Area	8.4 (7.8-8.8)	8.4 (8.1-8.8)	74 (46-102)	7 (0-15)	888 (100-1000)	675 (572-738)	129 (95-170)	83 (68-100)	355 (54-484)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
2.9 (1.6-3.9)	14 (10-17)	14 (9.0-19)	- -	0.305 (0.250-0.360)	2.18 (1.50-2.76)	41.6 (16.0-90.9)	- -	2.3 (1.6-3.0)
0.2 (0-0.4)	5.1 (3.5-6.5)	0.1 (0-0.4)	0.5 (0.2-0.8)	0.125 (0.070-0.160)	0.171 (0.050-0.480)	11.3 (4.3-28.1)	70 (50-90)	3.8 (2.3-5.3)
15 (10-24)	840 (760-920)	300 (210-352)	2.9 (1.1-4.7)	0.085 (0.030-0.230)	0.130 (0.040-0.290)	8.6 (4.8-13)	8 (5-10)	5.4 (3.2-8.6)

Table 31. Mean percentage of major cations and anions in lakes located in the Gulf Coastal Lowlands of Central Florida.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Crews Lake	59	11	26	3	49	0	18	33
Lake Maggiore	37	11	50	2	17	1	18	64
Lake Manatee	43	33	19	5	38	0	41	21
Moon Lake	36	12	50	2	20	0	26	55
Lake Padgett	43	20	29	7	36	0	25	39
Lake Rousseau	79	12	8	0	83	0	9	8
Lake Seminole	43	15	37	4	36	3	22	40
Lake Tarpon	20	14	64	2	5	0	17	78
Lake Thonotosassa	43	12	40	5	40	2	27	31
Upper Myakka Lake	52	27	19	2	5	29	47	19

(Table 31). These values result because Lake Rousseau is located in a region dominated by limestone of the Inglis Formation (Vernon and Puri 1964). In addition, the Withlacoochee River drains extensive inland limestone deposits.

Geology also influences the trophic status of Lake Rousseau. Mean total nitrogen concentrations and mean chlorophyll a concentrations averaged 462 and 2.3 mg/m^3 respectively. These low values, which are characteristic of oligotrophic lakes, result because Lake Rousseau has a high flushing rate and extensive growths of aquatic macrophytes. Total phosphorus concentrations, however, averaged 47.9 mg/m^3 and ranged up to 65.8 mg/m^3. These values, which are characteristic of eutrophic lakes, result primarily because the upper Withlacoochee River drains deposits of the phosphatic Hawthorn Formation (Vernon and Puri 1964). Because total phosphorus levels are naturally high and extensive growths of aquatic macrophytes occur, Lake Rousseau probably should be classified as a naturally eutrophic lake.

Crews Lake is located in a deposit of Suwannee Limestone (Vernon and Puri 1964). Similar to Lake Rousseau, pH in Crews Lake (Table 29) averaged slightly above 7.0. Calcium (Table 32) was the dominant cation (59%) and bicarbonate was the dominant anion (49%). However, in contrast to Lake Rousseau, total alkalinity only averaged 21 mg/l as $CaCO_3$. Total and calcium hardness concentrations averaged 30 and 25 mg/l as $CaCO_3$ respectively. Specific conductance averaged 78 µmhos/cm. These lower values have two probable causes. First, sand and clay deposits tend to isolate Crews Lake from the underlying limestone. Second, relative to Lake Rousseau, Crews Lake has a very small watershed. This reduces the chance for surface and groundwater inflows to contact limestone deposits. In addition, it increases the importance of direct rainfall as a water source. The small watershed and the absence of major phosphate deposits also contribute to lower plant nutrient levels in Crews Lake. Total phosphorus and total nitrogen concentrations averaged 12.7 and 714 mg/m^3 respectively. Chlorophyll a concentrations averaged 3.6 mg/m^3. Based on conventional criteria (Table 4), Crews Lake would be classified as an oligo-mesotrophic lake.

Moon lake is located on the sandy, chalk deposits of the St. Marks Formation. The lake can be chemically characterized as a slightly acidic, soft-water lake. Measured pH (Table 29) averaged 6.7 and total alkalinity averaged 8 mg/l as $CaCO_3$. Total hardness averaged 18 mg/l as $CaCO_3$ and calcium hardness averaged 14 mg/l as $CaCO_3$. Specific conductance averaged 78 μmhos/cm. Sodium (Table 31) was the dominant anion (55%). These values result because Moon Lake, which is located very close to the Gulf of Mexico, has a small watershed and direct rainfall in the major source of water.

In contrast, Lake Padgett, which is located further inland and has a larger watershed, can be chemically characterized as a slightly alkaline, moderately hard-water lake. Measured pH (Table 29) averaged 7.3 and total alkalinity averaged 23 mg/l as $CaCO_3$. Total and calcium hardness concentrations averaged 45 and 31 mg/l as $CaCO_3$ respectively. Specific conductance averaged 134 μmhos/cm. Calcium (43%) and magnesium (20%) were the dominant cations (Table 31) and bicarbonate (36%) occurred in equal proportion to sulfate and chloride.

The trophic status of these lakes, however, is similar. Total nitrogen concentrations averaged 663 mg/m^3 in Moon Lake and 530 mg/m^3 in Lake Padgett. Total phosphorus concentrations averaged 13.6 and 14.1

mg/m^3 respectively and chlorophyll a concentrations averaged 3.4 and 2.4 mg/m^3 respectively in Moon Lake and Lake Padgett. Lake Padgett also had substantial growths of aquatic macrophytes. Based on these data, Moon Lake and Lake Padgett should probably be classified as oligo-mesotrophic. This is probably typical of other lakes in this area.

Lake Tarpon (Table 29) is also located close to the Gulf of Mexico and is slightly acidic (mean pH 6.8). Sodium is the dominant cation (64%) and chloride is the dominant anion (78%) (Table 31). Total nitrogen concentrations averaged 635 mg/m^3 and chlorophyll a concentrations averaged 3.8 mg/m^3. Unlike Moon Lake, however, Lake Tarpon has a high mineral content. Specific conductance averaged 596 µmhos/cm. Total and calcium hardness concentrations averaged 103 and 62 mg/l as $CaCO_3$. Sodium averaged 89 mg/l and chloride averaged 172 mg/l. Sulfate concentrations averaged 51 mg/l. Total phosphorus concentrations averaged 39.4 mg/m^3. These values result because Lake Tarpon is apparently connected by sinks to highly mineralized groundwater (Holcomb 1968).

Lake Thonotosassa is also located in deposits of the St. Marks Formation. This lake is inland and has a relatively large watershed. Chemically, Lake Thonotosassa can be characterized as an alkaline, moderately hard-water lake. Measured pH values averaged 8.1 and total alkalinity averaged 48 mg/l as $CaCO_3$. Total hardness averaged 64 mg/l as $CaCO_3$ and calcium hardness averaged 51 mg/l as $CaCO_3$. Lake Thonotosassa can also be characterized as a highly eutrophic lake (Cowell et al. 1975). Total nitrogen concentrations (Table 29) averaged 1500 mg/m^3 and total phosphorus concentrations averaged 834 mg/m^3. Chlorophyll a concentrations averaged 66.8 mg/m^3 but ranged up to 81.4 mg/m^3.

These values result in part because Lake Thonotosassa receives drainage from phosphate deposits of the Hawthorn Formation. In addition, nutrients from the municipal treatment plant at Plant City contribute to the lake's total nutrient load (Holcomb 1968). In this study, it was not possible to determine the relative importance of each of these sources. If the drainage from the Hawthorn Formation is significant, Lake Thonotosassa was probably naturally eutrophic even before the discharge of waste products elevated nutrient levels.

Alligator Lake, Lake Maggiore, and Lake Seminole are located in a region dominated by deposits of the phosphatic Hawthorn Formation (Vernon and Puri 1964). As a group (Table 29 and Table 30), these lakes can be characterized as eutrophic. In this study, total nitrogen and total phosphorus concentrations in Lake Maggiore average 2300 mg/m^3 and 76.5 mg/m^3 respectively. In Lake Seminole, total nitrogen concentrations averaged 1900 mg/m^3 and total phosphorus concentrations averaged 122 mg/m^3. Chlorophyll a concentrations averaged 66.7 mg/m^3 in Lake Maggiore and 64.9 mg/m^3 in Lake Seminole. Although these lakes are located in an urbanized area, the presence of the Hawthorn Formation probably means these lakes were naturally eutrophic even before major development occurred.

Chemically, these lakes can be characterized as alkaline, hard-water lakes of high mineral content. Measured pH values (Table 29 and Table 30) averaged between 7.7 and 8.8. Mean total alkalinity averaged between 89 and 110 mg/l as $CaCO_3$. Total hardness concentrations averaged between 115 and 282 mg/l as $CaCO_3$ and mean specific conductance ranged between 363 and 1000 μmhos/cm. These values result because of saltwater intrusions. For example, Lake Seminole and Alligator Lake were formed from a bayou and a tidal creek (Holcomb 1968, 1969). The high mineral content of these lakes is, therefore, probably natural and not a result of increased urbanization.

Lake Manatee and Upper Myakka Lake are also located in regions dominated by deposits of the Hawthorn Formation (Vernon and Puri 1964). In addition, the Manatee River and the Myakka River drain deposits of the Bone Valley Formation. Consequently, these lakes (Table 29) have high phosphorus concentrations. Total phosphorus concentrations averaged 163 mg/m^3 in Lake Manatee and 207 mg/m^3 in Upper Myakka Lake. Though total nitrogen values and chlorophyll _a_ concentrations (Table 29) averaged below values characteristic of eutrophic lakes (Table 4), these lakes should be characterized as eutrophic. High flushing rates and growths of aquatic macrophytes reduce algal levels in these lakes. In the case of Upper Myakka Lake, dense growths of _Hydrilla verticillata_ completely covered the lake during the study period.

Chemically, lakes in this region can be characterized as moderately hard-water lakes. In Lake Manatee, pH averaged 6.7 while pH in Upper Myakka Lake (as a result of hydrilla growth) averaged 7.6. Total alkalinity averaged 30 mg/l as $CaCO_3$ in Lake Manatee and 41 mg/l as $CaCO_3$ in Upper Myakka Lake. Total hardness concentrations averaged 54 and 80 mg/l as $CaCO_3$ and specific conductance averaged 134 and 201 μmhos/cm. In both lakes (Table 31), calcium and magnesium were the dominant cations and sulfate and chloride were the dominant anions.

In the Gulf Coastal Lowlands, there are also a number of lakes which receive groundwater inputs via artesian wells. Webb Area (Table 30), located in Charlotte County, is such a lake (Holcomb 1969). Measured pH values averaged above 8.0. Total alkalinity averaged 74 mg/l as $CaCO_3$ and total hardness concentrations averaged 675 mg/l as $CaCO_3$. Specific conductance averaged 888 µmhos/cm. Sodium and chloride concentrations averaged 355 and 840 mg/l respectively and sulfate concentrations averaged 300 mg/l. While these values are probably not typical of all lakes that receive artesian inputs, they do suggest inputs from artesian wells may alter surface water chemistry. For any particular lake, changes in lake water quality will depend upon the amount of water entering and the chemical quality of the source aquifer.

2. Brooksville Ridge: The Brooksville Ridge (Figure 4) is a long north-south ridge located in parts of Pasco, Sumter, Hernando, Citrus, Marion, Levy, Alachua, and Gilchrist counties. White (1970) observed that the southern portion of the ridge is about 97 km long and varies in width from 16 to 24 km. The northern extension is about 80 km long and varies in width from 6 to 10 km. Along most of the ridge, sand, clay, and sandy-clay deposits of the Alachua Formation are dominant (Vernon and Puri 1964). In the southern reaches of the ridge, deposits of Suwannee Limestone and the Hawthorn Formation occur (Vernon and Puri 1964). Along the western edge of the ridge, thick deposits of white sand occur (White 1970). The Brooksville Ridge has an extremely irregular surface and there are a number of lakes located in low lying areas. In this study, four of these lakes, Lake Iola, Lake Lindsey, Mountain Lake, and Lake Pasadena, were sampled. Data for these lakes are presented in Table 32. Additional data from the Florida Game and Fresh Water Fish Commission are presented in Table 33 and data for Watermelon Pond (Shannon 1970) are presented in Table 34.

From the available data, lakes on the Brooksville Ridge can be

Table 32. Means of limnological parameters measured on lakes located on the Brooksville Ridge. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Iola	7.6 (7.2-9.0)	27 (26-28)	0 (0-1)	130 (122-146)	48 (46-49)	27 (26-28)	8.4 (8.0-9.0)	3.2 (2.6-3.7)	16 (16-17)
Lake Lindsey	6.0 (5.9-6.1)	4 (3-5)	0 (0-0)	59 (56-64)	14 (12-15)	10 (7.5-12)	5.7 (5.0-7.1)	2.0 (1.8-2.2)	11 (10-12)
Mountain Lake	6.3 (6.1-6.6)	12 (8-15)	0 (0-0)	62 (60-64)	21 (19-24)	12 (11-14)	5.4 (5.3-5.5)	0.5 (0.1-0.9)	9.3 (9.0-9.5)
Lake Pasadena	6.4 (6.3-6.5)	6 (5-7)	0 (0-0)	93 (86-100)	26 (25-27)	11 (10-13)	7.9 (7.1-8.7)	1.8 (1.7-1.9)	20 (18-22)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Iola	16 (13-19)	0.2 (0.1-0.3)	20.6 (10.7-29.7)	561 (375-725)	15.1 (3.9-31.5)	7.6 (1.7-15.9)	10 (10-10)	2.9 (1.8-4.0)
Lake Lindsey	5.7 (4.5-7.6)	0.1 (0-0.1)	93.9 (51.4-184)	2200 (1600-2700)	41.5 (29.3-56.9)	39.6 (15.9-64.0)	44 (40-50)	0.8 (0.6-1.2)
Mountain Lake	4.6 (3.2-5.6)	0.4 (0.3-0.5)	244 (223-261)	818 (608-991)	16.3 (1.2-31.7)	6.6 (2.9-18.1)	123 (120-125)	1.3 (1.1-1.5)
Lake Pasadena	8.9 (5.7-18)	0.1 (0.1-0.2)	87.5 (66.3-97.1)	796 (666-900)	27.0 (23.1-34.9)	8.7 (4.4-12.6)	55 (45-60)	1.2 (1.0-1.5)

Table 33. Means of limnological parameters measured in lakes located on the Brooksville Ridge. Numbers in parentheses are the minimum and maximum values measured. Period or record 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Clear	7.5 (7.0-8.0)	7.4 (7.0-7.9)	37 (35-38)	0.5 (0.0-3.0)	187 (172-200)	46 (43-49)	13 (11-15)	4.4 (3.7-5.6)	12 (10-14)
Lindsey	6.1 (5.2-7.4)	6.2 (5.6-6.7)	4.6 (2.0-9.0)	0.0 (0.0-0.0)	47 (35-59)	9.0 (8.0-10)	2.5 (2.0-2.8)	0.6 (0.3-0.8)	2.8 (2.3-3.1)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
2.9 (2.6-3.3)	21 (20-22)	11 (7.5-13)	*** ***	0.035 (0.010-0.060)	0.102 (0.060-0.150)	9.2 (0.0-17.6)	*** ***	6.1 (4.9-9.9)
1.0 (0.3-2.1)	5.8 (4.8-6.5)	0.05 (0.0-0.4)	0.6 (0.0-1.1)	0.110 (0.090-0.130)	0.170 (0.050-0.380)	2.8 (0.0-6.4)	25 (20-30)	5.1 (4.0-6.8)

Table 34. Means of limnological parameters measured in Watermelon Pond. Numbers in parentheses are the minimum and maximum values measured. Period of record 1969-1970. Data from Shannon (1970).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)	POTASSIUM (mg/l)	TOTAL PHOSPHATE (mg/l)	TOTAL ORGANIC NITROGEN (mg/l)	AMMONIA NITROGEN (mg/l)
Watermelon	38 (34-44)	2.1 (1.6-2.9)	0.7 (0.6-0.8)	3.7 (2.6-4.6)	0.2 (0.1-0.3)	0.052 (0.020-0.105)	0.860 (0.610-1.170)	0.047 (0.000-0.090)

	NITRATE NITROGEN (mg/l)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/l pt)	SECCHI (m)
Watermelon	0.080 (0.040-0.160)	9.0 (4.2-16.6)	74 (26-159)	1.0 (0.3-1.4)

Table 35. Mean percentage of major cations and anions in lakes located on the Brooksville Ridge.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Iola	38	30	26	6	40	1	25	34
Lake Lindsey	33	14	43	9	16	0	23	61
Mountain Lake	36	26	34	2	40	0	15	44
Lake Pasadena	25	31	38	5	14	0	21	65

chemically divided into two groups. The first group, which includes Lake Lindsey, Mountain Lake, Lake Pasadena, and Watermelon Pond, can be characterized as acidic, soft-water lakes. In this study (Table 32), mean pH ranged from 6.0 to 6.4. Total alkalinity averaged between 4 and 12 mg/l as $CaCO_3$. Total hardness concentrations averaged between 14 and 26 mg/l as $CaCO_3$. In all the lakes, mean specific conductance averaged between 38 and 93 μmhos/cm. These chemical values probably result because direct rainfall is a major source of water and because surface and subsurface inputs flow through sandy soils. The second group, which includes Lake Iola and Clear Lake, can be characterized as alkaline, relatively hard, soft-water lakes. Measured pH averaged close to 7.5 in both lakes. Total alkalinity averaged 27 mg/l as $CaCO_3$ in Lake Iola and 37 mg/l as $CaCO_3$ in Clear Lake. Total hardness concentrations averaged 48 mg/l as $CaCO_3$ in Laka Iola and 46 mg/l as $CaCO_3$ in Clear Lake. Whereas sodium and chloride ions contribute considerably to the mineral composition of many lakes in the first group (Table 35), calcium and magnesium are the dominant cations in Lake Iola and bicarbonate and sulfate are the dominant anions. The chemical composition of Lake Iola and Clear Lake differs from the other lakes largely because Lake Iola and Clear Lake are in a region dominated by deposits of Suwannee Limestone (Vernon and Puri 1964).

With the exception of Lake Lindsey, the present trophic status of lakes on the Brooksville Ridge is similar. In this study (Table 32), total nitrogen concentrations averaged between 561 and 796 mg/m^3. Total phosphorus concentrations averaged between 15.1 and 27 mg/m^3 and chlorophyll a concentrations averaged between 6.6 and 8.7 mg/m^3. Based on these data, lakes on the Brooksville Ridge would be characterized as mesotrophic. Lake Lindsey, however, would be characterized as eutrophic. Total nitrogen and total phosphorus concentrations averaged 2200 and

41.5 mg/m^3 respectively. Chlorophyll a concentrations averaged 39.6 mg/m^3. These data, however, are not similar to values reported by the Florida Game and Fresh Water Fish Commission (Table 33), but Lake Lindsey has lost over 2 m of water since their study. This water loss has probably been largely responsible for the increase in plant nutrient concentrations. However, maximum measured total phosphorus values in all the lakes (Table 32) exceed 30 mg/m^3. This suggests all the lakes on the Brooksville Ridge may be slightly eutrophic. Mountain Lake presently supports excessive growths of *Eichhornia crassipes* and Lake Iola has extensive growths of *Hydrilla verticillata*, which also suggests the lakes are slightly eutrophic. Probably the best trophic classification for lakes on the Brooksville Ridge would be meso-eutrophic, especially in regions where the phosphatic deposits of the Hawthorn Formation occur.

3. Tsala Apopka Plain: The Tsala Apopka Plain (Figure 4) is located east of the Brooksville Ridge in portions of Pasco, Hernando, Sumter, and Citrus counties. The plain is an 80 km valley of variable width formed by stream and solution processes. In the northern end of the valley, limestone deposits of the Inglis Formation and the Williston Formation are common, but deposits of Suwannee Limestone are dominant in the southern end (Vernon and Puri 1964). On the western side of the valley, there are numerous small lakes and sloughs. These water bodies are interconnected and many are intermittent (Holcomb 1968, 1969). In this study, 2 lakes, Lake Panasoffkee and Tsala Apopka Lake (Hernando Pool), were sampled. Data are presented in Table 36. Additional data from the Florida Game and Fresh Water Fish Commission are presented in Table 37.

Based on the available data, lakes located on the Tsala Apopka Plain can be characterized as alkaline, hard-water lakes. In this study (Table 36), pH averaged 8.3 in Lake Panasoffkee and 7.3 in Tsala Apopka Lake

Table 36. Means of limnological parameters measured in lakes located on the Tsala Apopka Plain. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (μmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Lake Panasoffkee	8.3 (8.0-8.9)	101 (52-172)	1 (0-5)	231 (165-295)	117 (76-156)	101 (58-145)	5.7 (4.7-6.5)	0.2 (0-0.3)	9.6 (8.8-11)
Tsala Apopka Lake (Hernando Pool)	7.3 (7.2-7.6)	42 (39-45)	0 (0-0)	109 (103-115)	47 (44-49)	41 (39-44)	5.4 (4.3-6.3)	0.1 (0-0.1)	9.0 (8.0-9.5)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Lake Panasoffkee	22 (9.7-32)	9.3 (1.6-16)	34.0 (17.9-68.5)	583 (425-716)	16.7 (12.4-24.8)	3.7 (1.5-5.9)	38 (10-75)	BOTTOM (***-***)
Tsala Apopka Lake (Hernando Pool)	4.3 (0-9.6)	0.9 (0.1-1.5)	48.3 (29.9-76.7)	488 (208-600)	11.4 (7.2-18.2)	2.8 (1.8-4.5)	24 (20-30)	2.9 (2.6-3.0)

Table 37. Means of limnological parameters measured in lakes located in the Tsala Apopka Plain. Numbers in parentheses are the minimum and maximum values measured. Period or record 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (µmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Panasoffkee	8.1 (7.8-8.6)	8.0 (7.9-8.2)	107 (78-125)	1.0 (0.0-6.0)	279 (239-299)	139 (121-157)	46 (36-56)	4.0 (3.1-4.7)	5.5 (4.5-9.4)
Tsala Apopka (Hernando Pool)	7.1 (6.0-7.7)	7.4 (7.1-7.7)	43 (37-51)	0.0 (0.0-0.0)	126 (110-148)	52 (46-62)	17 (14-22)	1.4 (0.9-1.9)	4.3 (3.6-5.3)
Tsala Apopka (Floral City Pool)	7.2 (6.0-7.8)	7.7 (7.3-7.9)	67 (43-101)	0.0 (0.0-0.0)	175 (110-250)	66 (47-90)	26 (16-38)	1.9 (1.2-2.9)	5.3 (4.3-6.7)
Tsala Apopka (Inverness)	7.4 (7.1-7.6)	7.4 (7.2-7.6)	50 (40-60)	0.0 (0.0-0.0)	151 (128-168)	- -	21 (17-26)	1.7 (1.3-2.2)	4.7 (3.9-5.0)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
0.7 (0.0-1.3)	7.8 (6.5-9.0)	18 (12-31)	- -	0.025 (0.020-0.030)	0.113 (0.050-0.200)	14.2 (14.3-22.9)	- -	5.5 (3.9-7.3)
0.08 (0.0-0.2)	7.4 (5.5-8.2)	0.3 (0.0-1.2)	1.0 (0.9-1.1)	0.115 (0.050-0.210)	0.103 (0.020-0.330)	4.0 (2.0-6.4)	23 (15-30)	7.7 (5.0-10)
0.6 (0.0-1.6)	8.3 (7.0-9.0)	1.5 (0.0-5.5)	3.4 (2.7-4.0)	0.425 (0.150-0.970)	0.155 (0.040-0.380)	6.4 (0.0-16.0)	65 (30-100)	5.3 (1.5-7.4)
0.4 (0.2-0.5)	- -	0.4 (0.0-1.5)	- -	- -	0.138 (0.110-0.170)	6.5 (0.8-16.0)	- -	5.5 (4.7-6.5)

Table 38. Mean percentage of major cations and anions in lakes located on the Tsala Apopka Plain.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Panasoffkee	77	13	10	0	72	2	17	10
Tsala Apopka Lake (Hernando Pool)	70	10	20	0	71	0	7	21

(Hernando Pool). Total alkalinity averaged 101 and 42 mg/l as $CaCO_3$ respectively, and total hardness concentrations averaged 117 and 47 mg/l as $CaCO_3$ respectively. The higher values in Lake Panasoffkee result because this lake is spring-fed (Holcomb 1968), while Tsala Apopka Lake receives a greater proportion of its water from direct rainfall. In both lakes, however, the mineral composition (Table 38) is similar. Calcium is the dominant cation (>79%) and bicarbonate (>70%) is the dominant anion.

The trophic status of Lake Panasoffkee and Tsala Apopka Lake can be characterized as oligo-mesotrophic or mesotrophic. In this study,(Table 36), total nitrogen concentrations averaged 583 mg/m^3 in Lake Panasofkee and 488 mg/m^3 in Tsala Apopka Lake (Hernando Pool). Total phosphorus concentrations averaged 16.7 and 11.4 mg/m^3, respectively, and chlorophyll a concentrations averaged 16.7 and 11.4 mg/m^3. However, total phosphorus values ranged up to 24.8 mg/m^3 and measured chlorophyll a concentrations in the Florida Game and Fresh Water Fish Commission studies (Table 37) ranged much higher than those recorded in this study. This suggests the lakes on the Tsala Apopka Plain can best be characterized as mesotrophic lakes.

4. Sumter Upland: The Sumter Upland (Figure 4) is a 1400 km^2 highland located in portions of Marion, Sumter, and Lake counties. Regional geology is dominated primarily by limestone of the Crystal River Formation, but deposits of the Hawthorn Formation and Fort Preston Formation also occur (Vernon and Puri 1964). The region has very few lakes and these occur only where sands overlie limestone or deposits of the Fort Preston Formation. In this study, 5 natural lakes (Lake Deaton, Lake Miona, Lake Okahumpka, Smith Lake and Lake Weir) were sampled. Data are presented in Table 39.

With the exception of Smith Lake, all the study lakes can be

Table 39. Means of limnological parameters measured in lakes located on the Sumter Upland. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (μmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Deaton	7.2 (6.8-7.7)	25 (23-27)	0 (0-0)	165 (165-168)	33 (30-36)	14 (12-17)	20 (19-21)	2.5 (1.3-3.0)	32 (31-34)
Lake Miona	7.2 (6.9-7.5)	25 (24-26)	0 (0-0)	138 (130-145)	41 (41-42)	31 (30-32)	11 (10-13)	1.1 (0.3-1.6)	20 (19-20)
Lake Okahumpka	8.3 (7.6-10.1)	50 (38-71)	10 (0-18)	177 (155-205)	60 (49-82)	44 (33-63)	13 (12-16)	0.9 (0-2.8)	23 (21-24)
Smith Lake	5.4 (5.2-5.5)	2 (1-2)	0 (0-0)	62 (60-66)	12 (11-13)	5.7 (4.8-7.0)	6.5 (5.8-7.1)	0.8 (0.6-0.9)	11 (10-11)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 @ Pt)	SECCHI (m)
Lake Deaton	7.0 (3.5-14)	4.4 (2.7-6.8)	99.4 (82.7-126)	2100 (1400-3000)	29.2 (20.5-34.6)	36.8 (23.0-54.3)	23 (15-30)	0.5 (0.4-0.7)
Lake Miona	12 (8.7-18)	0.3 (0.1-0.3)	31.6 (21.3-50.5)	1300 (925-1500)	15.3 (12.5-20.0)	16.0 (10.8-21.2)	26 (15-40)	1.1 (1.0-1.2)
Lake Okahumpka	5.8 (0-14)	1.2 (0.3-2.7)	239 (98.9-440)	880 (758-983)	13.8 (6.2-19.9)	4.9 (3.1-6.5)	20 (15-30)	BOTTOM (***-***)
Smith Lake	11 (7.1-18)	0 (0-0)	31.2 (26.5-35.3)	392 (290-542)	11.1 (2.9-24.0)	2.4 (1.0-3.8)	10 (10-10)	2.8 (2.0-3.5)

Table 39. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Weir	7.1 (7.0-7.3)	12 (9-14)	0 (0-0)	136 (132-140)	25 (24-26)	10 (9.0-11)	17 (16-18)	2.0 (1.9-2.1)	28 (28.0-28.8)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Weir	8.4 (5.7-13)	0.1 (0-0.3)	27.0 (22.3-34.9)	641 (608-683)	12.2 (4.0-27.0)	7.7 (3.4-11.0)	3 (0-5)	2.3 (1.9-3.0)

Table 40. Mean percentage of major cations and anions in lakes located on the Sumter Upland.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Deaton	18	23	55	4	32	0	9	58
Lake Miona	45	16	37	2	38	0	19	43
Lake Okahumpka	48	18	32	1	35	22	7	36
Smith Lake	21	22	52	4	6	0	40	55
Lake Weir	16	23	57	4	20	0	14	66

chemically characterized as alkaline, relatively hard, soft-water lakes. Measured pH values averaged between 7.1 and 8.3. Mean total alkalinity ranged between 12 and 25 mg/l as $CaCO_3$. Mean total hardness concentrations ranged from 25 to 60 mg/l as $CaCO_3$ and calcium hardness concentrations averaged between 10 and 44 mg/l as $CaCO_3$. Smith Lake, however, is a relatively deep sinkhole lake and probably receives nearly all of its water from direct rainfall. Consequently, Smith Lake had a mean pH of 5.4, a mean total alkalinity of 2 mg/l as $CaCO_3$, a mean total hardness of 12 mg/l as $CaCO_3$ and a mean calcium hardness of 5.7 mg/l as $CaCO_3$. Overall mineral content, as reflected by the mean specific conductance which ranged from 136 to 177 µmhos/cm, is moderate in all lakes except Smith Lake (mean specific conductance of 62 µmhos/cm). Mineral composition (Table 40) is mixed in all the study lakes.

The trophic status of lakes located in the Sumter Upland is highly variable. Smith Lake had a mean total nitrogen concentration of 392 mg/m^3, mean total phosphorus concentration of 11.1 mg/m^3 and a mean chlorophyll a concentration of 2.4 mg/m^3 which suggests this lake is oligotrophic or oligomesotrophic. Lake Deaton, however, had a mean total nitrogen concentration of 2100 mg/m^3, a mean total phosphorus concentration of 29.2 mg/m^3 and a mean chlorophyll a concentration of 36.8 mg/m^3, which strongly suggest Lake Deaton is a eutrophic lake. Based on available data (Table 39), Lake Miona, Lake Okahumpka, and Lake Weir would be classified as mesotrophic lakes. However, Lake Okahumpka was completely filled with *Hydrilla verticillata*, thus Lake Okahumpka probably can be classified as eutrophic or meso-eutrophic. In general, with the exception of sinkhole lakes like Smith Lake, lakes on the Sumter Upland probably can best be characterized as mesotrophic or meso-eutrophic lakes.

5. Central Valley: The Central Valley (Figure 4) is a large lowland area located between the Mount Dora Ridge on the east and the Sumter and Lake Uplands on the west. The valley extends from southern Alachua County to northern Orange County and is occupied primarily by the drainage systems of the Oklawaha River. In the northern end, the regional geology is dominated by deposits of the phosphatic Hawthorn Formation (Vernon and Puri 1964). The middle reaches are dominated by limestone deposits of the Crystal River Formation and the southern portion is dominated by deposits of the Fort Preston and Fort Thompson Formations (Vernon and Puri 1964). In many areas, the valley floor extends below the piezometric surface. In these areas, numerous springs and spring-fed lakes occur. In addition, there are numerous nonspring-fed lakes scattered throughout the broad valley. In this study, 11 natural lakes (Lake Apopka Lake Dorr, Lake Eaton, Lake Eustis, Lake Griffin, Lake Harris, Lochloosa Lake, Newnans Lake, Orange Lake, Lake Wauberg, and Lake Yale) were sampled. Data are presented in Table 41. Additional data for lakes in the Central Valley were obtained from the Florida Game and Fresh Water Fish Commission (Table 42) and Shannon (1970) (Table 43.)

Water quality in the Central Valley is highly variable. Measured pH values (Tables 41, 43) ranged from 5.4 to 9.1 and mean total alkalinity ranged from 7 to 131 mg/l as $CaCO_3$. Mean specific conductance (Tables 41, 42, 43) ranged from 25 to 425 μmhos/cm and mean total hardness concentrations ranged from 22 to 165 mg/l as $CaCO_3$. Mean total nitrogen concentrations (Table 41) ranged from 683 to 4600 mg/m^3 and mean total phosphorus concentrations ranged from 14.3 to 166 mg/m^3. Mean chlorophyll a concentrations (Tables 41, 42, 43) ranged from 3.2 to 156 mg/m^3. Water color averaged between 3 and 415 mg/l as Pt and water clarity averaged between 0.1 and 2.4 m. (Tables 41, 42, 43). Much of this

Table 41. Means of limnological parameters measured in lakes located in the Central Valley. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Lake Apopka	8.9 (8.5-9.3)	131 (120-145)	11 (3-18)	340 (320-380)	165 (153-181)	96 (77-115)	19 (17-27)	10 (9.5-11)	35 (33-39)
Lake Dora	8.9 (8.8-9.0)	120 (114-127)	9 (7-12)	321 (295-350)	155 (145-166)	93 (84-107)	17 (16-18)	9.6 (9.1-10)	32 (30-34)
Lake Eaton	7.0 (6.8-7.4)	27 (18-40)	0 (0-0)	105 (80-148)	52 (39-73)	38 (27-57)	5.3 (4.7-6.3)	0.2 (0.1-0.3)	8.2 (7.3-9.0)
Lake Eustis	8.7 (8.5-8.9)	104 (96-111)	6 (1-7)	272 (250-300)	126 (116-134)	82 (75-94)	13 (13-14)	5.4 (4.9-5.7)	23 (23-24)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m³)	TOTAL N (mg/m³)	TOTAL P (mg/m³)	CHLOROPHYLL $\underline{a}$ (mg/m³)	COLOR (mg/l Pt)	SECCHI (m)
Lake Apopka	23 (19-28)	4.0 (1.1-8.6)	36.0 (18.8-56.0)	4600 (3200-6000)	166 (114-209)	156 (100-225)	37 (30-40)	0.2 (0.1-0.3)
Lake Dora	25 (20-28)	1.8 (1.3-2.2)	68.6 (32.8-121)	3100 (2800-4100)	90.3 (73.0-98.9	124 (73.1-168)	43 (25-50)	0.4 (0.3-0.5)
Lake Eaton	15 (0-43)	11 (6.9-16)	728 (499-968)	1100 (891-1200)	54.5 (35.5-70.3)	3.2 (0.5-6.0)	415 (300-600)	0.4 (0.4-0.5)
Lake Eustis	15 (10-20)	1.1 (0.7-1.3)	64.3 (25.5-129)	1800 (1500-2400)	46.1 (36.9-55.9)	65.1 (30.6-100)	19 (15-25)	0.4 (0.4-0.6)

Table 41. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l CaCO$_3$)	PHENOL ALKALINITY (mg/l CaCO$_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l CaCO$_3$)	CALCIUM HARDNESS (mg/l CaCO$_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Lake Griffin	8.6 (8.4-8.9)	96 (86-110)	3 (1-6)	261 (230-300)	117 (105-133)	74 (60-91)	15 (14-15)	4.8 (4.3-5.1)	24 (23-26)
Lake Harris	8.5 (8.3-8.6)	95 (92-97)	1 (0-3)	225 (210-250)	109 (104-112)	78 (74-84)	9.9 (9.3-11)	2.5 (2.2-2.7)	17 (16-18)
Lochloosa Lake	7.4 (7.3-7.5)	23 (21-25)	0 (0-0)	77 (71-84)	31 (30-32)	23 (22-25)	5.6 (5.4-6.1)	0.3 (0.1-0.4)	8.8 (8.5-9.3)
Newnans Lake	6.8 (6.7-6.9)	14 (12-18)	0 (0-0)	59 (54-64)	22 (22-23)	14 (13-16)	6.3 (5.4-7.7)	0.4 (0.2-0.5)	8.7 (8.0-9.3)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Lake Griffin	17 (13-20)	1.3 (0.3-3.2)	71.6 (21.7-146)	2200 (1600-2800)	83.2 (62.8-116)	72.8 (41.5-104)	23 (15-30)	0.4 (0.2-0.5)
Lake Harris	11 (7.3-16)	1.0 (0.3-1.5)	73.0 (48.8-93.7)	1100 (862-1400)	24.2 (19.6-30.7)	20.8 (11.5-32.5)	15 (10-25)	0.8 (0.6-0.9)
Lochloosa Lake	4.0 (0-7.9)	0.3 (0.2-3.8)	239 (126-373)	1200 (875-1500)	36.4 (18.1-58.7)	32.0 (24.7-44.9)	61 (45-80)	0.7 (0.5-1.0)
Newnans Lake	3.4 (0-9.6)	1.0 (0.5-1.7)	363 (296-457)	1300 (883-1500)	52.3 (22.6-81.5)	38.0 (24.1-55.0)	93 (45-150)	0.6 (0.5-0.7)

Table 41. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Orange Lake	7.2 (7.0-8.0)	18 (15-20)	0 (0-0)	67 (60-72)	25 (24-26)	18 (15-20)	6.3 (5.9-7.2)	0.2 (0.1-0.4)	8.9 (8.5-9.3)
Lake Wauberg	7.8 (7.1-9.1)	21 (18-39)	0 (0-1)	74 (64-80)	22 (22-23)	16 (15-17)	8.2 (7.2-9.6)	0.6 (0.4-1.0)	11 (10-11)
Lake Yale	8.3 (8.2-8.5)	116 (114-120)	0 (0-2)	264 (250-270)	114 (109-119)	68 (65-72)	20 (19-22)	3.6 (3.3-3.8)	23 (23-23)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Orange Lake	4.2 (0-10)	0.4 (0.1-0.6)	194 (127-293)	1100 (875-1200)	31.0 (9.6-57.2)	35.4 (27.4-49.3)	54 (35-80)	0.8 (0.6-1.0)
Lake Wauberg	7.4 (4.4-11)	0.4 (0.2-0.6)	63.7 (42.1-86.3)	2100 (1700-2800)	79.9 (59.1-113)	110 (101-123)	17 (15-20)	0.4 (0.3-0.5)
Lake Yale	7.2 (4.2-13)	1.3 (0.1-2.0)	61.4 (45.8-84.4)	683 (408-833)	14.3 (9.4-17.4)	9.6 (8.3-10.7)	7 (5-10)	1.4 (1.2-1.5)

Table 42. Means of limnological parameters measured in lakes located in the Central Valley. Numbers in parentheses are the minimum and maximum values measured. Period of record 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Apopka	8.9 (8.4-9.3)	8.9 (8.5-9.3)	117 (93-132)	12 (2-20)	331 (280-390)	146 (137-154)	38 (30-46)	14 (12-15)	13 (11-15)
Beauclair	8.8 (8.3-9.4)	9.0 (8.6-9.1)	118 (99-137)	22 (6-32)	355 (320-403)	160 (146-172)	39 (34-44)	14 (9.3-17)	15 (12-16)
Carlton	9.1 (8.2-9.5)	9.1 (8.4-9.5)	93 (68-106)	19 (7-36)	315 (230-370)	139 (138-140)	32 (28-37)	13 (11-15)	15 (14-18)
Dora	9.2 (8.8-9.8)	9.2 (8.9-9.5)	106 (69-133)	24 (14-29)	331 (290-360)	148 (128-169)	35 (28-41)	13 (8.8-17)	15 (12-16)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m³)	COLOR (mg/1 Pt)	SECCHI (ft)
5.4 (4.3-5.9)	27 (25-28)	19 (16-22)	*** ***	0.075 (0.060-0.090)	0.997 (0.340-1.70)	88.2 (64.2-104)	*** ***	1.0 (0.8-1.3)
6.5 (6.0-7.3)	29 (29-29)	29 (24-35)	*** ***	0.100 (0.060-0.140)	0.443 (0.170-1.04)	89.7 (24.9-144)	*** ***	1.1 (0.8-1.3)
7.0 (5.6-8.2)	28 (27-28)	21 (16-26)	4.3 (4.1-4.4)	0.250 (0.160-0.340)	1.47 (0.960-1.80)	86.3 (64.2-152)	45 (30-60)	1.3 (0.8-2.3)
6.1 (4.5-7.2)	28 (27-29)	18 (16-22)	3.0 (2.7-3.3)	0.290 (0.150-0.390)	0.745 (0.280-1.30)	56.2 (32.1-88.2)	30 (30-30)	2.1 (0.8-8.0)

Table 42. (cont.).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (µmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Eustis	8.6 (7.4-9.6)	8.6 (8.4-9.2)	85 (62-98)	10 (0-18)	263 (220-302)	111 (102-127)	29 (26-31)	8.5 (5.8-12)	11 (9.8-13)
Harris	8.3 (7.8-8.8)	8.3 (7.6-8.8)	73 (50-86)	2 (0-7)	210 (168-250)	93 (87-99)	26 (18-30)	5.4 (3.7-7.0)	7.4 (6.0-8.3)
Lochloosa	7.7 (6.7-8.9)	7.5 (6.7-8.7)	23 (16-28)	0.7 (0-4)	105 (94-115)	32 (31-32)	9.5 (6.7-15)	2.6 (1.9-3.5)	5.1 (4.1-6.0)
Ola	7.0 (6.7-7.6)	7.0 (6.6-7.3)	7 (3-14)	0 (0-0)	238 (210-250)	54 (41-61)	10 (9.2-12)	7.1 (6.1-7.9)	15 (14-16)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
3.4 (2.6-4.1)	20 (18-22)	11 (10-13)	1.7 (1.5-1.8)	0.118 (0.100-0.150)	0.434 (0.160-0.870)	50.1 (16.0-104)	15 (10-20)	1.6 (1.1-2.3)
1.6 (1.3-2.1)	14 (13-15)	5.8 (4.5-7.0)	*** ***	0.070 (0.040-0.100	0.080 (0.050-0.130)	25.1 (16.0-32.1)	*** ***	2.8 (2.3-3.8)
0.6 (0.5-0.7)	10 (9.0-11)	2.7 (0-7.0)	*** ***	0.295 (0.170-0.420)	0.143 (0.130-0.180)	22.9 (8.0-32.1)	*** ***	2.3 (1.8-2.8)
6.9 (6.7-8.0)	24 (23-25)	51 (42-56)	1.1 (0.5-1.7)	0.083 (0.030-0.190)	0.155 (0.030-0.490)	6.7 (2.7-14.4)	3 (0-5)	7.8 (5.5-11)

Table 42. (cont.).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (µmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Orange	7.6 (7.0-8.8)	7.4 (6.8-8.3)	17 (14-21)	0.7 (0-3)	89 (76-100)	23 (22-23)	6.1 (5.2-7.2)	1.8 (1.6-1.9)	5.1 (4.2-5.8)
Rodman Reservoir	7.7 (7.3-8.3)	7.4 (6.3-7.9)	101 (78-113)	0 (0-0)	425 (360-595)	*** ***	48 (41-54)	8.3 (6.0-10)	22 (13-41)
Yale	7.6 (5.4-8.4)	8.2 (7.9-8.6)	95 (83-109)	2 (0-6)	278 (240-301)	98 (92-104)	23 (20-26)	7.6 (5.6-10)	18 (16-20)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
0.6 (0.4-0.9)	9.8 (9.5-10)	0.4 (0-2.0)	*** ***	0.140 (0.080-0.200)	0.133 (0.080-0.190)	18.9 (6.4-35.3)	*** ***	3.5 (2.8-5.0)
2.1 (1.0-3.6)	*** ***	38 (21-51)	*** ***	*** ***	0.148 (0.080-0.300)	6.7 (3.2-9.6)	*** ***	6.2 (4.0-11)
2.9 (2.3-3.8)	2.6 (1.0-5.0)	23 (22-24)	*** ***	0.115 (0.110-0.120)	0.075 (0.040-0.140)	11.6 (0-16.0)	*** ***	4.1 (3.2-5.7)

Table 43. Means of limnological parameters measured in lakes located in the Central Valley. Numbers in parentheses are the minimum and maximum values measured. Period of record 1969-1970. Data from Shannon (1970).

	SPECIFIC CONDUCTANCE μmhos/cm 25C	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)	POTASSIUM (mg/l)	TOTAL PHOSPHATE (mg/l)	TOTAL ORGANIC NITROGEN (mg/l)	AMMONIA NITROGEN (mg/l)
Lake Apopka	315 (304-324)	55 (30-100)	14 (13-16)	14 (10-18)	3.7 (1.2-5.0)	0.380 (0.286-0.500)	4.45 (3.45-5.74)	0.273 (0.080-0.580)
Bivens Arm	254 (214-340)	26 (7-36)	4.4 (3.1-5.1)	9.8 (8.5-11.0)	2.3 (1.0-3.5)	0.546 (0.365-0.730)	1.88 (1.06-3.28)	0.192 (0.000-0.380)
Burnt Pond	63 (53-78)	7.7 (5.0-11)	1.3 (1.1-1.7)	4.7 (4.0-6.0)	0.8 (0.1-1.2)	0.478 (0.350-0.605)	1.69 (1.22-2.51)	0.416 (0.040-0.850)
Cale Pond	44 (40-47)	3.9 (2.6-4.7)	0.9 (0.8-1.0)	5.4 (4.7-6.5)	0.3 (0.1-0.8)	0.184 (0.113-0.220)	1.41 (0.99-1.91)	0.413 (0.040-0.880)

	NITRATE NITROGEN (mg/l)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l pt)	SECCHI (m)
Lake Apopka	0.153 (0.000-0.260)	60.4 (50.8-74.0)	78 (75-80)	0.2 (0.2-0.3)
Bivens Arm	0.048 (0.00-0.210)	[illegible]6.0 (14.0-154.1)	42 (23-60)	0.6 (0.3-0.9)
Burnt Pond	0.240 (0.00-0.550)	29.0 (19.4-39.4)	351 (228-564)	0.6 (0.3-0.8)
Cale Pond	0.043 (0.020-0.070)	23.5 (7.3-34.2)	404 (264-588)	0.7 (0.6-0.8)

Table 43. Means of limnological parameters measured in lakes located in the Central Valley. Numbers in parentheses are the minimum and maximum values measured. Period of record 1969-1970. Data from Shannon (1970).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)	POTASSIUM (mg/l)	TOTAL PHOSPHATE (mg/l)	TOTAL ORGANIC NITROGEN (mg/l)	AMMONIA NITROGEN (mg/l)
Lake Apopka	315 (304-324)	53 (30-100)	14 (13-16)	14 (10-18)	3.7 (1.2-5.0)	0.380 (0.286-0.500)	4.45 (3.45-5.74)	0.273 (0.080-0.580)
Bivens Arm	254 (214-340)	26 (7-36)	4.4 (3.1-5.1)	9.8 (8.5-11.0)	2.3 (1.0-3.5)	0.546 (0.365-0.730)	1.88 (1.06-3.28)	0.192 (0.000-0.380)
Burnt Pond	63 (53-78)	7.7 (5.0-11)	1.3 (1.1-1.7)	4.7 (4.0-6.0)	0.8 (0.1-1.2)	0.478 (0.350-0.605)	1.69 (1.22-2.51)	0.416 (0.040-0.850)
Cale Pond	44 (40-47)	3.9 (2.6-4.7)	0.9 (0.8-1.0)	5.4 (4.7-6.5)	0.3 (0.1-0.8)	0.184 (0.113-0.220)	1.41 (0.99-1.91)	0.413 (0.040-0.880)

	NITRATE NITROGEN (mg/l)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l pt)	SECCHI (m)
Lake Apopka	0.153 (0.000-0.260)	60.4 (50.8-74.0)	78 (75-80)	0.2 (0.2-0.3)
Bivens Arm	0.048 (0.00-0.210)	[illegible]6.0 (14.0-154.1)	42 (23-60)	0.6 (0.3-0.9)
Burnt Pond	0.240 (0.00-0.550)	29.0 (19.4-39.4)	351 (228-564)	0.6 (0.3-0.8)
Cale Pond	0.043 (0.020-0.070)	23.5 (7.3-34.2)	404 (264-588)	0.7 (0.6-0.8)

Table 43. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)	POTASSIUM (mg/l)	TOTAL PHOSPHATE (mg/l)	TOTAL ORGANIC NITROGEN, (mg/l)	AMMONIA NITROGEN (mg/l)
Clear Lake	136 (100-167)	18 (14-24)	1.4 (1.2-1.5)	6.0 (5.0-6.9)	0.6 (0.3-0.8)	0.392 (0.170-0.710)	1.27 (0.80-1.93)	0.203 (0.000-0.800)
Lake Dora	313 (260-371)	54 (27-100)	14 (12-16)	15 (10-19)	4.6 (0.8-7.0)	0.384 (0.200-0.516)	3.33 (1.28-6.92)	0.180 (0.080-0.480)
Lake Eustis	252 (227-286)	41 (18-80)	9.1 (8.0-11)	13 (10-15)	2.6 (1.4-4.5)	0.167 (0.150-0.190)	2.22 (1.45-2.62)	0.143 (0.090-0.220)
Lake Griffin	255 (233-275)	44 (18-87)	9.1 (8.0-10)	14 (10-17)	2.8 (0.8-4.0)	0.183 (0.120-0.240)	2.63 (2.23-2.93)	0.160 (0.040-0.330)

	NITRATE NITROGEN (mg/l)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l pt)	SECCHI (m)
Clear Lake	0.020 (0.000-0.050)	26.4 (11.0-62.1)	85 (61-100)	0.8 (0.3-1.2)
Lake Dora	0.180 (0.000-0.820)	50.4 (19.2-108)	96 (64-138)	0.4 (0.2-0.6)
Lake Eustis	0.117 (0.000-0.350)	23.7 (19.4-28.2)	47 (27-60)	0.8 (0.5-1.1)
Lake Griffin	0.033 (0.020-0.040)	47.3 (42.3-49.8)	36 (21-53)	0.7 (0.5-0.8)

Table 43. (cont.).

	SPECIFIC CONDUCTANCE (μmhos/cm 25C)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN (mg/1)	AMMONIA NITROGEN (mg/1)
Lake Harris	210 (132-261)	33 (14-67)	5.8 (4.1-6.9)	7.9 (6.1-9.7)	2.5 (0.6-5.0)	0.037 (0.020-0.060)	1.18 (1.07-1.34)	0.163 (0.050-0.290)
Hawthorne	168 (135-195)	16 (2.8-24)	2.2 (1.2-3.2)	8.9 (8.8-9.0)	0.9 (0.5-1.3)	0.079 (0.020-0.140)	1.86 (1.28-3.28)	0.063 (0.000-0.180)
Jeggord	56 (54-57)	1.9 (0.8-3.0)	1.1 (1.0-1.2)	7.0 (5.5-8.0)	0.6 (0.2-0.9)	0.087 (0.080-0.091)	0.470 (0.410-0.510)	0.060 (0.000-0.160)
Kanapaha	122 (91-158)	25 (15-44)	1.7 (1.3-2.5)	4.6 (4.0-5.5)	0.6 (0.3-0.9)	0.422 (0.140-0.700)	2.20 (0.75-3.71)	0.047 (0.040-0.050)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Lake Harris	0.037 (0.000-0.080)	14.5 (12.4-16.5)	29 (5-53)	1.1 (0.9-1.2)
Hawthorne	0.010 (0.000-0.050)	56.8 (24.8-117)	58 (39-80)	0.7 (0.2-1.2)
Jeggord	0.020 (0.010-0.030)	7.0 (6.3-8.0)	192 (163-214)	0.8 (0.6-1.1)
Kanapaha	0.027 (0.000-0.080)	42.7 (9.6-85.0)	121 (103-131)	0.4 (0.3-0.5)

Table 43. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN (mg/1)	AMMONIA NITROGEN (mg/1)
Unnamed Twenty	314 (255-425)	53 (40-79)	5.2 (3.9-6.2)	12 (1.4-19)	2.6 (1.0-3.5)	0.410 (0.136-0.890)	2.06 (0.97-3.47)	0.322 (0.000-0.850)
Unnamed Twenty-seven	47 (43-50)	4.5 (3.2-5.9)	1.1 (1.0-1.1)	4.2 (2.8-5.8)	0.4 (0.3-0.5)	0.325 (0.215-0.500)	0.580 (0.500-0.710)	0.103 (0.000-0.270)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Unnamed Twenty	0.013 (0.000-0.030)	92.8 (27.4-139)	69 (42-130)	0.3 (0.2-0.7)
Unnamed Twenty-seven	0.173 (0.000-0.490)	30.1 (6.7-53.8)	92 (88-100)	1.4 (1.1-1.8)

Table 43. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	TOTAL PHOSPHATE (mg/1)	TOTAL ORGANIC NITROGEN (mg/1)	AMMONIA NITROGEN (mg/1)
Palatka Pond	25 (22-29)	1.6 (1.1-2.0)	0.5 (0.5-0.5)	2.6 (1.0-3.8)	0.2 (0.1-0.3)	0.024 (0.010-0.033)	1.22 (0.74-1.67)	0.023 (0.000-0.050)
Tuscawilla	44 (44-44)	7.9 (7.9-7.9)	1.1 (1.1-1.1)	2.8 (2.8-2.8)	0.1 (0.1-0.1)	0.350 (0.350-0.350)	1.24 (1.24-1.24)	0.040 (0.040-0.040)
Lake Wauberg	66 (57-71)	7.0 (5.4-10)	1.2 (0.9-1.4)	6.0 (4.2-7.8)	0.7 (0.3-1.0)	0.169 (0.090-0.260)	1.67 (1.10-2.56)	0.221 (0.030-0.470)
Unnamed Ten	50 (45-54)	2.6 (1.9-3.2)	0.9 (0.8-1.0)	6.8 (5.0-8.0)	0.7 (0.2-1.0)	0.064 (0.040-0.110)	0.862 (0.610-1.230)	0.130 (0.040-0.270)

	NITRATE NITROGEN (mg/1)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 pt)	SECCHI (m)
Palatka Pond	0.000 (0.000-0.000)	15.6 (4.3-33.1)	93 (71-119)	1.2 (0.5-2.5)
Tuscawilla	0.030 (0.030-0.030)	11.3 (11.3-11.3)	245 (245-245)	0.8 (0.8-0.8)
Lake Wauberg	0.028 (0.000-0.110)	37.3 (16.8-83.2)	75 (31-179)	0.9 (0.6-1.1)
Unnamed Ten	0.092 (0.000-0.440)	12.6 (3.3-38.1)	124 (93-195)	1.5 (1.1-2.7)

Table 43. (cont.).

	SPECIFIC CONDUCTANCE µmhos/cm 25C	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)	POTASSIUM (mg/l)	TOTAL PHOSPHATE (mg/l)	TOTAL ORGANIC NITROGEN (mg/l)	AMMONIA NITROGEN (mg/l)
Little Orange	51 (45-55)	3.3 (2.0-4.4)	1.0 (1.0-1.1)	6.8 (5.4-8.0)	1.0 (0.3-1.5)	0.105 (0.090-0.130)	0.937 (0.830-1.060)	0.087 (0.040-0.150)
Lochloosa Lake	87 (71-96)	8.8 (6.2-10)	2.4 (1.5-3.4)	7.4 (6.0-8.7)	0.5 (0.2-0.8)	0.058 (0.050-0.063)	1.42 (1.15-1.76)	0.180 (0.110-0.220)
Newnans Lake	60 (45-73)	5.1 (3.5-7.0)	1.4 (1.0-1.8)	7.1 (6.0-8.4)	0.5 (0.2-0.8)	0.110 (0.080-0.150)	1.41 (0.66-2.35)	0.363 (0.030-0.800)
Orange Lake	77 (60-89)	7.8 (5.8-9.0)	1.8 (1.4-2.2)	8.8 (8.3-9.1)	0.7 (0.2-1.1)	0.063 (0.040-0.083)	1.07 (0.58-1.61)	0.155 (0.050-0.360)

	NITRATE NITROGEN (mg/l)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/l pt)	SECCHI (m)
Little Orange	0.120 (0.020-0.310)	9.8 (4.4-20.3)	166 (127-230)	0.9 (0.6-1.2)
Lochloosa Lake	0.017 (0.010-0.030)	23.3 (19.1-25.5)	116 (90-157)	0.9 (0.8-0.9)
Newnans Lake	0.068 (0.020-0.220)	47.4 (26.1-86.8)	189 (61-245)	0.5 (0.4-0.6)
Orange Lake	0.075 (0.020-0.250)	15.6 (11.9-20.6)	107 (41-179)	1.0 (0.8-1.2)

Table 44. Mean percentage of major cations and anions in lakes located in the Central Valley.

LAKE	CATIONS				ANIONS			
	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Apopka	44	31	19	6	54	10	12	24
Lake Dora	45	31	18	6	54	9	13	24
Lake Eaton	59	21	18	0	50	0	28	22
Lake Eustis	51	27	18	4	62	6	10	22
Lake Griffin	48	28	20	4	61	4	12	23
Lake Harris	58	23	16	2	71	2	8	18
Lochloosa Lake	52	18	28	1	58	0	11	31
Newnans Lake	38	22	37	1	48	0	12	41
Orange Lake	46	17	35	1	52	0	13	36
Lake Wauberg	40	14	44	2	47	1	18	34
Lake Yale	42	28	27	3	74	0	5	21

variability, however, can be explained if the lakes are divided into 2 groups; lakes of low mineral content and lakes of high mineral content. This division is directly related to the geology of the Central Valley, although watershed size to lake volume ratios and anthropogenic inputs are important factors modifying the edaphic influence.

Lakes of low mineral content are located primarily in the northern Central Valley in sandy deposits. Direct rainfall and surface/subface flows which have passed through slightly calcareous, phosphatic sands are the major source of water to these lakes. In this study (Table 41), this lake type was represented by Lake Eaton, Lochloosa Lake, Newnans Lake, Orange Lake and Lake Wauberg. In these lakes, mean specific conductance ranged from 59 to 105 µmhos/cm. Mean total hardness concentrations ranged from 22 to 52 mg/l as $CaCO_3$. Mean pH ranged from 6.8 to 7.4 and mean total alkalinity ranged from 14 to 27 mg/l as $CaCO_3$. Calcium and magnesium (Table 44) were the dominant cations and bicarbonate and sulfate were the dominant anions. Total nitrogen concentrations averaged between 1100 and 2100 mg/m^3 and total phosphorus concentrations averaged between 31 and 79 mg/m^3. Chlorophyll a concentrations averaged between 3.2 and 110 mg/m^3. Similar data for this lake type are reported by the Florida Game and Fresh Water Fish Commission (Table 42) and Shannon (Table 43). From the available data, these lakes can be characterized as naturally eutrophic, soft-water lakes.

Lakes of high mineral content in the Central Valley are located primarily in areas that are below the piezometeric surface. Consequently, these lakes receive a considerable portion of their total water supply from mineralized groundwater. In addition, surface inflows generally originate in calcareous nutrient-rich soils. In the present study, (Table 41), this lake type was represented by Lake Apopka, Lake Dora, Lake Eustis, Lake Griffin, Lake Harris, and Lake Yale. In these lakes, mean specific conductance ranged between 225 and 340 µmhos/cm. Mean total hardness concentrations ranged from 109 to 165 mg/l as $CaCO_3$ and mean calcium hardness concentrations ranged from 68 to 96 mg/l as $CaCO_3$. Mean pH ranged from 8.3 to 8.9 and mean total alkalinity ranged from 95 to 131 mg/l as $CaCO_3$. Calcium and magnesium (Table 44) were the dominant anions. Total nitrogen concentrations averaged between 683 and 4600 mg/m^3 and total phosphorus concentrations averaged between 14.2 and 166 mg/m^3. Chlorophyll a concentrations averaged between 9.6 and 156 mg/m^3. Similar data for this lake group are reported by the Florida Game and Fresh Water Fish Commission (Table 42) and Shannon (Table 43). Based on the available data, lakes of high mineral content in the Central Valley can generally be classified as eutrophic, hard-water lakes. Lake Yale is the only exception and this lake would be classified as mesotrophic. Though these lakes are naturally productive, as is the case for most hard-water lakes (Moyle 1954, 1956; Jones and Bachmann 1978), the disposal of nutrient-rich waste products has significantly increased the productivity of many of these lakes (Huffstuttler 1965; Holcomb 1968, 1969; Shannon and Brezonik 1972).

6. Mount Dora Ridge: The Mount Dora Ridge is a large north-south ridge of insoluable clastics located in portions of Lake, Marion, and

Orange counties. The main geological formation is the Fort Preston Formation (Vernon and Puri 1964; White 1970). The northern portion of the ridge is primarily white sand (White 1970) and there are few lakes. The southern portion of the ridge, however, contains numerous small solution lakes. In this study, 2 of these lakes, Lake Butler and Lake Down, were sampled. Data are presented in Table 45. Data for Lake Tibet (Butler) were obtained from the Florida Game and Fresh Water Fish Commission (Table 46).

Based on available data, lakes on the Mount Dora Ridge can be characterized as acidic, soft-water lakes of relatively low mineral content. Mean pH ranged from 5.5 to 6.5 and mean total alkalinity ranged from 1 to 3 mg/l as $CaCO_3$. Mean specific conductance averaged between 197 and 208 μmhos/cm. Total hardness concentrations averaged between 20 and 23 mg/l as $CaCO_3$. Sulfate concentrations were high, averaging between 41 and 64 mg/l. Calcium and magnesium (Table 47) were the dominant cations, but unlike many other lakes in Florida, magnesium occurred in greater abundance than calcium. Sulfate ions (Table 47) comprised over 60% of the measured anions.

As a group, lakes on the Mount Dora Ridge can be characterized as oligotrophic. Mean total nitrogen concentrations (Table 45) ranged from 236 to 309 mg/m^3 and mean total phosphorus concentrations ranged from 8.0 to 11.1 mg/m^3. Chlorophyll a concentrations averaged between 0.6 and 1.1 mg/m^3. Consequently, water clarity is high. During this study, Secchi disc readings averaged between 6.0 and 6.4 m.

7. Marion Upland: The Marion Upland (Figure 4) is a large, generally

Table 45. Means of limnological parameters measured in lakes located on the Mount Dora Ridge. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Butler	5.5 (5.4-5.7)	1 (0.6-2)	0 (0-0)	207 (195-220)	60 (58-62)	20 (20-22)	14 (13-15)	8.6 (8.1-9.0)	27 (26-28)
Lake Down	6.5 (6.2-6.6)	3 (2-3)	0 (0-0)	208 (200-220)	63 (61-65)	23 (23-24)	13 (12-14)	8.9 (8.4-9.2)	25 (24-27)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Butler	64 (52-69)	0.1 (0-0.2)	10.2 (5.4-13.2)	236 (165-292)	11.1 (5.2-17.7)	1.1 (0.6-1.7)	3 (0-5)	6.0 (6.0-6.0)
Lake Down	61 (52-67)	0.1 (0-0.1)	11.0 (8.1-17.0)	309 (237-350)	8.0 (2.1-15.9)	1.0 (0.7-1.6)	3 (0-5)	6.2 (6.0-6.4)

Table 46. Means of limnological parameters measured in Lake Tibet. Numbers in parentheses are the minimum and maximum values measured. Period or record, 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Lake Butler TIBET	6.3 (5.8-6.8)	6.2 (5.8-6.8)	2 (1-4)	0 (0-0)	197 (165-230)	40 (38-42)	6.6 (5.6-7.3)	5.8 (4.6-7.1)	12 (11-14)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
5.6 (5.8-6.8)	20 (18-22)	41 (36-49)	0.3 (0-0.6)	0.025 (0-0.070)	0.114 (0.010-0.460)	0.6 (0-1.1)	5 (5-5)	10 (8.0-13)

Table 47. Mean percentage of major cations and anions in lakes located on the Mount Dora Ridge.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Butler	20	39	30	11	1	0	63	36
Lake Down	23	38	28	11	3	0	62	35

flat area located in eastern Marion and Lake counties. The geology of this region is dominated primarily by deposits of the Fort Preston Formation (Vernon and Puri 1964). Deposits of the Jackson Bluff Formation, however, occur in the vicinity of Lake Kerr (Vernon and Puri 1964). North of Lake Dorr, numerous small sinkhole lakes occur, while south of Lake Dorr there are a number of lakes located in low poorly-drained lands. In this study, 4 natural lakes (Lake Dorr, Lake Kerr, Sellers Lake, and Wildcat Lake) located on the Marion Upland were sampled. Data are presented in Table 48. Additional data for Lake Dorr and Lake Kerr (Table 49) were obtained from the Florida Game and Fresh Water Fish Commission.

Based on the available data, lakes on the Marion Upland can be characterized as acidic, soft-water lakes. Mean pH values ranged from 4.8 to 6.1 and total alkalinity concentrations averaged between 1 and 3 mg/ 1 as $CaCO_3$. Mean total hardness concentrations ranged from 4.9 to 23 mg/1 as $CaCO_3$ and calcium hardness concentrations averaged between 2.2 and 17 mg/1 as $CaCO_3$. As reflected by the low average specific conductance (33 to 105 μmhos/cm), the content of non-hardness-causing minerals was low. With the exception of Lake Kerr, which receives small inputs of mineralized groundwater, sodium (Table 50) is the dominant cation. Sulfate and chloride (Table 50) comprised over 90% of the measured anion.

The trophic status of the study lakes, with the possible exception of Lake Dorr, can be characterized as oligotrophic or oligo-mesotrophic Mean total nitrogen concentrations ranged from 192 to 369 mg/m^3 and mean phosphorus concentrations ranged from 4.3 and 20.2 mg/m^3. Chlorophyll

Table 48. Means of limnological parameters measured in lakes located on the Marion Upland. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Dorr	5.2 (4.8-5.6)	2 (1-3)	0 (0-0)	44 (43-47)	9.2 (8.5-10)	5.3 (4.5-6.5)	5.2 (4.6-5.7)	0.3 (0.2-0.4)	7.3 (6.8-8.0)
Lake Kerr	6.1 (6.0-6.1)	3 (2-4)	0 (0-0)	105 (102-108)	23 (23-24)	17 (14-22)	10 (10-11)	0.4 (0.3-0.5)	17 (17-18)
Sellers Lake	4.9 (4.8-4.9)	1 (0.4-1)	0 (0-0)	37 (35-39)	5.1 (4.8-5.5)	2.3 (1.5-3.5)	4.6 (4.0-5.2)	0.2 (0.1-0.3)	6.6 (6.4-7.0)
Wildcat Lake	4.8 (4.7-4.9)	1 (0.4-2)	0 (0-0)	33 (30-35)	4.9 (3.0-9.0)	2.2 (1.5-2.5)	4.4 (3.7-5.1)	0.1 (0.1-0.1)	6.5 (6.0-7.0)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 @ Pt)	SECCHI (m)
Lake Dorr	7.6 (3.4-16)	1.3 (0.5-2.3)	276 (217-310)	369 (333-405)	20.2 (9.1-34.6)	4.2 (2.4-6.1)	92 (75-100)	1.2 (0.9-1.5)
Lake Kerr	18 (13-23)	0.8 (0.5-1.1)	24.3 (17.7-31.6)	221 (180-246)	13.0 (6.3-26.8)	1.5 (1.0-2.8)	15 (5-35)	3.3 (2.5-4.5)
Sellers Lake	6.8 (3.8-13)	0 (0-0.1)	24.8 (12.5-35.1)	255 (194-317)	4.3 (0.1-12.9)	2.0 (0.4-3.8)	3 (0-5)	5.8 (4.9-6.3)
Wildcat Lake	6.0 (0-13)	0.1 (0.1-0.2)	70.0 (40.2-107)	192 (142-258)	8.2 (0-13.2)	1.3 (0.9-2.0)	18 (10-30)	3.2 (2.4-4.0)

Table 49. Means of limnological parameters measured in Lake Dorr and Lake Kerr. Numbers in parentheses are the minimum and maximum values measured. Period of record 1967, 1973. Data from Holcomb (1968-1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (µmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Dorr	5.9 (4.6-6.7)	5.9 (5.5-6.2)	3.0 (1.0-5.0)	0.0 (0.0-0.0)	68 (57-94)	11 (10-11)	2.0 (1.8-2.2)	1.0 (0.9-1.1)	4.9 (4.4-5.4)
Kerr	6.2 (5.7-6.9)	6.3 (6.0-6.7)	2.0 (0.5-3.5)	0.0 (0.0-0.0)	122 (107-138	19 (17-20)	5.1 (4.4-5.9)	1.8 (1.4-2.0)	9.3 (8.3-11)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
0.4 (0.3-0.6)	9.5 (9.5-9.5)	4.0 (3.0-5.0)	*** ***	0.650 (0.620-0.680)	0.132 (0.120-0.150)	5.0 (1.1-15.0)	*** ***	3.3 (2.0-4.6)
0.5 (0.4-0.6)	18 (17-19)	15 (11-17)	*** ***	0.020 (0.000-0.040)	0.030 (0.010-0.040)	1.7 (1.1-2.4)	*** ***	11 (6.9-16)

Table 50. Mean percentage of major cations and anions in lakes located on the Marion Upland.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Dorr	25	19	53	2	9	0	39	51
Lake Kerr	36	14	49	1	6	0	41	54
Sellers Lake	15	18	65	2	5	0	41	54
Wildcat Lake	15	19	65	1	6	0	38	56

a concentrations averaged between 1.3 and 5 mg/m^3 and water clarity averaged between 1.2 and 5.8 m. Lake Dorr, however, is the most productive lake due to its relatively large watershed to lake volume ratio. This results in a higher nutrient loading. Based on total phosphorus content, Lake Dorr might best be characterized as a mesotrophic lake. Low water clarity in Lake Dorr results because the lake receives highly-colored water from surrounding poorly-drained lands.

8. Crescent City Ridge: The Crescent City Ridge (Figure 4) is a remnant highland located east of the St. Johns River in portions of Putnam and Volusia counties. The regional geology is dominated by deposits of the Fort Preston Formation (Vernon and Puri 1964). Topography is karstic and there are numerous small lakes. In general, these lakes can be divided into 3 groups: 1) lakes receiving water from poorly-drained lands; 2) lakes receiving inputs of mineralized groundwater; 3) lakes receiving the majority of their water from direct rainfall and surface/subsurface inflows which have passed through well-drained sandy soils. In this study, 3 of these lakes (Lake Margaret, Lake Stella, and Lake Broward) were sampled. Data are presented in Table 51 and Table 52.

Lake Margaret represents those lakes that receive drainage from poorly-drained lands. Measured pH values averaged 4.6 and total alkalinity values averaged 0 mg/l as $CaCO_3$. Specific conductance averaged 59 µmhos/cm. Total hardness concentrations averaged 9.4 mg/l as $CaCO_3$ and calcium hardness concentrations averaged 2.8 mg/l as $CaCO_3$. Sodium was the dominant cation (59%) and chloride was the dominant anion (63%).

Table 51. Means of limnological parameters measured in lakes located on the Crescent City Ridge. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Broward	5.5 (5.1-5.9)	1 (1-2)	0 (0-0)	71 (70-74)	14 (14-15)	7.3 (7.0-8.0)	7.1 (6.8-8.0)	1.4 (1.3-1.7)	11 (10-11)
Lake Margaret	4.6 (4.4-4.7)	0 (0-0.4)	0 (0-0)	59 (59-60)	9.4 (9.0-9.5)	2.8 (2.0-3.5)	7.0 (6.6-7.2)	0.4 (0.3-0.7)	10 (8.5-11)
Lake Stella	7.0 (6.7-7.5)	16 (14-17)	0 (0-0)	239 (235-245)	72 (69-75)	42 (39-44)	16 (16-17)	8.3 (7.4-8.8)	27 (26-28)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Broward	12 (10-16)	.0.1 (0.1-0.2)	10.5 (5.5-19.3)	172 (108-267)	3.6 (0.5-7.1)	1.5 (1.0-2.5)	4 (0-10)	5.7 (5.0-6.6)
Lake Margaret	7.5 (5.4-11)	1.0 (0.5-1.3)	301 (279-325)	714 (414-1300)	20.1 (16.9-24.9)	7.5 (5.2-10.9)	65 (50-75)	0.7 (0.4-0.9)
Lake Stella	61 (50-67)	0.1 (0-0.2)	16.0 (8.2-22.2)	458 (417-528)	12.9 (7.8-23.4)	2.7 (1.5-5.1)	12 (5-15)	4.1 (2.6-5.5)

Table 52. Mean percentage of major cations and anions in lakes located on the Crescent City Ridge.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Broward	23	22	49	6	5	0	42	53
Lake Margaret	11	26	59	2	1	0	35	63
Lake Stella	35	26	30	9	13	0	54	32

Total nitrogen concentrations averaged 714 mg/m^3 and total phosphorus concentrations averaged 20.1 mg/m^3. Chlorophyll a concentrations averaged 7.5 mg/m^3. Water color averaged 65 mg/l as Pt. From these data, lakes receiving drainage from poorly-drained lands on the Crescent City Ridge can probably be characterized as acid-colored, mesotrophic lakes of low mineral content.

Lake Stella represents those lakes that receive inputs of mineralized groundwater. Measured pH values averaged 7.0 and total alkalinity averaged 16 mg/l as $CaCO_3$. Specific conductance averaged 239 μmhos/cm. Total hardness concentrations averaged 72 mg/l as $CaCO_3$ and calcium hardness concentrations averaged 42 mg/l as $CaCO_3$. Sulfate concentrations averaged 61 mg/l. Sulfate ions (Table 52) were the dominant anions (54%). Calcium (35%) and magnesium (26%) were the dominant cations. Total nitrogen concentrations averaged 12.0 mg/m^3. Chlorophyll a concentrations averaged 2.7 mg/m^3, but ranged up to 5.1 mg/m^3. In addition, there were extensive growths of aquatic macrophytes. Water color averaged 12 mg/l as Pt and water transparency averaged 4.1 m. From these data, lakes receiving inputs of mineralized groundwater on the Crescent City Ridge can probably be characterized as mesotrophic lakes of moderate mineral content.

Lake Broward represents those lakes that receive the majority of their water from direct rainfall and surface/subsurface inflows which have passed through well-drained sandy soils. Measured pH values averaged 5.5 and total alkalinity concentrations averaged 1 mg/l as $CaCO_3$. Specific conductance averaged 71 μmhos/cm. Total hardness concentrations averaged 14 mg/l as $CaCO_3$ and calcium hardness concentrations averaged

7.3 mg/l as $CaCO_3$. Sodium (Table 52) was the dominant cation (49%) and chloride followed by sulfate was the dominant anion (53%). Total nitrogen concentrations averaged 172 mg/m^3 and total phosphorus concentrations averaged 3.6 mg/m^3. Chlorophyll a concentrations averaged 1.5 mg/m^3. Water color averaged 4 mg/l as Pt and water transparency averaged 5.7 m. Based on these data, lakes receiving the majority of their water from direct rainfall or surface/subsurface inflows which have passed through well-drained sandy soils on the Crescent City Ridge can probably be characterized as clear, acid, oligotrophic lakes of low mineral content.

9. Deland Ridge: The Deland Ridge (Figure 4) is a remnant highland located east of the St. Johns River in Volusia County. The major geological formation in this region is the Fort Preston Formation (Vernon and Puri 1964). Topography is karstic and there are numerous, small, shallow lakes. In this study, only Lake Winnemissett, a small deep lake, was sampled. Data are presented in Tables 53 and 54.

Lake Winnemissett can be characterized as an oligotrophic lake of moderate mineral content. Measured pH values averaged 6.8 and total alkalinity averaged 7 mg/l as $CaCO_3$. Specific conductance averaged 173 μmhos/cm and total hardness averaged 52 mg/l as $CaCO_3$. Sulfate concentrations were high, averaging 50 mg/l as $CaCO_3$. Calcium and magnesium were the dominant cations and sulfate (64%) was the dominant anion. Total nitrogen concentrations averaged 259 mg/m^3 and total phosphorus concentrations averaged 7.0 mg/m^3. Consequently, chlorophyll a

Table 53. Means of limnological parameters measured in lakes located on the Deland Ridge. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Lake Winnemissett	6.8 (6.6-7.1)	7 (6-7)	0 (0-0)	173 (165-185)	52 (51-54)	33 (29-41)	9.0 (7.8-11)	6.0 (5.4-6.4)	16 (16-17)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Lake Winnemissett	50 (39-55)	0.2 (0.1-0.3)	9.1 (5.7-10.7)	259 (192-358)	7.0 (0.7-16.8)	1.0 (0.4-1.5)	4 (0-10)	5.8 (4.8-6.6)

Table 54. Mean percentage of major cations and anions in lakes located on the Deland Ridge.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Winnemissett	42	23	25	10	8	0	64	28

concentrations averaged only 1.0 mg/m^3 and water transparency averaged 5.8 m. If Lake Winnemissett is typical of other lakes in this region, lakes on the Deland Ridge are among the most oligotrophic lakes in Florida.

10. Eastern Valley: The Eastern Valley (Figure 4) which includes the St. Johns River Offset (White 1970), is a broad flat valley located in portions of St. Lucie, Indian River, Brevard, Orange, Seminole, Lake, Volusia, Flagler, Putnam, Clay, St. Johns, and Duval counties. Deposits of peats, muds, and marine sediments dominate the regional geology (Vernon and Puri 1964). The dominant physical feature in the Eastern Valley is the north-flowing St. Johns River and its associated lakes. Numerous lakes, however, are also located throughout the Eastern Valley. In this study, 12 lakes (Lake Ashby, Lake Cypress, Crescent Lake, Lake Dexter, Lake Dias, Lake Disston, Lake George, Lake Harney, Lake Jessup, Lake Monroe, Lake Poinsett, Lake Washington) were sampled. Data are presented in Table 55 and Table 56. Additional data obtained from the U.S. Army Corps of Engineers (1980) are presented in Table 57.

From the available data, it can be seen that water quality in the Eastern Valley is highly variable. Mean pH ranged from 5.2 to 8.4 and mean totalalkalinity ranged from 3 to 72 mg/l as $CaCO_3$. Mean specific conductance ranged between 52 and 1100 μmhos/cm. Total hardness concentrations averaged between 15 and 222 mg/l as $CaCO_3$ and calcium hardness concentrations averaged between 6.9 and 146 mg/l as $CaCO_3$. Sodium concentrations averaged between 6.0 and 186 mg/l and chloride concentrations averaged between 9.9 and 327 mg/l. Mean sulfate concentrations

Table 55. Means of limnological parameters measured in lakes located in the Eastern Valley. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (μmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Ashby	6.9 (6.7-7.4)	12 (11-16)	0 (0-0)	80 (59-94)	24 (19-29)	17 (12-21)	7.3 (5.8-8.8)	0.8 (0.6-0.9)	14 (10-16)
Blue Cypress	7.7 (7.3-8.5)	31 (22-36)	0 (0-0)	180 (170-200)	53 (46-59)	44 (36-52)	20 (18-22)	2.2 (2.0-2.4)	37 (32-41)
Crescent Lake	6.8 (6.3-8.1)	20 (11-29)	0 (0-0)	234 (96-350)	55 (25-82)	39 (18-60)	26 (10-41)	1.5 (1.1-1.9)	52 (19-85)
Lake Dexter	7.2 (6.8-8.7)	51 (30-62)	1 (0-4)	730 (460-980)	147 (94-196)	100 (71-117)	104 (66-150)	4.5 (3.3-5.9)	190 (119-270)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Ashby	6.8 (0-17)	1.8 (1.0-3.0)	517 (483-542)	577 (458-683)	17.8 (5.6-31.0)	12.4 (2.8-33.0)	145 (120-200)	0.8 (0.4-1.2)
Blue Cypress	9.2 (5.6-14)	5.3 (2.3-11)	264 (172-361)	747 (611-941)	66.5 (20.7-101)	5.4 (0.9-16.7)	110 (80-150)	1.1 (0.7-1.5)
Crescent Lake	17 (4.3-33)	2.1 (0.7-3.8)	728 (582-841)	1100 (983-1300)	30.0 (10.2-41.1)	27.5 (2.4-47.1)	247 (175-350)	0.6 (0.3-0.8)
Lake Dexter	54 (32-83)	5.7 (3.4-7.7)	202 (45-404)	994 (833-1200)	115 (74.5-171)	17.6 (4.8-44.6)	136 (50-250)	0.7 (0.5-0.9)

Table 55. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Dias	6.7 (6.5-7.3)	9 (8-11)	0 (0-0)	92 (85-102)	27 (25-29)	20 (17-23)	7.4 (6.5-8.1)	2.3 (2.2-2.5)	13 (13-14)
Lake Disston	5.2 (5.0-5.9)	3 (2-5)	0 (0-0)	52 (44-59)	15 (14-17)	6.9 (6.0-8.5)	6.0 (4.8-7.4)	0.5 (0.3-0.7)	9.9 (6.3-12.3)
Lake George	8.4 (8.1-9.4)	59 (46-68)	6 (0-19)	888 (720-1200)	179 (145-219)	111 (89-133)	129 (100-165)	5.2 (4.0-6.5)	233 (192-303)
Lake Harney	7.5 (7.3-8.4)	47 (45-50)	0 (0-0)	1100 (460-1900)	222 (96-364)	130 (72-194)	186 (60-350)	8.8 (3.9-15)	327 (119-585)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Dias	14 (7.7-22)	3.9 (3.2-4.7)	342 (317-383)	639 (517-880)	52.7 (30.3-64.5)	6.3 (0.5-13.0)	133 (100-150)	1.0 (0.5-1.5)
Lake Disston	5.4 (0-14)	3.3 (2.8-3.9)	747 (529-988)	832 (542-968)	10.2 (2.0-20.6)	1.6 (0.8-2.8)	383 (300-500)	0.4 (0.3-0.6)
Lake George	77 (60-104)	2.4 (0-6.2)	168 (122-224)	1400 (775-2000)	55.6 (38.1-102)	48.2 (12.0-78.8)	88 (60-100)	0.7 (0.5-1.0)
Lake Harney	109 (21-211)	3.1 (0.9-5.6)	231 (93-404)	1100 (790-1300)	99.4 (63.1-155)	11.8 (1.9-34.2)	103 (60-150)	0.8 (0.6-1.0)

Table 55. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Jessup	8.4 (7.8-9.6)	72 (41-89)	6 (0-18)	722 (540-840)	155 (133-169)	101 (87-112)	101 (60-137)	7.1 (5.3-9.5)	183 (122-240)
Lake Monroe	7.6 (7.3-8.2)	45 (29-58)	0 (0-0)	907 (460-1200)	172 (95-216)	108 (68-146)	140 (64-200)	7.3 (4.1-11)	261 (107-410)
Lake Poinsett	7.7 (7.3-8.3)	58 (54-64)	0 (0-0)	842 (460-1300)	205 (135-292)	146 (103-199)	111 (53-185)	4.4 (3.2-6.9)	228 (113-375)
Lake Washington	7.8 (7.8-7.9)	62 (56-67)	0 (0-0)	428 (320-520)	133 (110-150)	101 (91-113)	45 (33-60)	2.5 (2.1-3.0)	97 (70-130)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Jessup	47 (38-59)	4.2 (0-15)	167 (65.3-265)	2800 (725-6400)	347 (270-543)	157 (53.7-346)	46 (35-50)	0.3 (0.1-0.6)
Lake Monroe	70 (15-112)	3.4 (0-5.6)	284 (116-598)	1300 (991-1500)	91.1 (52.6-153)	37.4 (7.3-73.6)	89 (40-150)	0.5 (0.3-0.5)
Lake Poinsett	69 (32-110)	4.4 (1.0-6.4)	208 (101-390)	1100 (776-1500)	49.1 (25.0-78.5)	9.5 (1.9-16.7)	94 (50-150)	0.6 (0.5-0.7)
Lake Washington	30 (17-41)	3.4 (0.1-6.7)	108 (49-217)	1100 (754-1300)	31.8 (16.9-49.8)	3.4 (0.9-5.8)	92 (60-150)	0.8 (0.3-1.3)

Table 56. Mean percentage of major cations and anions in lakes located in the Eastern Valley.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Ashby	41	16	38	2	33	0	18	49
Blue Cypress Lake	45	8	43	3	34	0	10	56
Crescent Lake	34	14	49	2	18	0	16	66
Lake Dexter	26	13	60	1	13	0	15	71
Lake Dias	42	16	34	6	22	0	34	44
Lake Disston	22	28	43	2	14	0	25	62
Lake George	24	15	60	1	10	3	17	70
Lake Harney	20	14	63	2	8	0	18	74
Lake Jessup	26	14	57	2	16	3	13	68
Lake Monroe	22	13	63	2	9	0	15	76
Lake Poinsett	32	13	53	1	13	0	16	71
Lake Washington	43	14	42	1	27	0	13	59

Table 57. Means of limnological parameters measured in lakes located along the St. Johns River for 1973-1979. Data from U.S. Army Corps of Engineers (1980).

LAKE	pH	TOTAL ALKALINITY (mg/1 as $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Blue Cypress Lake	7.0 (6.4-7.5)	28 (10-42)	230 (150-300)	16 (11-21)	4.0 (2.8-6.0)	21 (15-30)	1.6 (0.8-2.6)	47 (32-61)
Helen Blazes	6.8 (5.0-8.0)	70 (6-134)	467 (205-980)	36 (17-62)	8.5 (3.0-26)	36 (12-96)	2.6 (0.9-5.4)	81 (24-224)
Lake Poinsett	6.8 (5.8-7.4)	60 (24-114)	466 (70-1100)	43 (12-110)	12 (2.6-41)	73 (16-260)	3.8 (1.8-8.8)	165 (37-585)
Sawgrass	7.0 (4.7-8.2)	65 (20-150)	408 (135-980)	33 (14-66)	7.3 (2.4-20)	28 (3.2-58)	2.1 (0.6-5.6)	69 (24-136)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL NITROGEN (mg/1)	TOTAL PHOSPHORUS (mg/1)	SECCHI (m)
Blue Cypress Lake	15 (7.4-35)	7.5 (2.0-19)	0.386 (0.130-1.160)	1.29 (0.67-1.86)	0.092 (0.050-0.170)	1.6 (0.6-3.7)
Helen Blazes	27 (8.7-62)	9.8 (4.0-25)	0.328 (0.020-0.920)	1.67 (0.67-3.37)	0.080 (0.030-0.265)	1.2 (0.3-2.5)
Lake Poinsett	42 (4.6-143)	8.5 (1.2-29)	0.384 (0.070-1.260)	1.48 (0.72-2.34)	0.017 (0.027-0.610)	1.7 (0.5-4.5)
Sawgrass	24 (6.6-47)	7.4 (1.2-23)	0.347 (0.030-0.720)	1.64 (0.31-3.53)	0.062 (0.021-0.215)	1.4 (0.2-3.5)

LAKE	pH	TOTAL ALKALINITY (mg/1 as $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Washington	7.0 (4.9-7.9)	57 (24-114)	423 (130-872)	33 (15-68)	8.0 (2.7-25)	33 (7.0-80)	2.5 (0.8-9.1)	92 (8.8-416)
Winder	7.1 (6.5-7.8)	58 (32-116)	554 (110-1600)	39 (18-75)	10 (3.2-28)	55 (16-200)	3.3 (1.6-7.0)	129 (36-450)

ranged from 5.4 to 109 mg/l. Total nitrogen concentrations averaged between 577 and 2800 mg/m^3 and total phosphorus concentrations averaged between 10.2 and 347 mg/m^3. Mean chlorophyll a concentrations ranged from 1.6 to 157 mg/m^3. As is the case with other large physiographic regions, much of this variability is directly related to regional geology and lake origin.

A major lake type in the Eastern Valley is the river-run lakes of the St. Johns River. This lake type includes Blue Cypress, Helen Blazes, Sawgrass, Lake Washington, Winder, Lake Poinsett, Lake Harney, Lake Jessup, Lake Monroe, Lake Dexter, and Lake George. As a group, these lakes can be chemically characterized as alkaline, hard-water lakes of high mineral content. In this study, mean pH ranged from 7.2 to 8.4 and mean total alkalinity ranged from 31 to 72 mg/l as $CaCO_3$. Mean specific conductance ranged from 180 to 1100 µmhos/cm. Total hardness concentrations averaged between 44 and 146 mg/l as $CaCO_3$. Mean sodium concentrations ranged from 20 to 186 mg/l and chloride concentrations averaged between 37 and 327 mg/l. With the exception of Blue Cypress and Lake Washington, which had a mixed chemical composition, sodium (Table 56) was the dominant cation and chloride was the dominant anion. The concentration of most chemical parameters was generally lower in the southern lakes, especially Blue Cypress. In these lakes, atmospheric precipitation is the dominant mechanism controlling surface water chemistry, but once the St. Johns River passes north of Sawgrass Lake, inputs of mineralized water derived from marine sediments and salt springs increase in importance (McLane 1955). The chemical composition of these lakes, therefore, will vary considerably depending upon the amount of rainfall. During periods of high rainfall, the mineral content of the lakes will be low, but during periods of rainfall deficiency, the mineral content will be extremely high due to the greater relative input of mineralized water.

Based on conventional criteria (Table 4), the lakes of the St. Johns River, with the possible exception of Blue Cypress, can be characterized as eutrophic lakes. Total nitrogen concentrations averaged between 747 and 2800 mg/m^3 and total phosphorus concentrations averaged between 31.8 and 347 mg/m^3. Mean chlorophyll _a_ concentrations ranged from 3.4 to 157 mg/m^3. In many cases, the lakes have received or continue to receive inputs of nutrient-rich wastes. However, these lakes are undoubtedly naturally eutrophic. For example, in the case of Lake Jessup, the U.S.Environmental Protection Agency (1980) estimated municipal point sources contributed 41,000 kg P/yr and non-point sources contributed 95,000 kg P/yr. If all of the municipal sources were removed, phosphorus loading models (Canfield 1979; Canfield and Bachmann 1981) suggest phosphorus concentrations would be reduced from 500 mg/m^3 to 257 mg/m^3. Assuming most of the non-point source contribution is natural, this phosphorus concentration would be more than sufficient to maintain Lake Jessup in a eutrophic state.

Lake Ashby, Crescent Lake, Lake Dias, and Lake Disston are not river-run lakes of the St. Johns River. As a group, these lakes can be chemically characterized as acid to slightly acid, soft-water lakes of moderate mineral content. In this study, mean pH ranged from 5.2 to 6.9 and mean total alkalinity concentrations averaged between 3 and 20 mg/l as $CaCO_3$. Specific conductance averaged between 52 and 234 µmhos/cm. Total hardness concentrations averaged between 15 and 55 mg/l as $CaCO_3$. Sodium concentrations averaged between 6.0 and 26 mg/l and chloride concentrations averaged between 9.9 and 52 mg/l. Unlike the St. Johns River lakes in which sulfate concentrations generally averaged over 30 mg/l, sulfate concentrations in these lakes averaged between 5.4 and 17 mg/l. Calcium and magnesium were the dominant cations and sulfate and chloride were the dominant anions (Table 56). These values result largely because these lakes receive most of their water from non-calcareous sandy soils and direct rainfall. Only Crescent Lake, which had the highest measured concentrations in this group, receives any significant inputs of mineralized water.

The trophic status of these lakes is variable. Mean total nitrogen concentrations ranged from 577 to 1100 mg/m^3 and mean total phosphorus concentrations ranged from 10.2 to 52.7 mg/m^3. Chlorophyll a concentrations averaged between 1.6 and 27.5 mg/m^3. Based on total phosphorus concentrations, however, these lakes, with the exception of Lake Disston, could be characterized as eutrophic. Phosphorus levels are sufficient to support algal blooms and these blooms probably would be detected with an expanded sampling program.

11. Osceola Plain: The Osceola Plain (Figure 4) is a major physiographic feature of east-central Florida. The plain, which lies between the Eastern Valley and the Lake Wales Ridge, is a broad flat area extending from southern Seminole County to Okeechobee County. Deposits of peats, muds, and estuarine sediments dominate surface geology (Vernon and Puri

1964. Numerous large, shallow lakes are found throughout the region. In addition, in south-central Orange County and north-central Osceola County, there are numerous small lakes. These lakes in association with a few large lakes like East Lake Tohopekaliga form a distinctive lake district.

In this study, 15 lakes (Alligator Lake, Lake Arbuckle, Cypress Lake, Lake Gentry, Lake Hart, Lake Hatchineha, Lake Kissimmee, Lawne Lake, Lake Marian, Lake Mary Jane, Lake Rosalie, Tiger Lake, Lake Tohopekaliga, East Lake Tohopekaliga, Lake Weohyakapka) were sampled. Date are presented in Tables 58 and 59. Based on the data collected in this study, lakes on the Osceola Plain, with the exception of Lawne Lake, can be chemically characterized as soft-water lakes. Mean total alkalinity ranged from 2 to 39 mg/l as $CaCO_3$. Total hardness concentrations averaged between 18 and 49 mg/l as $CaCO_3$ and calcium hardness concentrations averaged between 6.8 and 37 mg/l as $CaCO_3$. Mean specific conductance ranged from 76 to 171 μmhos/cm. These lakes, however, can be divided into 2 groups. Alligator, Lake Gentry, Lake Hart, Lake Mary Jane and East Lake Tohopekaliga are all located in the lake district found in south-central Orange County and north-central Osceola County. In these lakes, mean pH ranged from 5.1 to 6.1 and total alkalinity averaged between 2 and 4 mg/l as $CaCO_3$. Total hardness concentrations averaged between 18 and 21 mg/l as $CaCO_3$ and specific conductance averaged between 84 and 105 μmhos/cm. Sodium was the dominant cation and chloride was the dominant anion. Lake Arbuckle, Cypress Lake, Lake Hatchineha, Lake Kissimmee, Lake Marian, Lake Rosalie, Tiger Lake, Lake Tohopekaliga, and Lake Weohyakapka are all located outside the lake district and receive water inputs from calcareous sources like

Table 58. Means of limnological parameters measured in lakes located on the Osceola Plain. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Alligator Lake	5.7 (5.1-6.3)	2 (2-3)	0 (0-0)	105 (96-112)	21 (20-22)	8.7 (7.0-11)	11 (10-13)	1.6 (1.5-1.8)	23 (21-24)
Lake Arbuckle	7.0 (6.9-7.3)	10 (7-12)	0 (0-0)	108 (100-115)	36 (34-39)	24 (23-25)	7.6 (6.8-8.9)	2.5 (2.4-2.7)	13 (12-14)
Cypress Lake	7.8 (7.3-10.0)	22 (17-28)	3 (0-7)	135 (110-160)	36 (32-40)	25 (22-28)	14 (12-16)	2.1 (1.9-2.5)	22 (19-24)
Lake Gentry	6.1 (5.9-6.3)	3 (2-4)	0 (0-0)	94 (80-105)	20 (18-21)	9.4 (7.0-12)	11 (9.8-12)	1.3 (1.2-1.5)	21 (18-23)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL $\underline{a}$ (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Alligator Lake	12 (6.6-15)	1.6 (1.3-2.2)	228 (204-257)	1300 (950-1500)	41.7 (27.3-53.1)	29.2 (12.7-41.3)	53 (30-75)	0.7 (0.5-0.9)
Lake Arbuckle	27 (22-32)	0.9 (0.7-1.0)	134 (74.7-172)	1100 (475-1900)	172 (125-204)	18.3 (15.5-26.7)	62 (40-75)	0.9 (0.8-1.0)
Cypress Lake	8.3 (6.2-11)	1.1 (0.4-1.9)	205 (126-350)	1700 (1000-2200)	74.6 (49.5-103)	61.7 (26.7-89.0)	51 (30-70)	0.6 (0.3-1.0)
Lake Gentry	12 (6.1-18)	1.3 (0.7-2.1)	1100 (932-1500)	1300 (1200-1400)	17.9 (7.1-29.6)	9.2 (3.0-19.6)	225 (200-250)	0.5 (0.4-0.5)

Table 58. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Lake Hart	5.9 (5.7-6.1)	4 (3-5)	0 (0-0)	90 (81-95)	21 (20-22)	9.6 (8.0-11)	9.3 (8.4-10)	0.9 (0.8-1.0)	18 (17-19)
Lake Hatchineha	7.3 (7.1-7.6)	24 (22-25)	0 (0-0)	106 (89-115)	39 (37-42)	28 (26-32)	7.9 (6.3-9.7)	1.5 (1.2-1.9)	14 (12-16)
Lake Kissimmee	7.9 (7.4-9.3)	22 (20-24)	1 (0-3)	118 (108-126)	37 (35-40)	27 (25-29)	10 (10-11)	1.6 (1.5-1.7)	15 (12-18)
Lawne Lake	7.6 (7.5-7.6)	59 (54-62)	0 (0-0)	207 (188-235)	85 (78-90)	69 (64-73)	11 (10-12)	3.8 (2.5-4.7)	14 (14-15)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Lake Hart	13 (7.9-20)	2.1 (1.4-2.5)	632 (540-720)	660 (438-833)	17.3 (8.9-30.3)	4.3 (3.6-5.1)	68 (50-83)	1.1 (0.7-1.7)
Lake Hatchineha	14 (7.9-17)	2.6 (1.9-3.5)	722 (659-816)	796 (675-977)	42.9 (17.1-56.0)	16.1 (2.1-44.3)	67 (50-75)	0.6 (0.5-0.7)
Lake Kissimmee	11 (6.4-15)	0.3 (0.2-0.5)	192 (138-235)	570 (481-618)	14.6 (6.9-22.1)	4.0 (2.8-5.8)	47 (30-60)	1.6 (1.2-2.3)
Lawne Lake	27 (16-37)	2.6 (1.2-3.6)	155 (121-192)	847 (668-1100)	49.1 (16.3-70.5)	19.0 (7.2-29.2)	112 (60-175)	0.8 (0.6-1.0)

Table 58. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Marian	7.8 (7.3-9.9)	22 (20-24)	3 (0-8)	104 (92-120)	32 (31-34)	26 (24-29)	8.9 (7.6-10)	2.3 (2.3-2.4)	16 (15-17)
Lake Mary Jane	5.1 (4.3-6.0)	3 (0-4)	0 (0-0)	84 (68-100)	19 (18-20)	8.9 (8.0-10)	9.0 (8.2-11)	0.7 (0.6-0.9)	18 (15-20)
Lake Rosalie	7.0 (6.8-7.1)	9 (9-10)	0 (0-0)	83 (74-88)	25 (24-26)	15 (12-19)	6.9 (6.3-7.3)	1.3 (1.2-1.4)	13 (12-13)
Tiger Lake	7.3 (6.8-9.3)	33 (8.4-64)	2 (0-5)	84 (78-90)	23 (21-26)	13 (11-15)	7.5 (6.8-7.9)	1.2 (1.1-1.4)	14 (13-14)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m³)	TOTAL N (mg/m³)	TOTAL P (mg/m³)	CHLOROPHYLL a (mg/m³)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Marian	13 (8.1-16)	0.5 (0.1-1.3)	334 (256-416)	1800 (1100-2600)	131 (17.1-311)	77.9 (19.0-137)	57 (35-70)	0.4 (0.2-0.7)
Lake Mary Jane	9.6 (5.4-13)	0.5 (0.5-0.6)	358 (345-371)	613 (532-691)	19.4 (12.9-29.4)	4.5 (3.3-5.5)	80 (63-100)	0.8 (0.6-1.1)
Lake Rosalie	13 (6.8-19)	1.0 (0.7-1.5)	811 (706-952)	1100 (970-1300)	19.1 (6.2-30.3)	4.2 (2.9-5.2)	183 (175-200)	0.6 (0.5-0.7)
Tiger Lake	11 (5.1-17)	3.8 (2.8-4.7)	299 (250-339)	1200 (933-1400)	46.2 (17.1-80.8)	17.4 (0.5-33.0)	129 (70-200)	0.6 (0.5-0.7)

Table 58. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/1 CaCO3)	PHENOL ALKALINITY (mg/1 CaCO3)	SPECIFIC CONDUCTANCE (μmhos/cm 25 C)	TOTAL HARDNESS (mg/1 CaCO3)	CALCIUM HARDNESS (mg/1 CaCO3)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Tohopekaliga	8.1 (7.6-9.5)	39 (25-63)	2 (0-6)	171 (134-225)	49 (40-66)	37 (27-54)	18 (14-27)	3.1 (2.5-4.1)	25 (20-31)
East Lake Tohopekaliga	6.1 (5.9-6.4)	3 (3-4)	0 (0-0)	96 (90-106)	18 (18-20)	6.8 (5.0-9.5)	11 (10-12)	1.9 (1.8-2.0)	21 (20-22)
Lake Weohyakapka	7.0 (7.0-7.2)	8 (7-10)	0 (0-0)	76 (64-86)	21 (20-23)	10 (8.5-12)	6.4 (6.0-7.0)	1.2 (1.1-1.4)	14 (11-19)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m³)	TOTAL N (mg/m³)	TOTAL P (mg/m³)	CHLOROPHYLL *a* (mg/m³)	COLOR (mg/1 @ Pt)	SECCHI (m)
Lake Tohopekaliga	14 (9.4-18)	3.0 (0-6.8)	241 (182-260)	1700 (1500-2000)	368 (17.1-1100)	69.6 (37.5-107)	53 (50-60)	0.4 (0.3-0.5)
East Lake Tohopekaliga	15 (6.9-23)	0.7 (0.2-1.1)	160 (86.3-245)	643 (582-711)	23.8 (13.5-31.4)	8.6 (5.8-13.3)	32 (20-40)	1.5 (1.1-2.0)
Lake Weohyakapka	12 (6.3-17)	3.6 (1.2-6.5)	381 (144-569)	455 (345-524)	28.0 (15.4-47.4)	5.1 (3.7-7.1)	42 (30-50)	1.0 (0.7-1.5)

Table 59. Mean percentage of major cations and anions in lakes located on the Osceola Plain.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Alligator Lake	18	25	52	4	5	0	26	69
Lake Arbuckle	43	21	30	6	18	0	50	32
Cypress Lake	36	16	43	4	23	9	20	47
Lake Gentry	21	23	51	4	7	0	23	69
Lake Hart	22	26	46	3	10	0	31	60
Lake Hatchineha	48	19	29	3	44	0	21	36
Lake Kissimmee	43	17	36	3	35	5	22	38
Lawne Lake	60	14	22	4	55	0	26	19
Lake Marian	47	12	35	5	30	11	16	42
Lake Mary Jane	22	24	48	2	8	0	30	62
Lake Rosalie	35	23	36	4	23	0	33	44
Tiger Lake	31	24	38	4	42	7	22	29
Lake Tohopekaliga	39	13	43	4	39	5	17	40
East Lake Tohopekaliga	15	26	53	5	6	0	33	61
Lake Weohyakapka	27	29	37	4	21	0	30	49

the Lake Wales Ridge or municipal treatment plants. In these lakes, alkalinity and hardness concentrations tended to average higher and pH values average above 7.0 (Table 58). In addition, the chemical composition of these lakes is mixed (Table 59). Lawne Lake, however, is an alkaline, hard-water lake. Measured pH averaged 7.6 and total alkalinity averaged 59 mg/l as $CaCO_3$. Total hardness concentrations averaged 85 mg/l as $CaCO_3$ and calcium hardness concentrations averaged 69 mg/l as $CaCO_3$. Specific conductance averaged 207 μmhos/cm. These values result because Lawne Lake receives water from the calcareous Orlando Ridge and a municipal water treatment plant.

Based on conventional criteria (Table 4), lakes on the Osceola Plain can be characterized as mesotrophic or eutrophic. Mean total nitrogen concentrations ranged from 455 to 1800 mg/m^3 and mean total phosphorus concentrations ranged from 14.6 to 368 mg/m^3. Chlorophyll a concentrations averaged between 4.0 and 77.9 mg/m^3. For the most part, the lakes on the Osceola Plain are naturally productive. Lakes with small watershed to lake volume ratios, however, tend to be mesotrophic while lakes with large watershed to lake volume ratios tend to be eutrophic. Cultural eutrophication, however, has significantly influenced certain lakes. For example, the U.S. Environmental Protection Agency (1978b) estimated municipal point sources contributed 194,000 kg P/yr to Lake Tohopekaliga. This nutrient input has contributed significantly to the elevated total phosphorus and chlorophyll a concentrations found in this lake. However, non-point sources during the U.S. Environmental Protection Agency's study contributed 179,000 kg P/yr. If municipal point sources ceased discharging phosphorus, phosphorus loading models (Canfield 1979; Canfield and Bachmann 1981) predict phosphorus concentrations would fall from the measured value of 246 mg/m^3 to a level of 165 mg/m^3. This value is more than sufficient to maintain Lake Tohopekaliga in a eutrophic state. Because most of the non-point source phosphorus loading is probably natural, Lake Tohopekaliga was probably naturally eutrophic. This situation is very typical of other eutrophic lakes on the Osceola Plain.

12. Orlando Ridge: The Orlando Ridge (Figure 4) is an area of high ground located in southwest Seminole County and north-central Orange County. This region, which is surrounded by the Osceola Plain, was probably once part of the Central Highlands (Puri and Vernon 1964; White 1970). Deposits of the Fort Preston Formation dominate the regional geology (Vernon and Puri 1964) but calcareous, sandy deposits occur in many areas. Topography is karstic and there are numerous, small sinkhole lakes. In this study, 7 lakes (Lake Baldwin, Lake Conway, Lake Fairview, Lake Jessamine, Lake Maitland, Lake Underhill, Lake Virginia) were sampled. Data are presented in Tables 60 and 61. Additional data obtained from the Florida Game and Fresh Water Fish Commission are presented in Table 62.

In the studied lakes, mean pH ranged from 7.6 to 8.4 and total alkalinity concentrations ranged from 29 to 99 mg/l as $CaCO_3$. Total hardness concentrations averaged between 60 and 106 mg/l as $CaCO_3$ and calcium hardness concentrations averaged between 32 and 86 mg/l as $CaCO_3$ Mean specific conductance ranged from 173 to 245 μmhos/cm. Sodium concentrations averaged between 6.2 and 16 mg/l and chloride concent-

Table 60. Means of limnological parameters measured in lakes located on the Orlando Ridge. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Baldwin	8.4 (8.0-8.9)	99 (97-103)	1 (0-2)	206 (200-210)	106 (102-111)	86 (80-92)	7.6 (6.9-8.3)	2.0 (1.7-2.4)	11 (11-12)
Lake Conway	7.6 (7.4-7.7)	29 (27-31)	0 (0-0)	193 (185-200)	60 (57-61)	32 (31-36)	16 (14-17)	4.5 (4.2-5.0)	24 (23-25)
Lake Fairview	8.0 (7.7-8.7)	52 (39-64)	0 (0-1)	173 (148-210)	65 (53-78)	55 (42-66)	9.6 (9.1-10)	2.4 (1.9-3.2)	14 (13-15)
Lake Jessamine	7.8 (7.6-8.3)	44 (43-45)	0 (0-0)	184 (175-190)	65 (63-66)	43 (41-44)	14 (13-15)	3.8 (3.3-4.4)	21 (20-21)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Baldwin	8.3 (5.3-15)	1.1 (0.7-1.7)	40.0 (23.0-60.5)	630 (242-1000)	38.8 (18.7-71.2)	21.6 (8.7-39.1)	11 (10-15)	1.5 (1.0-2.3)
Lake Conway	29 (24-33)	0.1 (0-0.1)	13.3 (11.0-16.5)	401 (350-517)	13.1 (3.7-24.2)	4.4 (1.7-6.6)	3 (0-5)	3.7 (3.4-4.0)
Lake Fairview	15 (9.4-22)	0.1 (0.1-0.2)	12.5 (7.5-21.7)	446 (330-517)	14.9 (6.7-28.8)	2.5 (1.5-3.9)	5 (0-10)	4.8 (2.7-6.0)
Lake Jessamine	18 (13-20)	0.2 (0.1-0.5)	17.7 (14.7-21.5)	612 (442-766)	16.1 (8.2-28.5)	4.9 (2.7-6.2)	5 (0-10)	3.4 (2.7-4.5)

Table 60. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Lake Maitland	7.7 (7.5-8.2)	69 (67-72)	0 (0-0)	205 (190-220)	88 (87-90)	71 (70-72)	8.8 (8.1-9.6)	3.6 (2.5-4.5)	16 (15-17)
Lake Underhill	7.6 (7.0-8.3)	58 (47-63)	0 (0-0)	183 (170-193)	85 (84-86)	72 (71-74)	6.5 (5.7-7.1)	3.2 (2.9-3.5)	9.8 (9.3-10)
Lake Virginia	7.9 (7.7-8.8)	57 (53-59)	0 (0-2)	177 (170-180)	75 (72-78)	59 (55-61)	8.8 (8.4-9.4)	2.6 (2.4-2.7)	16 (15-16)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL $\underline{a}$ (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Lake Maitland	16 (12-24)	0.2 (0-0.6)	16.4 (6.0-33.6)	597 (424-833)	28.4 (22.7-36.4)	9.6 (0.4-24.9)	4 (0-10)	1.8 (1.3-2.4)
Lake Underhill	22 (18-25)	0.2 (0.1-0.3)	30.6 (13.0-49.8)	777 (558-933)	53.5 (30.3-97.6)	38.2 (20.3-62.2)	10 (10-10)	0.8 (0.5-1.1)
Lake Virginia	15 (12-22)	0.5 (0.2-0.7)	27.5 (18.1-42.6)	519 (300-898)	31.4 (22.1-42.3)	17.3 (4.4-35.3)	3 (0-5)	1.6 (0.7-2.3)

Table 61. Mean percentage of major cations and anions in lakes located on the Orlando Ridge.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Baldwin	68	16	13	2	79	1	7	13
Lake Conway	32	28	34	6	31	0	32	36
Lake Fairview	62	11	23	4	60	1	17	22
Lake Jessamine	43	22	31	5	48	0	20	32
Lake Maitland	63	16	17	4	64	0	16	21
Lake Underhill	70	13	14	4	61	0	24	15
Lake Virginia	60	17	20	3	59	1	17	23

Table 62. Means of limnological parameters measured in lakes located on the Orlando Ridge. Numbers in parentheses are the minimum and maximum values measured. Period of record 1967-1973. Data from Holcomb (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/l)	PHENOL ALKALINITY (mg/l)	SPECIFIC CONDUCTANCE (µmhos/cm)	TOTAL HARDNESS (mg/l)	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)
Lake Killarney	7.8 (7.1-9.2)	7.7 (7.2-8.0)	53 (33-69)	1.5 (0-7)	196 (152-230)	59 (50-68)	21 (15-27)	3.2 (2.6-3.6)	10 (8.9-11)
Maitland	8.2 (7.4-8.4)	7.9 (7.2-8.7)	65 (48-76)	0.8 (0-4)	226 (095-265)	71 (56-78)	24 (18-30)	4.9 (3.9-5.6)	10 (8.4-12)
Lake Underhill	7.9 (7.2-8.7)	7.7 (7.3-8.0)	51 (6-72)	0.3 (0-2)	232 (210-260)	86 (79-90)	27 (24-29)	4.7 (2.5-5.8)	6.2 (5.5-6.8)
Virginia	7.8 (6.8-8.4)	7.8 (7.0-8.4)	73 (54-91)	0.9 (0-5)	245 (208-290)	84 (69-98)	27 (20-36)	5.0 (2.3-6.1)	8.8 (7.8-9.7)

POTASSIUM (mg/l)	CHLORIDE (mg/l)	SULFATE (mg/l)	SILICA (mg/l)	TOTAL IRON (mg/l)	TOTAL PHOSPHATE (mg/l)	CHLOROPHYLL a (mg/m³)	COLOR (mg/l Pt)	SECCHI (ft)
2.0 (0.8-2.9)	16 (14-17)	9.4 (7.0-12)	0.5 (0-1.0)	0.070 (0.050-0.100)	0.129 (0.000-0.320)	7.9 (1.1-22.5)	8 (5-10)	8.3 (3.8-15)
3.3 (2.4-4.2)	16 (16-17)	18 (16-20)	0.4 (0-0.8)	0.073 (0.010-0.180)	0.166 (0.070-0.340)	4.3 (1.1-6.4)	5 (5-5)	8.9 (5.6-14)
5.2 (3.9-6.2)	12 (12-13)	29 (10-36)	0.3 (0-0.6)	0.085 (0.040-0.150)	1.54 (0.03-11.00)	13.4 (0-25.7)	5 (5-5)	2.6 (0.3-4.0)
2.9 (0.3-4.4)	16 (15-18)	16 (12-20)	1.0 (0.3-1.6)	0.043 (0.020-0.090)	0.223 (0.050-0.610)	12.8 (4.8-25.7)	5 (5-5)	8.2 (3.6-18)

rations averaged between 9.9 and 24 mg/l. In all lakes, calcium and magnesium were the dominant cations and bicarbonate was generally the dominant anion. Only in Lake Conway and Lake Jessamine was bicarbonate not the dominant anion or calcium the dominant cation (Table 61). These lakes, however, lie on the edge of the Orlando Ridge. Water color averaged between 3 and 11 mg/l as Pt. Based on these data, lakes on the Orlando Ridge can generally be chemically characterized as clear, alkaline, hard-water lakes of moderate mineral content.

Lakes on the Orlando Ridge can also be characterized as mesotrophic or eutrophic lakes. Mean total nitrogen concentrations ranged from 401 to 777 mg/m^3 and mean total phosphorus concentrations ranged from 13.1 to 53.5 mg/m^3. Chlorophyll _a_ concentrations averaged between 2.5 and 38.2 mg/m^3 and mean water transparency averaged between 0.8 and 4.8 m. In this study, Lake Conway, Lake Fairview, Lake Jessamine, and Lake Maitland would be characterized as mesotrophic lakes and Lake Baldwin, Lake Underhill, and Lake Virginia would be characterized as eutrophic lakes. However, both Lake Fairview and Lake Maitland had extensive growths of _Hydrilla verticillata_ and other aquatic macrophytes, which suggests these lakes might be better characterized as eutrophic lakes. Therefore, most of the lakes located on the Orlando ridge are probably eutrophic. Although the Orlando Ridge is highly urbanized and cultural eutrophication has undoubtedly impacted many lakes in this region, most lakes are probably naturally productive as is typical of many hard-water lakes (Moyle 1954, 1956; Jones and Bachmann 1978).

13. Lake Wales Ridge: The Lake Wales Ridge (Figure 4) is a long, narrow ridge extending from southern Highlands County to northern Orange County. The ridge is a prominant topographic feature of the Florida peninsula and seems to be the severed distal remnant of a much longer ridge which once included the Mount Dora Ridge and the Trail Ridge (White 1970). Sandy, calcareous deposits of the Fort Preston Formation dominate the regional geology (Vernon and Puri 1964). As is the case with other regions which have deposits from the Fort Preston Formation, topography on the Lake Wales Riege is karstic and there are numerous lakes. In this study, 6 lakes (Dinner Lake, Lake Lotela, Lake Marion, Lake Pierce, Reedy Lake, Lale Wales) were sampled. Data are presented in Table 63 and Table 64. Additional data obtained from the Florida Game and Fresh Water Fish Commission are presented in Table 65.

With the exception of Lake Effie and Lake Tracy, both of which receive large discharges from treatment plants (Holcomb 1968), the lakes sampled on the Lake Wales Ridge can be chemically characterized as alkaline, soft-water lakes of moderate mineral content. Mean pH values ranged from 7.3 to 8.3 and total alkalinity concentrations averaged between 14 and 48 mg/l as $CaCO_3$. Total hardness concentrations averaged between 30 and 66 mg/l as $CaCO_3$. Mean specific conductance ranged from 97 to 175 μmhos/cm. Calcium and magnesium were the dominant cations and bicarbonate and sulfate were the dominant anions (Table 64.) Based on these data, most lakes on the Lake Wales Ridge can probably be characterized as alkaline, soft-water lakes, but

Table 63. Means of limnological paramters measured in lakes located on the Lake Wales Ridge. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Dinner Lake	8.0 (7.6-8.5)	37 (36-39)	0 (0-0)	175 (160-190)	64 (63-65)	36 (35-38)	10 (8.9-11)	4.2 (3.6-4.7)	16 (15-17)
Lake Lotela	7.3 (7.1-7.6)	14 (14-15)	0 (0-0)	97 (88-110)	30 (29-33)	4.8 (3.5-7.5)	7.5 (6.8-8.4)	2.1 (1.8-2.2)	12 (11-12)
Lake Marion	7.3 (6.9-8.6)	29 (22-36)	0 (0-1)	106 (90-118)	46 (42-49)	34 (31-40)	4.7 (4.4-5.2)	1.1 (1.0-1.2)	9.0 (8.3-10)
Lake Pierce	7.8 (7.5-9.2)	37 (34-42)	1 (0-5)	120 (108-128)	49 (47-52)	33 (31-37)	5.5 (4.9-6.8)	3.2 (2.4-3.7)	10 (9.3-11)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m³)	TOTAL N (mg/m³)	TOTAL P (mg/m³)	CHLOROPHYLL a (mg/m³)	COLOR (mg/1 Pt)	SECCHI (m)
Dinner Lake	19 (14-24)	1.5 (1.3-1.7)	138 (66.7-178)	378 (283-488)	55.9 (37.7-84.9)	2.7 (2.0-3.7)	37 (25-45)	1.1 (0.5-2.2)
Lake Lotela	18 (14-23)	0.6 (0.4-0.8)	25.8 (20.3-37.9)	306 (117-453)	11.9 (8.1-20.9)	7.2 (6.6-8.3)	8 (5-10)	2.2 (1.3-2.7)
Lake Marion	20 (13-25)	1.2 (0.1-2.5)	273 (190-357)	691 (525-875)	270 (75-397)	5.9 (3.0-9.6)	69 (45-100)	0.8 (0.5-1.1)
Lake Pierce	15 (6.2-24)	0.6 (0.3-1.0)	435 (335-647)	1032 (866-1200)	54.3 (28.4-71.3)	11.9 (7.2-19.2)	138 (60-200)	0.3 (0.1-0.5)

Table 63. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Reedy Lake	7.9 (7.5-9.2)	26 (25-28)	1 (0-5)	174 (160-185)	65 (63-67)	37 (34-40)	11 (9.5-12)	5.1 (4.8-5.4)	16 (16-17)
Lake Wales	7.7 (7.5-8.2)	40 (40-41)	0 (0-0)	119 (110-125)	52 (52-53)	38 (36-40)	6.1 (5.6-6.8)	1.7 (1.6-1.8)	10 (9.5-11)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Reedy Lake	11 (7.6-17)	0.3 (0.2-0.5)	84.9 (74.6-120)	1102 (808-1320)	22.3 (18.0-31.9)	10.4 (6.2-16.1)	79 (70-90)	1.4 (1.2-1.5)
Lake Wales	22 (15-29)	0.3 (0.05-0.5)	100 (54.2-139)	1566 (983-1970)	78.7 (60.4-112)	33.7 (9.3-49.3)	22 (15-30)	0.5 (0.4-0.6)

Table 64. Mean percentage of major cations and anions in lakes located on the Lake Wales Ridge.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Dinner Lake	39	30	25	6	41	0	35	25
Lake Lotela	10	51	33	5	30	0	34	35
Lake Marion	59	20	18	2	54	0	22	23
Lake Pierce	50	25	18	6	54	5	18	23
Reedy Lake	38	30	24	7	24	3	48	24
Lake Wales	55	22	19	3	60	0	19	21

Table 65. Means of limnological parameters measured in lakes on the Lake Wales Ridge. Numbers in parentheses are the minimum and maximum values measured. Period of record 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/l)	PHENOL ALKALINITY (mg/l)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/l)	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)
Effie	8.2 (7.2-9.3	8.2 (6.8-9.2)	145 (104-194)	5.8 (0.0-23)	386 (280-550)	127 (106-148)	36 (27-45)	7.4 (6.4-8.5)	31 (24-42)
Pierce	8.2 (7.2-9.4)	8.3 (7.2-9.3)	33 (23-39)	3.0 (0.0-10)	131 (113-160)	47 (45-48)	12 (9.0-14)	3.9 (2.8-4.9)	4.7 (3.7-5.6)
Reedy	8.2 (7.3-9.2)	8.0 (7.4-8.3)	48 (40-58)	0.5 (0.0-3.0)	214 (190-235)	66 (63-69)	17 (16-17)	6.2 (5.6-6.8)	9.4 (4.4-12)

POTASSIUM (mg/l)	CHLORIDE (mg/l)	SULFATE (mg/l)	SILICA (mg/l)	TOTAL IRON (mg/l)	TOTAL PHOSPHATE (mg/l)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l Pt)	SECCHI (ft)
8.9 (6.4-12)	18 (18-18)	9.0 (5.0-12)	*** ***	0.245 (0.100-0.390)	5.51 (3.00-7.00)	221 (24.1-626)	*** ***	0.9 (0.3-1.8)
1.2 (0.9-1.4)	8.3 (7.5-9.0)	9.6 (6.0-12)	*** ***	0.100 (0.090-0.110)	0.078 (0.040-0.150)	14.1 (4.0-25.7)	*** ***	3.0 (2.2-4.2)
3.7 (3.3-4.4)	13 (12-14)	29 (23-32)	*** ***	0.075 (0.070-0.080)	0.095 (0.040-0.150)	14.0 (4.8-32.1)	*** ***	2.8 (1.8-5.2)

Table 65. (cont.).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (µmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Tracy	7.5 (7.2-8.1)	7.7 (7.5-7.9)	115 (100-134)	0.0 (0.0-0.0)	282 (249-325)	104 (91-120)	36 (29-44)	4.9 (3.5-6.1)	14 (11-16)
Lake Wales	8.3 (7.5-8.9)	7.9 (7.1-8.6)	44 (36-50)	5.6 (0.0-30)	160 (135-178)	58 (52-65)	17 (14-19)	3.3 (2.3-4.2)	6.6 (5.4-7.0)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
2.2 (1.6-3.1)	14 (11-16)	4.4 (2.7-6.5)	1.1 (0.9-1.3)	0.092 (0.050-0.140)	0.121 (0.040-0.290)	2.5 (1.6-3.2)	13 (5-20)	8.4 (5.0-12)
1.0 (0.4-1.5)	12 (10-12)	11 (7.0-14)	0.8 (0.0-1.6)	0.130 (0.030-0.320)	0.139 (0.020-0.310)	9.2 (4.8-16.0)	5 (5-5)	7.3 (2.9-14)

significant discharges of water derived from groundwater sources would result in the lakes becoming hard-water lakes as has happened in Lake Effie and Lake Tracy.

The trophic status of lakes on the Lake Wales Ridge is variable. In this study (Table 63), Lake Pierce and Reedy Lake, lakes with large watersheds, are eutrophic. In Lake Pierce, total nitrogen concentrations averaged 1200 mg/m^3, total phosphorus concentrations averaged 39.5 mg/m^3 and chlorophyll a concentrations averaged 22.5 mg/m^3. In Lake Reedy, total nitrogen concentrations averaged 1100 mg/m^3, total phosphorus concentrations averaged 27.9 mg/m^3 and chlorophyll a concentrations averaged 27.3 mg/m^3. Dinner Lake, Lake Lotela, Lake Marion, and Lake Wales, lakes with small watershed to lake volume ratios, are oligo-mesotrophic or mesotrophic. Mean total nitrogen concentrations ranged from 334 to 808 mg/m^3 and mean total phosphorus concentrations ranged from 8.6 to 22.1 mg/m^3. Chlorophyll a concentrations averaged between 2.5 and 11.4 mg/m^3. Many of these lakes, however, had noticeable growths of aquatic macrophytes. Based on this data, lakes on the Lake Wales Ridge can probably be best characterized as naturally mesotrophic or meso-eutrophic. However, significant discharges of nutrient-rich wastes can result in the lakes becoming highly eutrophic as has happened in Lake Effie (mean chlorophyll a concentrations of 221 mg/m^3).

14. Intraridge Valley: The Intraridge Valley (Figure 4) is a steep-walled lowland that splits the Lake Wales Ridge. The valley, which has a width of approximately 1.25 km, extends north from Lake Placid to

the north shore of Lake Livingston (White 1970). The valley is underlain by deposits of the Fort Preston Formation (Vernon and Puri 1964), but the valley floor is largely covered with peat and peaty muck (White 1970). Numerous lakes are located in the valley. In this study, 7 lakes (Lake Huntley, Lake Jackson, Lake Josephine, Little Red Water, Lake Placid, Red Beach Lake, Sebring Lake) were sampled. Data are presented in Tables 66 and 67. Additional data obtained from the Florida Game and Fresh Water Fish Commission are presented in Table 68.

Based on data gathered in this study (Table 66), lakes in the Intraridge Valley can be chemically characterized as acid, soft-water lakes. Measured pH values averaged between 5.3 and 6.7 and mean total alkalinity concentrations ranged from 2 to 5 mg/l as $CaCO_3$. Total hardness concentrations averaged between 11 and 24 mg/l as $CaCO_3$ and calcium hardness concentrations averaged between 6.4 and 13 mg/l as $CaCO_3$. Mean specific conductance ranged from 50 to 97 µmhos/cm. Sodium (Table 67) was generally the dominant cation, and sulfate and chloride were the dominant anions. Data from the Florida Game and Fresh Water Fish Commission (Table 68) are in general agreement with the data from this study, but suggest there may be times when some lakes within the Intraridge Valley are slightly alkaline. In these lakes, however, pH does not average greatly above 7.0.

As a group, lakes in the Intraridge Valley can be characterized as oligo-mesotrophic or mesotrophic lakes. Mean total nitrogen concentrations ranged from 271 to 690 mg/m^3 and mean total phosphorus concentrations, with the exception of Lake Sebring, ranged from 14.3 to 34.0 mg/m^3. Lake Sebring, for reasons that are not apparent, had a total phosphorus concentration of 112 mg/m^3.

Table 66. Means of limnological parameters measured in lakes located in the Intraridge Valley. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Huntley	5.9 (5.6-6.2)	3 (1-4)	0 (0-0)	97 (90-102)	23 (22-24)	10 (8-13)	8.2 (7.4-9.1)	3.9 (3.2-4.2)	14.6 (13.3-15.5)
Lake Jackson	5.3 (4.6-6.7)	3 (2-4)	0 (0-0)	87 (82-95)	19 (17-23)	9.1 (7.0-11)	7.9 (7.0-8.6)	1.9 (1.8-2.1)	14 (13-14)
Lake Josephine	5.6 (5.3-5.9)	3 (2-3)	0 (0-0)	83 (75-89)	24 (22-26)	13 (13-14)	6.5 (6.0-7.0)	1.1 (0.9-1.2)	11 (10-11)
Little Red Water	5.8 (5.6-6.0)	2 (1-3)	0 (0-0)	50 (46-54)	11 (11-12)	6.8 (5.5-8.0)	5.0 (4.4-5.7)	0.7 (0.6-0.8)	8.7 (8.3-9.3)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m³)	TOTAL N (mg/m³)	TOTAL P (mg/m³)	CHLOROPHYLL a (mg/m³)	COLOR (mg/1 @ Pt)	SECCHI (m)
Lake Huntley	21.9 (18-25)	1.0 (0.7-1.3)	27.1 (17.7-36.7)	405 (309-533)	22.1 (15.5-29.8)	5.6 (2.2-8.1)	13 (5-15)	1.6 (1.4-2.1)
Lake Jackson	15 (8.3-20)	1.0 (0.1-1.4)	19.0 (14.7-25.5)	271 (216-358)	14.3 (12.4-17.1)	2.6 (1.2-3.9)	6 (5-10)	2.8 (2.4-3.3)
Lake Josephine	21 (15-25)	1.3 (0.1-1.8)	123 (77.5-148)	518 (424-608)	24.0 (15.5-36.9)	10.8 (6.2-18.1)	52 (40-70)	0.8 (0.6-1.0)
Little Red Water	9.3 (5.2-12)	0.4 (0.2-0.6)	156 (109-222)	474 (409-550)	34.0 (21.2-52.2)	16.3 (11.6-24.2)	28 (15-40)	0.7 (0.5-0.9)

Table 66. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (μmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Lake Placid	6.6 (6.3-6.9)	4 (3-5)	0 (0-0)	58 (53-61)	14 (13-15)	6.4 (6.0-7.5)	5.6 (5.0-6.3)	1.2 (1.1-1.3)	10 (9.3-11)
Red Beach Lake	6.7 (6.6-6.9)	5 (4-5)	0 (0-0)	59 (56-61)	15 (14-16)	8.0 (6.5-10)	5.6 (5.0-7.1)	1.3 (0.9-1.5)	10 (9.5-11)
Lake Sebring	5.8 (5.6-6.1)	2 (2-4)	0 (0-0)	54 (48-58)	13 (13-14)	7.6 (7.0-9.0)	5.0 (4.4-5.5)	0.9 (0.8-1.0)	8.8 (8.3-9.5)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l @ Pt)	SECCHI (m)
Lake Placid	12 (8.9-17)	0.3 (0.2-0.5)	18.4 (14.1-25.0)	544 (237-1100)	13.0 (7.0-25.3)	6.2 (2.6-12.3)	7 (5-10)	2.2 (1.8-2.7)
Red Beach Lake	10 (8.4-13)	1.1 (0.6-1.6)	114 (95.5-146)	448 (359-591)	16.3 (11.0-23.8)	9.9 (7.1-13.0)	31 (25-35)	1.1 (0.8-1.4)
Lake Sebring	10 (5.7-15)	1.7 (0.7-2.3)	244 (136-378)	690 (431-966)	112 (75.3-148)	5.6 (2.9-8.1)	133 (100-150)	0.4 (0.1-0.5)

Table 67. Mean percentage of major cations and anions in lakes located in the Intraridge Valley.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Huntley	22	28	39	11	6	0	50	45
Lake Jackson	23	26	44	6	9	0	40	50
Lake Josephine	33	27	36	3	6	0	55	39
Little Red Water Lake	29	20	47	4	8	0	40	51
Lake Placid	23	27	44	6	13	0	41	46
Red Beach Lake	28	23	43	6	15	0	35	49
Lake Sebring	29	22	42	4	10	0	42	49

Table 68. Means of limnological parameters measured in lakes located in the Intraridge Valley. Numbers in parentheses are the minimum and maximum values measured. Period of record 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971), Duchrow and Starling (1972) and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (µmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Francis	7.0 (6.5-7.8)	6.5 (6.1-7.3)	14 (5.0-50)	0.0 (0.0-0.0)	108 (85-131)	22 (21-24)	4.1 (3.2-4.7)	2.7 (2.3-3.1)	6.5 (5.6-7.1)
Jackson	6.9 (6.6-7.4)	7.0 (6.6-7.3)	5.0 (3.0-9.0)	0.0 (0.0-0.0)	91 (82-100)	20 (19-21)	3.6 (3.2-4.3)	2.2 (1.6-2.9)	5.9 (4.9-7.0)
June-in-Winter	7.1 (6.9-7.3)	7.0 (6.7-7.4)	8.2 (5.0-12)	0.0 (0.0-0.0)	115 (108-123)	28 (27-28)	5.0 (4.5-5.4)	3.2 (2.5-4.0)	6.7 (5.8-7.6)
Letta	7.1 (6.7-7.7)	6.9 (6.6-7.1)	7.7 (4.0-16)	0,0 (0.0-0.0)	121 (110-130)	21 (20-22)	3.7 (3.1-4.0)	3.6 (2.6-4.0)	7.3 (6.0-8.9)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
1.8 (1.6-2.8)	12 (10-13)	13 (10-16)	0.9 (0.5-1.3)	0.105 (0.040-0.180)	0.140 (0.060-0.280)	3.3 (0.0-8.6)	8 (5-10)	7.0 (5.3-9.1)
1.7 (1.4-2.4)	12 (10-13)	12 (9.5-14)	*** ***	0.015 (0.010-0.020)	0.060 (0.010-0.110)	4.3 (1.6-8.6)	*** ***	8.5 (4.5-10)
2.1 (1.1-2.6)	13 (12-14)	18 (16-20)	*** ***	0.055 (0.050-0.060)	0.055 (0.040-0.090)	8.4 (6.4-11.2)	*** ***	6.0 (5.2-6.7)
2.2 (1.1-2.6)	11 (10-12)	21 (18-24)	*** ***	0.055 (0.040-0.070)	0.102 (0.050-0.150)	3.3 (2.1-4.8)	*** ***	4.5 (3.5-5.8)

Table 68. (cont.).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Red Beach	6.4 (5.9-7.0)	6.1 (5.7-6.5)	4.0 (1.0-11)	0.0 (0.0-0.0)	59 (45-83)	9.3 (8.0-10)	1.6 (1.4-1.8)	1.2 (1.0-1.4)	4.1 (3.7-4.4)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m³)	COLOR (mg/1 Pt)	SECCHI (ft)
1.0 (0.6-1.9)	6.5 (6.0-6.8)	5.8 (4.4-9.0)	0.4 (0.3-0.5)	0.255 (0.180-0.330)	0.133 (0.020-0.380)	8.0 (3.2-19.3)	75 (50-100)	3.1 (2.0-3.9)

15. Lake Upland: The Lake Upland (Figure 4) is an area of continuous high ground located in Lake County. The region was once part of the continuous Central Highlands (White 1970). Much of the region is covered by sandy deposits of the Fort Preston Formation (Vernon and Puri 1964). In the southern portion of the Lake Upland, relict beach ridges are a dominant physical feature, but in the northern portion, a large, closely-spaced group of small lakes is most prominant (White 1970). In this study, 6 lakes (Crescent Lake, Johns Lake, Lake Louisa, Lake Minnehaha, Lake Minneola, Lake Susan) were sampled. Data are presented in Table 69 and Table 70. Additional data are obtained from the Florida Game and Fresh Water Fish Commission are presented in Table 71.

Based on this data, there seem to be two distinct groups of lakes on the Lake Upland. The first group, which includes Cherry Lake, Crescent Lake, Lake Louisa, Lake Minnehaha, Lake Minneola, and Lake Susan, is composed of those lakes lying in the drainage basin of the Palatlakaha River. In the study lakes, mean pH ranged from 4.9 to 6.4 and total alkalinity averaged between 2 and 5 mg/l as $CaCO_3$. Mean total hardness concentrations ranged from 15 to 20 mg/l as $CaCO_3$ and calcium hardness concentrations averaged between 8.3 and 11 mg/l as $CaCO_3$. Mean specific conductance ranged from 69 to 81 µmhos/cm. Sodium was the dominant cation and chloride was the dominant anion. This strongly suggests lakes in this group can be chemically characterized as acidic, soft-water lakes of low mineral content. The second group of lakes, which includes Lake Catherine and Johns Lake, is composed of those lakes lying outside the Palatlakaha River chain of lakes. From the data obtained for Lake Catherine and Johns Lake, these lakes probably have a much higher mineral content. In Lake

Table 69. Means of limnological parameters measured in lakes located on the Lake Upland. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (μmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Crescent Lake	6.3 (6.2-6.7)	4 (4-5)	0 (0-0)	81 (76-86)	20 (19-22)	11 (10-13)	7.7 (7.2-8.4)	1.7 (1.3-1.9)	14 (13-15)
Johns Lake	6.5 (6.4-6.7)	5 (4-7)	0 (0-0)	210 (193-225)	58 (55-60)	16 (15-17)	14 (13-15)	12 (11-12)	30 (28-32)
Lake Louisa	4.9 (4.8-5.0)	2 (1-2)	0 (0-0)	70 (68-70)	18 (18-20)	8.3 (7.5-9.5)	7.1 (6.2-8.0)	0.8 (0.6-0.9)	14 (13-15)
Lake Minnehaha	5.8 (5.6-5.9)	3 (2-4)	0 (0-0)	73 (70-76)	18 (18-19)	10 (9.0-11)	7.7 (6.8-8.5)	0.8 (0.6-1.0)	14 (13-15)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Crescent Lake	13 (9.2-19)	0.3 (0.1-0.6)	29.5 (20.4-40.2)	412 (308-474)	13.7 (10.6-22.6)	2.9 (2.0-4.8)	15 (15-15)	3.0 (2.4-4.0)
Johns Lake	53 (38-59)	0.3 (0.1-0.5)	48.9 (26.5-72.3)	579 (508-800)	27.0 (10.0-38.2)	7.2 (5.6-9.5)	18 (15-30)	1.0 (0.9-1.2)
Lake Louisa	5.7 (0-16)	1.1 (0-2.8)	556 (529-596)	872 (502-1100)	8.9 (3.5-17.3)	2.6 (2.0-3.0)	231 (200-250)	0.7 (0.6-0.8)
Lake Minnehaha	11 (6.2-19)	0.5 (0.3-0.7)	164 (45.8-261)	504 (361-625)	17.5 (10.2-30.4)	5.7 (5.0-7.3)	68 (60-80)	1.3 (1.2-1.4)

Table 69. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Lake Minneola	6.4 (6.2-6.7)	5 (4-7)	0 (0-0)	78 (76-80)	18 (16-20)	10 (9.0-11)	8.6 (7.8-9.2)	1.1 (0.9-1.3)	15 (15-17)
Lake Susan	5.1 (4.9-5.5)	2 (2-3)	0 (0-0)	69 (67-70)	18 (17-19)	8.8 (8.0-9.5)	7.2 (6.4-8.0)	0.8 (0.6-0.9)	14 (12-15)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL _a_ (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Lake Minneola	8.6 (5.4-11)	0.7 (0.6-0.9)	109 (41.8-211)	432 (361-492)	13.6 (10.7-17.1)	2.2 (1.6-2.7)	21 (15-35)	4.0 (2.9-5.0)
Lake Susan	7.0 (0-17)	1.1 (0-2.8)	485 (361-587)	841 (607-1000)	13.6 (4.4-21.3)	9.1 (1.7-22.5)	200 (125-250)	0.9 (0.7-1.2)

Table 70. Mean percentage of major cations and anions in lakes located on the Lake Upland.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Crescent Lake	28	23	43	5	12	0	35	53
Johns Lake	15	41	30	14	5	0	54	41
Lake Louisa	23	28	43	3	7	0	22	71
Lake Minnehaha	28	23	46	3	10	0	33	57
Lake Minneola	27	20	49	4	15	0	25	60
Lake Susan	25	25	44	3	8	0	25	67

Table 71. Means of limnological parameters measured in lakes located on the Lake Upland. Numbers in parentheses are the minimum and maximum values measured. Period of record 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971), Duchrow and Starling (1972) and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (μmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Catherine	7.7 (7.2-8.4)	7.8 (7.4-8.3)	120 (82-178)	0.5 (0-3)	276 (200-410)	120 (100-140)	37 (26-50)	3.8 (3.4-4.3)	13 (6.9-24)
Cherry Lake	6.2 (5.5-6.8)	6.4 (6.0-6.7)	4 (2-8)	0 (0-0)	80 (65-94)	15 (12-20)	3.0 (2.3-3.5)	1.4 (0.8-2.9)	6.4 (5.2-7.4)
Lake Louisa	5.0 (4.6-5.5)	5.3 (4.6-6.0)	2 (1-3)	0 (0-0)	72 (63-82)	12 (11-13)	2.7 (2.1-3.0)	1.2 (1.1-1.4)	5.2 (4.3-5.9)
Johns Lake	6.6 (6.2-6.9)	6.5 (5.9-7.2)	3.8 (2.0-6.0)	0.0 (0.0-0.0)	189 (149-220)	38 (37-39)	4.6 (3.7-6.3)	5.7 (5.1-6.3)	12 (9.5-16)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m³)	COLOR (mg/1 Pt)	SECCHI (ft)
3.9 (1.4-5.5)	12 (9.0-14)	0 (0-0)	- -	0.140 (0.100-0.180)	0.200 (0.090-0.290)	16.4 (3.2-48.1)	- -	4.0 (2.8-5.0)
0.9 (0.6-1.6)	13 (11-13)	5.6 (3.5-7.5)	1.4 (1.1-1.6)	0.210 (0.130-0.300)	0.114 (0.010-0320)	1.5 (0-3.2)	50 (50-50)	5.2 (3.3-7.3)
0.6 (0.4-1.0)	10 (10-10)	3.8 (0-6.0)	- -	0.395 (0.280-0.510)	0.058 (0.040-0.080)	2.7 (2.1-3.2)	- -	3.3 (2.7-3.7)
7.2 (5.6-9.0)	25 (24-25)	34 (25-54)	*** ***	0.065 (0.040-0.090)	0.135 (0.080-0.300)	6.8 (3.2-12.8)	*** ***	3.9 (2.3-5.5)

Table 71. (cont.).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (µmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
Lake Minnehaha	5.9 (5.0-6.4)	6.4 (5.9-7.3)	3 (1-4)	0 (0-0)	71 (63-80)	12 (11-13)	2.8 (2.1-3.2)	1.2 (1.1-1.3)	5.4 (4.5-6.0)
Lake Minniola	6.2 (5.3-6.8)	6.4 (5.8-7.1)	4 (2-7)	0 (0-0)	77 (62-90)	13 (11-14)	3.2 (2.3-4.1)	1.2 (1.1-1.4)	5.8 (4.7-6.7)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
0.7 (0.4-1.1)	11 (10-11)	4.3 (0-6.0)	- -	0.525 (0.420-0.630)	0.070 (0.050-0.090)	4.0 (1.6-6.4)	- -	4.5 (3.1-5.8)
0.9 (0.5-1.6)	13 (12-13)	5.4 (3.0-6.5)	- -	0.040 (0.020-0.060)	0.057 (0.030-0.110)	2.5 (0-4.8)	- -	6.6 (3.5-10)

Catherine, specific conductance averaged 276 µmhos/cm and total hardness concentrations averaged 120 mg/l as $CaCO_3$. In Johns Lake, specific conductance averaged 210 µmhos/cm and total hardness concentrations averaged 58 mg/l as $CaCO_3$. However, before further generalizations about the chemical composition of lakes in this grouping can be made, additional data from other lakes is needed.

As a group, lakes on the Lake Upland, with the exception of Lake Catherine, can be characterized as mesotrophic lakes. Mean total nitrogen concentrations ranged from 412 to 872 mg/m^3 and mean total phosphorus concentrations ranged from 8.9 to 27.0 mg/m^3. Chlorophyll *a* concentrations averaged between 1.5 and 9.1 mg/m^3. Cherry Lake, Crescent Lake, Lake Louisa, and Lake Minneola generally are less productive than the other lakes and might be best characterized as oligo-mesotrophic lakes. Lake Catherine, however, had an average chlorophyll *a* concentration of 16.1 mg/m^3 and a maximum chlorophyll *a* concentration of 48 mg/m^3, suggesting this lake is eutrophic. This condition, however, results from discharges of nutrient-rich wastes (Holcomb 1968).

16. Winter Haven Ridge: The Winter Haven Ridge (Figure 4) is an area of high ground located in north-central Polk County. Deposits of the Fort Preston Formation and deposits of the phosphatic Bone Valley Formation dominate the regional geology (Vernon and Puri 1964). Numerous small lakes are located throughout the area. In this study, 5 lakes (Lake Agnes, Ariana Lake, Lake Arietta, Eagle Lake, Lake Howard) were sampled. Data are presented in Table 72 and Table 73.

With the exception of Lake Agnes and Lake Arietta, the study lakes

Table 72. Means of limnological parameters measured in lakes located on the Winter Haven Ridge. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Agnes	6.9 (6.6-7.3)	6 (4-7)	0 (0-0)	125 (112-130)	35 (33-36)	13 (13-15)	9.6 (9.2-10)	4.9 (4.6-5.2)	20 (19-21)
Ariana Lake	8.0 (7.7-9.0)	35 (32-36)	1 (0-3)	204 (190-215)	71 (70-73)	36 (35-38)	15 (15-16)	5.3 (4.9-5.9)	22 (22-23)
Lake Arietta	6.9 (6.7-7.4)	6 (4-9)	0 (0-0)	199 (175-220)	57 (53-60)	14 (10-16)	15 (15-16)	5.6 (5.3-6.2)	27 (26-27)
Eagle Lake	7.6 (7.1-8.6)	29 (28-31)	0 (0-1)	238 (210-260)	83 (80-85)	31 (29-33)	15 (14-16)	7.9 (7.5-8.4)	26 (25-27)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Agnes	27 (20-32)	1.0 (0.6-1.4)	178 (130-210)	860 (797-1000)	54.5 (29.5-84.8)	18.7 (8.1-24.9)	77 (60-100)	0.9 (0.6-1.1)
Ariana Lake	41 (32-46)	3.0 (1.6-3.7)	43.0 (28.2-73.0)	695 (442-1000)	20.8 (15.4-22.7)	19.6 (7.3-38.2)	7 (5-15)	1.0 (0.8-1.3)
Lake Arietta	55 (48-60)	0.2 (0.1-0.4)	17.7 (7.4-35.3)	358 (208-524)	15.5 (8.5-31.5)	7.6 (0.8-19.5)	8 (5-10)	2.9 (1.6-4.5)
Eagle Lake	61 (49-81)	0.4 (0.1-0.9)	37.2 (14.1-53.4)	927 (600-1300)	28.9 (18.9-41.6)	25.1 (17.7-35.6)	13 (5-20)	0.8 (0.7-0.8)

Table 72. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Lake Howard	8.9 (8.5-9.3)	41 (36-44)	4 (2-7)	164 (160-170)	58 (56-61)	42 (39-45)	12 (11-13)	4.4 (3.9-4.6)	17 (16-18)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Lake Howard	20 (13-27)	0.5 (0.3-0.7)	10 (19.2-162)	2000 (1500-2500)	51.6 (43.4-68.9)	105 (65.5-141)	27 (20-40)	0,3 (0,2-0.5)

Table 73. Mean percentage of major cations and anions in lakes located on the Winter Haven Ridge.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Agnes	22	34	34	10	10	0	44	46
Ariana Lake	32	32	30	6	30	2	39	29
Lake Arietta	14	44	34	7	6	0	57	37
Eagle Lake	25	41	26	8	22	1	49	28
Lake Howard	46	18	29	6	38	10	24	28

can be chemically characterized as alkaline moderately hard-water lakes of relatively high mineral content. Mean pH ranged from 7.6 to 8.9 and mean total alkalinity concentrations ranged from 29 to 41 mg/l as $CaCO_3$. Total hardness concentrations averaged between 58 and 83 mg/l as $CaCO_3$. Mean specific conductance ranged from 164 to 238 μmhos/cm. In Lake Agnes and Lake Arietta, however, pH averaged 6.9 and total alkalinity concentrations averaged 6 mg/l as $CaCO_3$. The reason for these lower values is unknown, but both lakes are located on the northern edge of the Winter Haven Ridge. This suggests there may be two slightly different groups of lakes on the Winer Haven Ridge, but the existing data are insufficient to make such a determination.

Based on chlorophyll a concentrations, all the study lakes, with the exception of Lake Arietta, can be characterized as eutrophic lakes. Mean chlorophyll a concentrations ranged from 18.7 to 105 mg/m^3. Mean total phosphorus concentrations ranged from 20.9 to 54.5 mg/m^3. Mean total nitrogen concentrations ranged from 695 to 2000 mg/m^3. In Lake Arietta, total nitrogen concentrations averaged 358 mg/m^3, total phosphorus concentrations averaged 15.5 mg/m^3 and chlorophyll a concentrations averaged 7.6 mg/m^3, thus suggesting this lake is mesotrophic. However, measured total phosphorus and chlorophyll a coccentrations ranged above 30 mg/m^3 and 15 mg/m^3, respectively. This suggests Lake Arietta may be a slightly eutrophic lake. Consequently, lakes on the Winter Haven Ridge can probably be best characterized as eutrophic lakes. Because deposits of the phosphatic Bone Valley Formation occur in this region, the lakes are probably naturally eutrophic. However, the Winter Haven Ridge is highly urbanized and many lakes have received discharges of nutrient-rich wastes. This cultural eutrophication has undoubtedly increased primary productivity in many lakes.

17. Polk Upland: The Polk Upland (Figure 4) is an area of continuous high ground located between the Gulf Coastal Lowlands and the western edge of the Lake Wales Ridge. Portions of Hillsborough County, Polk County, Manatee County and Hardee County lie within this physiographic zone. Along the eastern edge, deposits of the Fort Preston Formation occur, but most of the region is underlain by deposits of the phosphatic Hawthorn and Bone Valley Formations (Vernon and Puri 1964). Most lakes are located in the eastern half of the Polk Upland in association with sand ridges. In this study, 6 lakes (Lake Buffam, Lake Clinch, Lake Gibson, Little Crooked Lake, Lake Lowery, Lake Parker) were sampled. Data are presented in Table 74 and Table 75. Additional data obtained from the Florida Game and Fresh Water Fish Commission are presented in Table 76.

Water quality on the Polk Upland is highly variable. In this study and the Florida Game and Fresh Water Fish Commission studies, mean pH ranged from 5.4 to 9.4 and total alkalinity concentrations averaged between 1 and 76 mg/l as $CaCO_3$. Total hardness concentrations averaged between 14 and 195 mg/l as $CaCO_3$ and mean specific conductance ranged from 82 to 281 μmhos/cm. In Lake Parker, calcium was the dominant cation and bicarbonate the dominant anion, but in most other lakes sodium and chloride were the dominant anions. Total nitrogen concentrations averaged between 306 and 1566 mg/m^3 and mean total phosphorus concentrations ranged

Table 74. Means of limnological parameters measured in lakes located on the Polk Upland. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (μmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Lake Buffam	5.4 (5.2-5.5)	1 (1-2)	0 (0-0)	95 (92-100)	22 (21-23)	8.6 (7.0-10)	9.2 (8.2-10)	2.4 (2.3-2.6)	17 (16-18)
Lake Clinch	6.7 (6.3-7.2)	4 (3-5)	0 (0-0)	83 (80-86)	22 (21-22)	9.8 (9.5-10.5)	7.0 (6.3-7.9)	2.7 (2.6-2.8)	12 (12-13)
Lake Gibson	6.4 (5.8-7.1)	10 (4-15)	0 (0-0)	105 (92-130)	27 (21-36)	13 (10-19)	9.9 (8.8-11)	3.3 (3.1-3.5)	15 (14-16)
Little Crooked Lake	5.4 (5.2-5.7)	2 (1-3)	0 (0-0)	82 (72-90)	19 (17-20)	8.6 (7.0-10)	9.1 (7.3-11)	1.4 (1.2-1.7)	16 (13-19)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Lake Buffam	19 (14-24)	1.5 (1.3-1.7)	138 (66.7-178)	378 (283-488)	55.9 (37.7-84.9)	2.7 (2.0-3.7)	37 (25-45)	1.1 (0.5-2.2)
Lake Clinch	18 (14-23)	0.6 (0.4-0.8)	25.8 (20.3-37.9)	306 (117-453)	11.9 (8.1-20.9)	7.2 (6.6-8.3)	8 (5-10)	2.2 (1.3-2.7)
Lake Gibson	20 (13-25)	1.2 (0.1-2.5)	273 (190-357)	691 (525-875)	270 (75-397)	5.9 (3.0-9.6)	69 (45-100)	0.8 (0.5-1.1)
Little Crooked Lake	15 (6.2-24)	0.6 (0.3-1.0)	435 (335-647)	1032 (866-1200)	54.3 (28.4-71.3)	11.9 (7.2-19.2)	138 (60-200)	0.3 (0.1-0.5)

Table 74. (cont.).

LAKE	pH	TOTAL ALKALINITY (mg/l $CaCO_3$)	PHENOL ALKALINITY (mg/l $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/l $CaCO_3$)	CALCIUM HARDNESS (mg/l $CaCO_3$)	SODIUM (mg/l)	POTASSIUM (mg/l)	CHLORIDE (mg/l)
Lake Lowery	6.2 (6.1-6.5)	5 (4-5)	0 (0-0)	107 (102-110)	20 (20-21)	13 (12-15)	14 (13-15)	3.0 (2.8-3.3)	25 (24-26)
Lake Parker	8.9 (8.8-9.1)	68 (63-76)	6 (2-9)	215 (200-260)	95 (92-100)	75 (72-81)	13 (12-15)	2.4 (2.1-2.5)	20 (19-21)

LAKE	SULFATE (mg/l)	SILICA (mg/l)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/l Pt)	SECCHI (m)
Lake Lowery	11 (7.6-17)	0.3 (0.2-0.5)	84.9 (74.6-120)	1102 (808-1320)	22.3 (18.0-31.9)	10.4 (6.2-16.1)	79 (70-90)	1.4 (1.2-1.5)
Lake Parker	22 (15-29)	0.3 (0.05-0.5)	100 (54.2-139)	1566 (983-1970)	78.7 (60.4-112)	33.7 (9.3-49.3)	22 (15-30)	0.5 (0.4-0.6)

Table 75. Mean percentage of major cations and anions in lakes located on the Polk Upland.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Buffam	19	30	44	7	3	0	44	54
Lake Clinch	24	29	38	9	10	0	46	43
Lake Gibson	25	26	40	8	20	0	40	40
Little Crooked Lake	21	24	48	4	4	0	39	57
Lake Lowery	24	13	55	7	9	0	22	69
Lake Parker	59	16	23	2	47	10	19	24

Table 76. Means of limnological parameters measured in lakes located on the Polk Upland. Numbers in parentheses are the minimum and maximum values measured. Period of record 1967-1973. Data from Holcomb (1968,1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/l)	PHENOL ALKALINITY (mg/l)	SPECIFIC CONDUCTANCE (µmhos/cm)	TOTAL HARDNESS (mg/l)	CALCIUM (mg/l)	MAGNESIUM (mg/l)	SODIUM (mg/l)
Crooked Lake	6.4 (5.8-6.9)	6.4 (5.9-6.8)	2 (1-5)	0 (0-0)	90 (80-100)	14 (14-14)	2.5 (2.3-2.7)	1.7 (1.6-2.0)	6.9 (6.2-7.4)
Gibson	7.2 (6.8-7.6)	7.2 (6.3-7.6)	17 (9-21)	0 (0-0)	138 (120-160)	30 (28-32)	7.1 (5.9-8.5)	3.3 (2.4-4.4)	11 (7.7-15)
Hancock	9.4 (8.8-10.0)	9.4 (8.3-9.7)	76 (36-106)	29 (13-62)	281 (240-340)	105 (90-131)	29 (24-36)	6.7 (2.7-10)	19 (13-24)
Hollingsworth	9.4 (8.8-10.1)	9.3 (8.2-10.1)	47 (32-56)	16 (10-24)	183 (165-205)	65 (57-72)	21 (20-24)	2.7 (1.6-3.8)	6.9 (6.1-7 9)

POTASSIUM (mg/l)	CHLORIDE (mg/l)	SULFATE (mg/l)	SILICA (mg/l)	TOTAL IRON (mg/l)	TOTAL PHOSPHATE (mg/l)	CHLOROPHYLL a (mg/m³)	COLOR (mg/l Pt)	SECCHI (ft)
0.9 (0.7-1.3)	14 (13-14)	9.0 (4.0-11)	- -	0.045 (0.040-0.050)	0.042 (0.010-0.060)	2.4 (1.1-4.8)	- -	9.0 (6.6-13)
2.6 (2.2-2.9)	18 (16-19)	14 (11-18)	- -	0.290 (0.240-0.340)	0.650 (0.450-1.00)	15.4 (3.2-28.9)	- -	2.2 (1.4-3.1)
2.5 (1.7-3.4)	15 (12-17)	25 (14-42)	11 (11-11)	0.220 (0.170-0.260)	2.44 (1.40-3.20)	144 (40.1-217)	28 (25-30)	0.8 (0.5-1.3)
1.2 (0.8-1.9)	13 (12-14)	8.2 (6.5-12)	1.2 (0.4-1.9)	0.173 (0.110-0.260)	0.774 (0.320-1.20)	54.8 (26.7-104)	5 (5-5)	1.6 (0.8-2.4)

from 2.4 to 144 mg/m^3, and water transparency ranged between 0.2 and 2.7 m. However, as is the case with other large physiographic regions in Florida, much of this variability is directly related to changes in regional geology.

Lake Clinch and Crooked Lake are located in sandy deposits of the Fort Preston Formation. In these lakes, mean pH ranged from 6.4 to 6.7. Total alkalinity averaged between 2 and 4 mg/l as $CaCO_3$ and total hardness concentrations averaged between 9.8 and 14 mg/l as $CaCO_3$. Mean specific conductance ranged from 83 to 90 μmhos/cm. Total nitrogen concentrations averaged 306 mg/m^3 in Lake Clinch and total phosphorus concentrations averaged close to 12 mg/m^3 in both Lake Clinch and Crooked Lake. Mean chlorophyll a concentrations ranged from 2.4 to 7.2 mg/m^3 and mean water transparency ranged from 2.2 to 2.7 m. If Lake Clinch and Crooked Lake are similar to other lakes in this geologic formation, lakes located in the Fort Preston Formation on the Polk Upland can be characterized as slightly acid, oligo-mesotrophic, soft-water lakes.

Lake Buffam and Little Crooked Lake, however, are located in eastern Polk County in deposits of the Bone Valley Formation and the Fort Preston Formation. These lakes are in a valley-like depression, similar to the Intraridge Valley, which contains peats and peaty muds (White 1970). In these lakes, pH averaged 5.4 and mean total alkalinity ranged from 1 to 2 mg/l as $CaCO_3$. Total hardness concentrations averaged between 19 and 22 mg/l as $CaCO_3$ and calcium hardness concentrations averaged 8.6 mg/l as $CaCO_3$. Mean specific conductance ranged from 82 to 95 μmhos/cm. Total nitrogen concentrations averaged 344 mg/m^3 in Lake Buffam and 1032 mg/m^3 in Little Crooked Lake. Total phosphorus concentrations averaged between 54.3 and 55.9 mg/m^3 and chlorophyll a concentrations averaged 2.7 mg/m^3 and 110 mg/m^3 in Lake Buffam and in Little Crooked Lake respectively. From these data, lakes in this region can be chemically characterized as acid, soft-water lakes. Based on total phosphorus concentrations, these lakes are potentially eutrophic lakes. However, data from this study suggests the lakes are presently mesotrophic

Lake Gibson and Lake Lowry are located in sandy deposits of the Hawthorn and Bone Valley Formations. During this study, mean pH ranged from 6.2 to 6.4 and total alkalinity concentrations averaged between 5 and 10 mg/l as $CaCO_3$. Mean total hardness concentrations averaged between 20 and 27 mg/l as $CaCO_3$ and calcium hardness concentrations averaged 13 mg/l as $CaCO_3$. Specific conductance averaged close to 106 µmhos/cm. Total nitrogen concentrations averaged between 691 and 1102 mg/m^3 and total phosphorus concentrations averaged between 22.3 and 270 mg/m^3. Chlorophyll a concentrations averaged between 5.9 and 10.4 mg/m^3. Data from the Florida Game and Fresh Water Fish Commission, however, shows all values can average higher in Lake Gibson, but based on the available data these lakes can be characterized as slightly acid, mesotrophic soft-water lakes. However, maximum measured total phosphorus concentrations are sufficiently high to maintain these lakes in a eutrophic state. Additional sampling might reveal these lakes are eutrophic because of the high phosphorus inputs from the phosphatic sands occuring in each lake's watershed.

Lake Hancock, Lake Hollingsworth, and Lake Parker are also located in phosphatic deposits from the Hawthorn and Bone Valley Formations, but these lakes, which are located just east of the Lakeland Ridge, receive inputs of groundwater which has been in contact with limestone (Stewart 1966). In these lakes, mean pH ranged from 8.9 to 9.4 and total alkalinity averaged between 47 and 76 mg/l as $CaCO_3$. Total hardness concentrations averaged between 65 and 105 mg/1 as $CaCO_3$ and mean total specific conductance ranged from 183 to 281 µmhos/cm. In Lake Parker, total nitrogen concentrations averaged 1566 mg/m^3 and total phosphorus concentrations averaged 78.7 mg/m^3. In Lake Hancock and Lake Hollingsworth, total phosphate concentrations ranged from 33.7 to 144 mg/m^3. Based on these data, the lakes can be characterized as alkaline, eutrophic, hard-water lakes. Because the lakes are located in a phosphatic region, they are naturally eutrophic. However, inputs of nutrient-rich wastes can greatly increase lake productivity as is shown by Lake Hancock.

18. Okeechobee Plain: The Okeechobee Plain (Figure 4) is a large area of low ground located in Highlands, Glades and Okeechobee counties The regional geology is dominated by deposits from the Recent and Pliestocene (Vernon and Puri 1964). Two large lakes, Lake Istokpoga and Lake Okeechobee, are located in this physiographic region. Both lakes were sampled in this study. Data are presented in Table 77 and Table 78.

In Lake Istokpoga, pH averaged 6.9 and total alkalinity concentrations averaged 33 mg/1 as $CaCO_3$ and specific conductance averaged 101 µmhos/cm. This lake can, therefore, be chemically characterized as a slightly acidic, soft-water lake. In contrast, Lake Okeechobee has an average pH of 8.4, an average total alkalinity of 100 m/1 as $CaCO_3$, an average total hardness of 151 mg/1 as $CaCO_3$ and an average specific conductance of 443 µmhos/cm. Lake Okeechobee can, therefore, be chemically characterized as an alkaline, hard-water lake of high mineral content. Lake Istokpoga

Table 77. Means of limnological parameters measured in lakes located on the Okeechobee Plain. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Istokpoga	6.9 (6.4-8.2)	11 (9-12)	0 (0-0)	101 (83-110)	33 (28-35)	22 (20-28)	7.7 (6.9-8.4)	2.3 (1.7-2.5)	14 (12-16)
Lake Okeechobee	8.4 (8.1-8.7)	100 (99-103)	2 (0-4)	443 (430-470)	151 (150-153)	98 (90-106)	46 (45-49)	4.8 (4.6-5.1)	71 (68-74)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 @ Pt)	SECCHI (m)
Lake Istokpoga	20 (17-23)	2.6 (1.5-3.5)	272 (219-327)	994 (654-1600)	44.7 (24.4-67.2)	31.2 (10.8-86.3)	92 (75-113)	0.5 (0.3-0.6)
Lake Okeechobee	56 (51-59)	7.0 (1.1-11)	114 (42.5-196)	1100 (955-1500)	105 (46.9-171)	14.8 (6.0-23.3)	47 (30-70)	0.5 (0.4-0.7)

Table 78. Mean percentage of major cations and anions in lakes located on the Okeechobee Plain.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Istokpoga	43	19	32	5	20	0	41	39
Lake Okeechobee	38	20	39	2	37	1	23	39

receives the majority of its water from poorly-drained non-calcareous soi's, whereas Lake Okeechobee receives most of its water from tributaries which have picked up mineralized groundwater. In additiona, Lake Okeechobee is below the piezometric surface, thus the lake probably receives appreciable quantities of ground water.

Both lakes can be characterized as eutrophic. Total nitrogen concentrations averaged between 994 and 1100 mg/m^3 and total phosphorus concentrations averaged between 44.7 and 105 mg/m^3. Mean chlorophyll a concentrations ranged from 14.8 to 31.2 mg/m^3. Because these lakes have very large watersheds located in regions that are relatively nutrient-rich and because rainfall can contribute significant amounts of nutrients (Joyner 1974), Lake Istokpoga and Lake Okeechobee are probably naturally eutrophic.

19. Immokalee Rise: The Immokalee Rise (Figure 4) is a large sandy region located in the northwestern portions of the Southern Physiographic Zone. This region includes portions of Lee County, Hendry County, and Collier County. The geology of this region is dominated by silty sands and clays of the Tamiami Formation, but marl and phosphatic sands also occur (Vernon and Puri 1964). Along the edge of the Immokalee Rise where sand overlies limestone, a line of solution lakes has developed (White 1970). In this study, Lake Trafford, the largest lake in the region, was sampled. Data are presented in Table 79 and Table 80.

Lake Trafford can be chemically characterized as an alkaline, hard-water lake of relatively high mineral content. Measured pH averaged 8.4 and total alkalinity concentrations averaged 111 mg/1 as $CaCO_3$. Total hardness concentrations averaged 92 mg/1 as $CaCO_3$ and calcium hardness

Table 79. Means of limnological parameters measured in lakes located on the Immokalee Rise. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (μmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/1 $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Lake Trafford	8.4 (8.1-9.1)	111 (62-162)	4 (0-14)	225 (193-240)	92 (68-111)	82 (54-99)	16 (14-17)	3.5 (2.7-4.4)	27 (23-30)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Lake Trafford	7.0 (2.9-11)	2.4 (1.1-3.1)	188 (107-223)	1300 (1100-1500)	65.5 (27.8-128)	27.7 (5.8-65.9)	48 (20-75)	1.0 (0.9-1.0)

Table 80. Mean percentage of major cations and anions in lakes located on the Immokalee Rise.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Lake Trafford	62	8	26	3	66	5	5	24

concentrations averaged 82 mg/l as $CaCO_3$. Specific conductance averaged 225 μmhos/cm. Calcium ions comprised over 60% of the measured cations and bicarbonate comprised over 65% of the anions. Lake Trafford can also be characterized as a eutrophic lake. Total nitrogen concentrations averaged 1300 mg/m^3 and total phosphorus concentrations averaged 65.6 mg/m^3. Chlorophyll a concentrations averaged 27.7 mg/m^3. In addition, Lake Trafford had extensive growths of aquatic macrophytes. If Lake Trafford is typical of other lakes on the Immokalee Rise, these lakes can be characterized as alkaline, eutrophic, hard-water lakes.

20. Atlantic Coastal Ridge: The Atlantic Coastal Ridge (Figure 4) is a narrow area of high ground extending along the Atlantic coast. The region is composed of relict beach ridges and bars (White 1970) and is generally wider near its southern end in Broward and Dade Counties. Deposits of sands and limestone dominate the region (Vernon and Puri 1964). Other than a few relict lagoon lakes, there are few natural lakes in the region, but there are numerous barrow pits. In this study, 2 lakes, Osborne Lake and Tigertail, were sampled. Data are presented in Table 81 and Table 82. Additional data for South Lake were obtained from the Florida Game and Fresh Water Fish Commission and are presented in Table 83.

Osborne Lake and South Lake are relict barrier lagoon lakes. In these lakes, pH averaged between 8.2 and 8.7 and mean total alkalinity ranged from 78 to 204 mg/l as $CaCO_3$. Total hardness concentrations averaged between 190 and 208 mg/l as $CaCO_3$ and mean specific conductance ranged from 477 to 1010 μmhos/cm. In Osborne Lake, total nitrogen

Table 81. Means of limnological parameters measured in lakes located on the Atlantic Coastal Ridge. Numbers in parentheses are the minimum and maximum values measured.

LAKE	pH	TOTAL ALKALINITY (mg/1 $CaCO_3$)	PHENOL ALKALINITY (mg/1 $CaCO_3$)	SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	TOTAL HARDNESS (mg/1 $CaCO_3$)	CALCIUM HARDNESS (mg/I $CaCO_3$)	SODIUM (mg/1)	POTASSIUM (mg/1)	CHLORIDE (mg/1)
Osborne Lake	8.2 (8.1-8.6)	204 (136-305)	0 (0-2)	477 (410-520)	190 (170-215)	175 (150-194)	39 (31-51)	4.9 (4.0-6.0)	58 (47-73)
Tigertail	8.9 (8.6-9.4)	66 (50-88)	6 (1-15)	166 (160-173)	56 (47-67)	52 (46-61`	16 (15-16)	1.1 (0.9-1.2)	24 (24-25)

LAKE	SULFATE (mg/1)	SILICA (mg/1)	TOTAL Fe (mg/m^3)	TOTAL N (mg/m^3)	TOTAL P (mg/m^3)	CHLOROPHYLL *a* (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (m)
Osborne Lake	37 (32-44)	3.9 (2.0-6.4)	84.9 (56.1-140)	1200 (891-1500)	138 (113-161)	39.9 (20.9-47.8)	60 (50-70)	1.0 (0.8-1.1)
Tigertail	6.7 (3.4-8.7)	0.5 (0.1-0.9)	47.9 (20.7-63.6)	607 (566-641)	14.1 (10.6-28.4)	2.5 (0.8-9.5)	4 (0-10)	BOTTOM (***-***)

Table 82. Mean percentage of major cations and anions in lakes located on the Atlantic Coastal Ridge.

	CATIONS				ANIONS			
LAKE	CALCIUM	MAGNESIUM	SODIUM	POTASSIUM	BICARBONATE	CARBONATE	SULFATE	CHLORIDE
Osborne Lake	62	5	30	2	63	0	12	25
Tigertail	57	4	37	1	51	11	6	32

Table 83. Means of limnological parameters measured in South Lake. Numbers in parentheses are the minimum and maximum values measured. Period or record 1967-1973. Data from Holcomb (1968, 1969), Duchrow (1970, 1971), Duchrow and Starling (1972), and Holcomb and Starling (1973).

LAKE	pH (Field)	pH (Laboratory)	TOTAL ALKALINITY (mg/1)	PHENOL ALKALINITY (mg/1)	SPECIFIC CONDUCTANCE (µmhos/cm)	TOTAL HARDNESS (mg/1)	CALCIUM (mg/1)	MAGNESIUM (mg/1)	SODIUM (mg/1)
South	8.7 (8.3-9.1)	8.6 (7.6-9.1)	78 (18-112)	10 (3-16)	1010 (950-1080)	208 (158-256)	52 (40-68)	16 (12-21)	145 (91-176)

POTASSIUM (mg/1)	CHLORIDE (mg/1)	SULFATE (mg/1)	SILICA (mg/1)	TOTAL IRON (mg/1)	TOTAL PHOSPHATE (mg/1)	CHLOROPHYLL a (mg/m^3)	COLOR (mg/1 Pt)	SECCHI (ft)
6.3 (2.8-8.7)	257 (222-295)	60 (40-90)	1.2 (0-2.4)	0.220 (0.140-0.330)	0.260 (0.110-0.340)	11.8 (1.6-25.7)	20 (20-20)	1.8 (1.0-3.6)

concentrations averaged 1200 mg/m^3 and total phosphorus concentrations averaged 138 mg/m^3. In South Lake, total phosphate concentrations averaged 0.26 mg/l. Mean chlorophyll a concentrations ranged from 11.8 to 39.9 mg/m^3. Based on this data, the barrier lagoon lakes on the Atlantic Coastal Ridge can probably be characterized as alkaline, eutrophic, hard-water lakes of high salinity. These conditions most likely result from input of mineralized water from the underlying aquifer.

Tigertail is a small barrow pit. In this study, pH averaged 8.9 and total alkalinity concentrations averaged 66 mg/l as $CaCO_3$. Total hardness concentrations averaged 56 mg/l as $CaCO_3$ and calcium hardness concentrations averaged 52 mg/l as $CaCO_3$. Specific conductance averaged 166 μmhos/cm. Calcium was the dominant cation and bicarbonate was the dominant anion. Total nitrogen concentrations averaged 607 mg/m^3 and total phosphorus concentrations averaged 14.1 mg/m^3. Chlorophyll a concentrations ranged from 0.8 to 9.5 mg/m^3 and extensive growths of aquatic macrophytes were observed. From this data, Tigertail can be characterized as an alkaline, mesotrophic, moderately hard-water lake. However, this may not be typical of other barrow pits in this region as other pits are considerably larger and deeper.

C. Chemical and Trophic State Characteristics of Florida Lakes: An Overview

1. Areal Variations in Water Quality: Figures 5 to 19 show the statewide areal variation for some of the limnological parameters measured in this study. Because the study lakes were sampled infrequently and only 165 lakes out of a possible 7700 lakes were sampled, all isograms

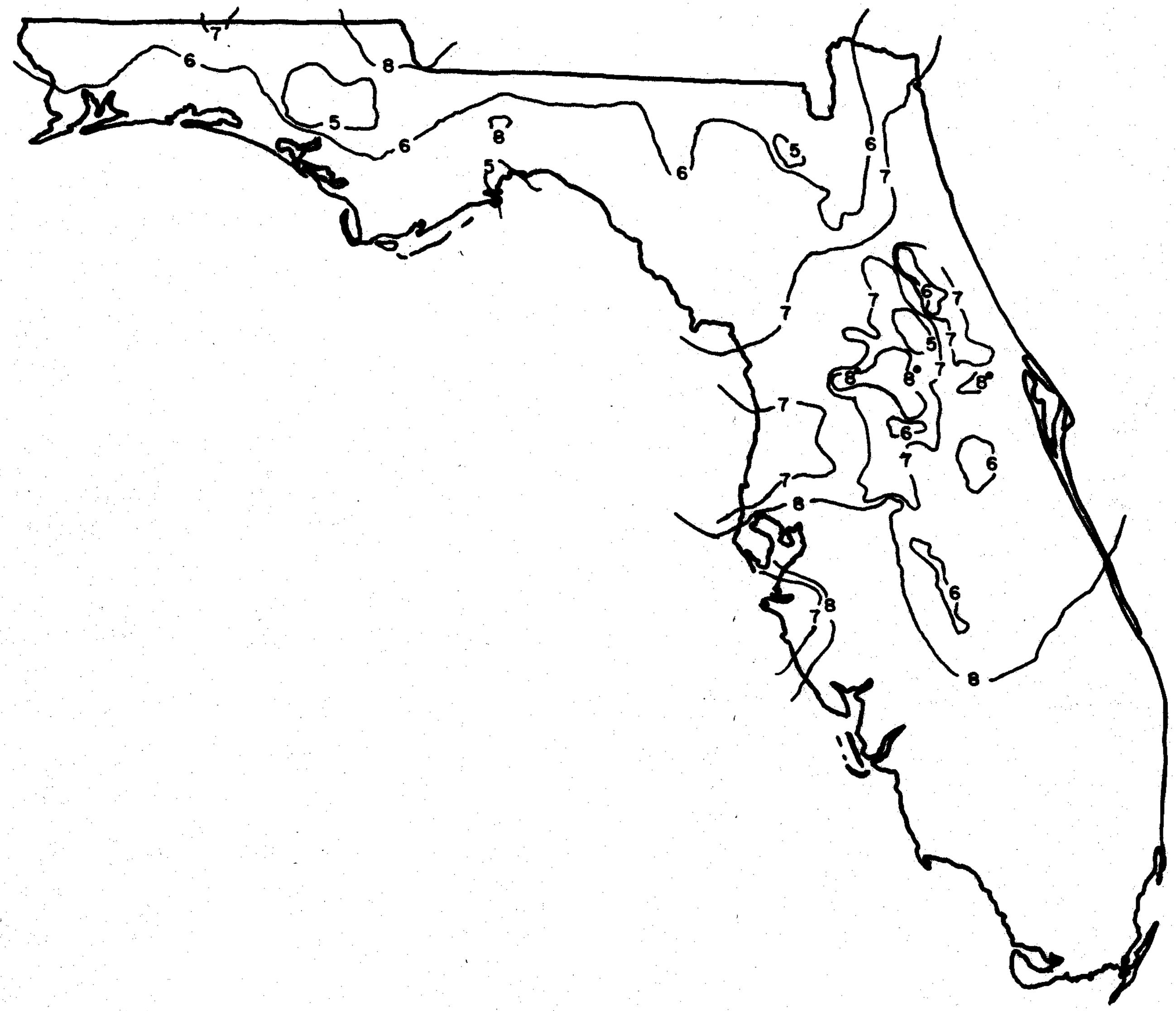

Figure 5. Distribution of lake pH values in Florida. Isograms represent maximum values except where • occurs then isograms represent minimum values.

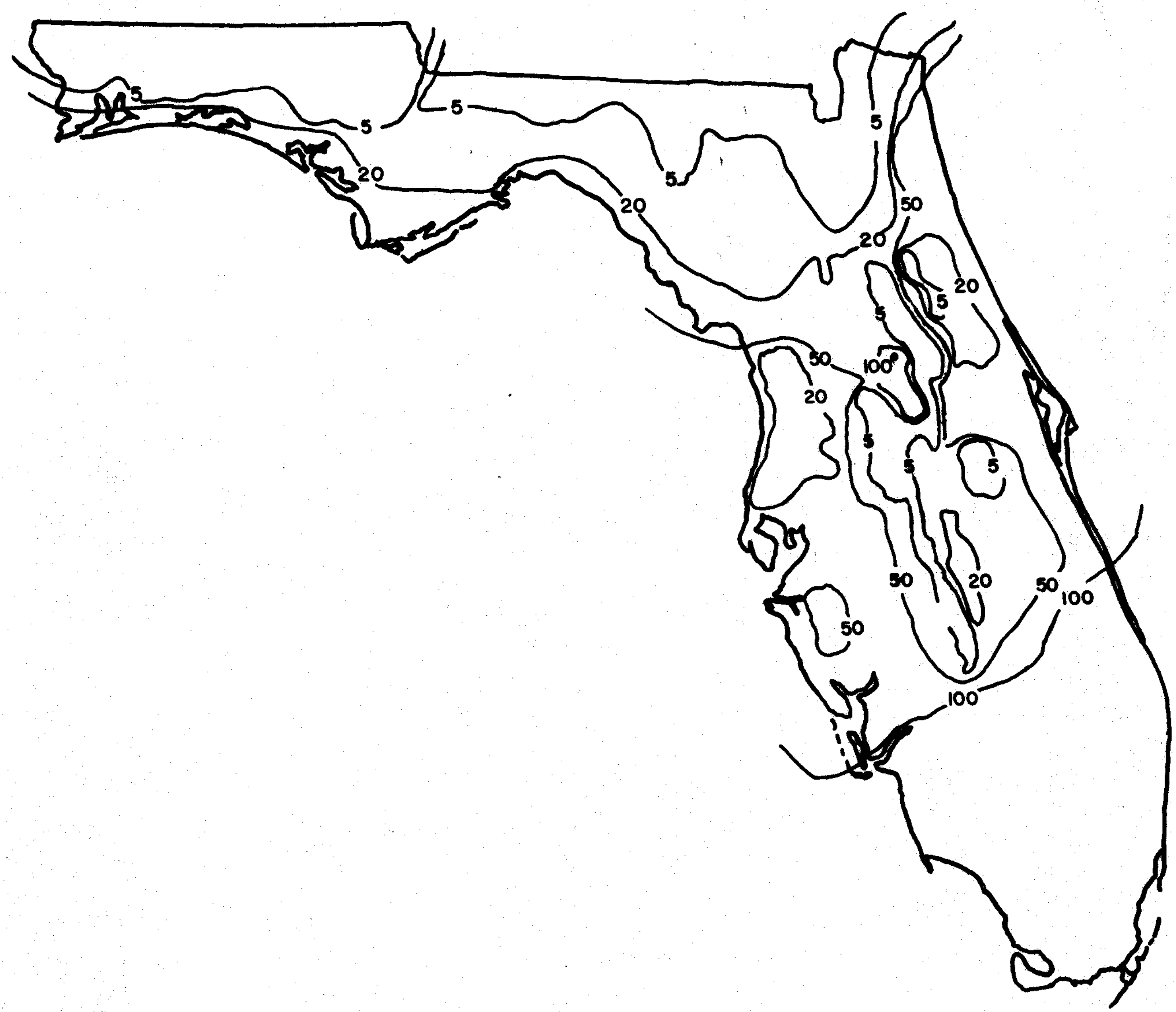

Figure 6. Distribution of lake total alkalinity concentrations (mg/l as $CaCO_3$) in Florida. Isograms represent maximum values except where ● occurs then isograms represent minimum values.

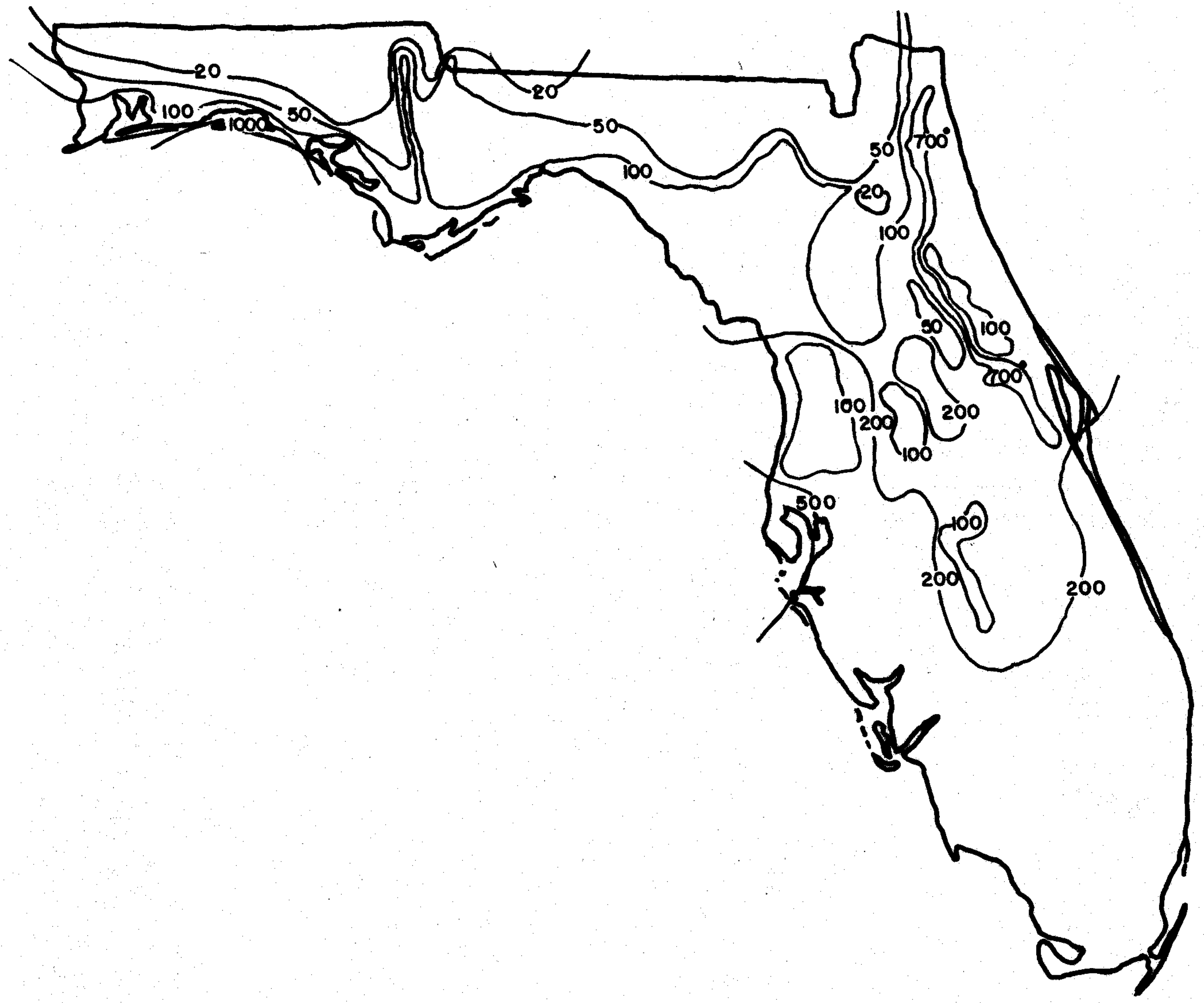

Figure 7. Distribution of lake specific conductance (µmhos/cm at 25 C) in Florida. Isograms represent maximum values except where ● occurs then isograms represent minimum values.

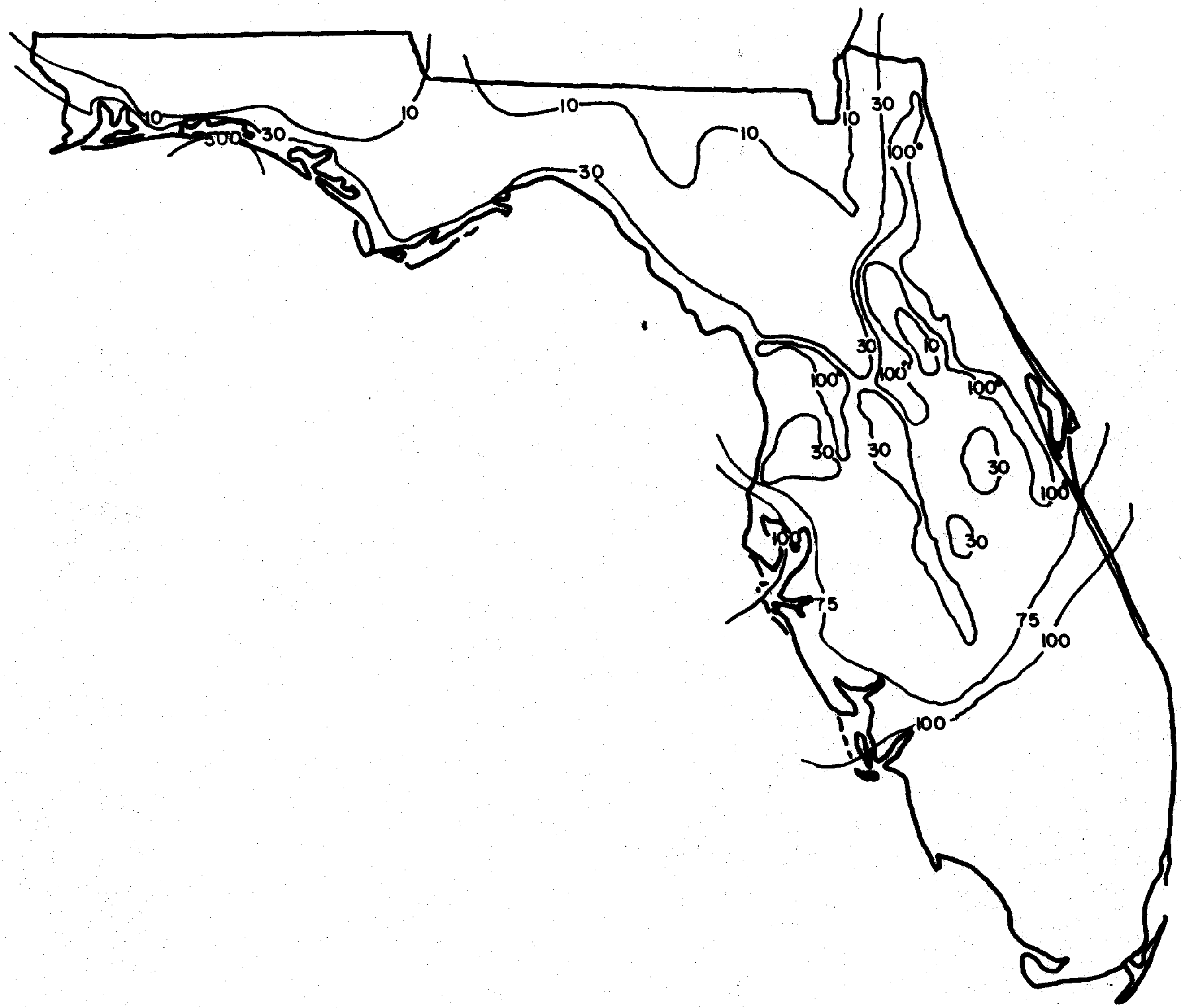

Figure 8. Distribution of lake total hardness concentrations (mg/l as $CaCO_3$) in Florida. Isograms represent maximum values except where • occurs then isograms represent minimum values.

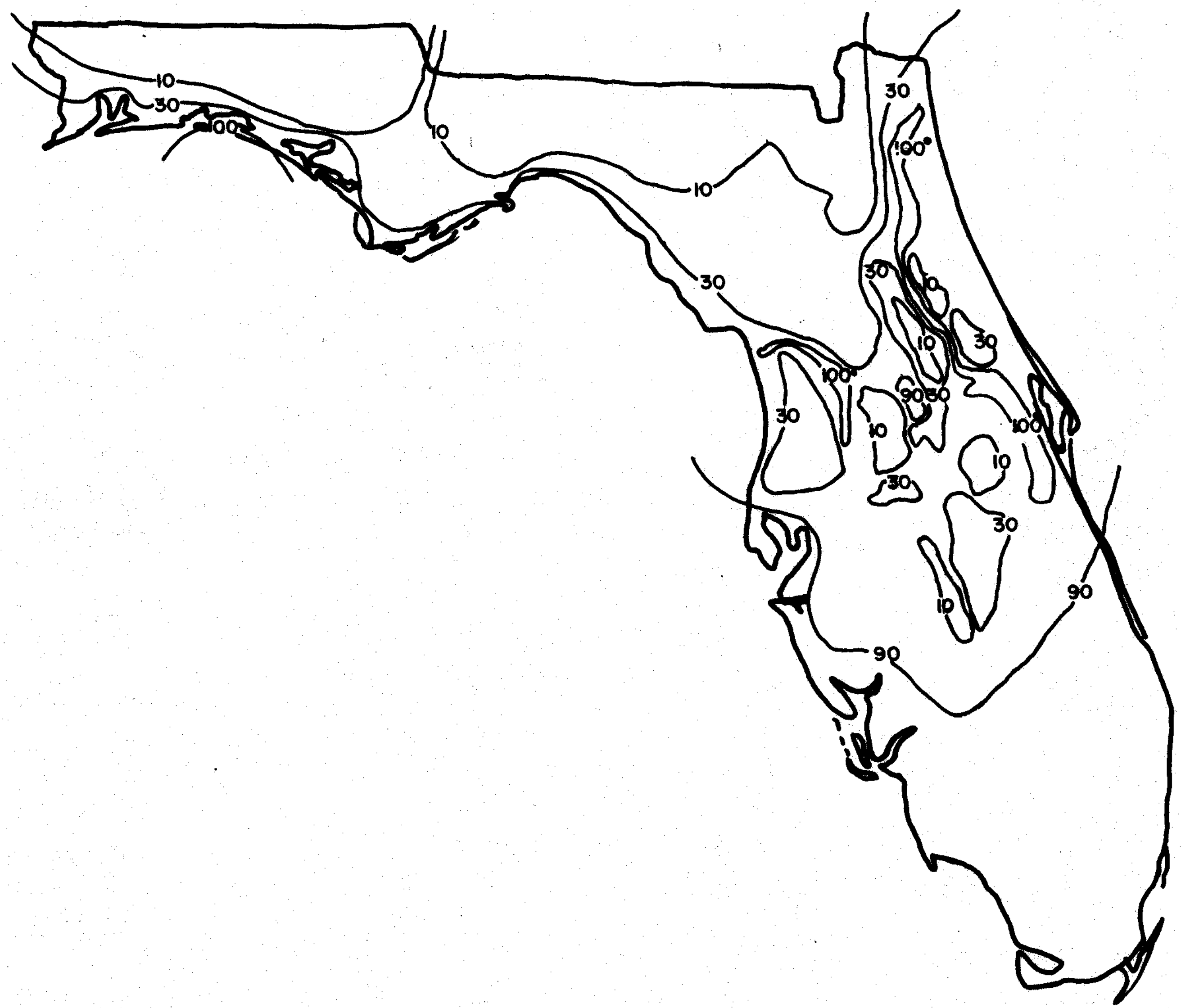

Figure 9. Distribution of lake calcium hardness concentrations (mg/l as $CaCO_3$) in Florida. Isograms represent maximum values except where • occurs then isograms represent minimum values.

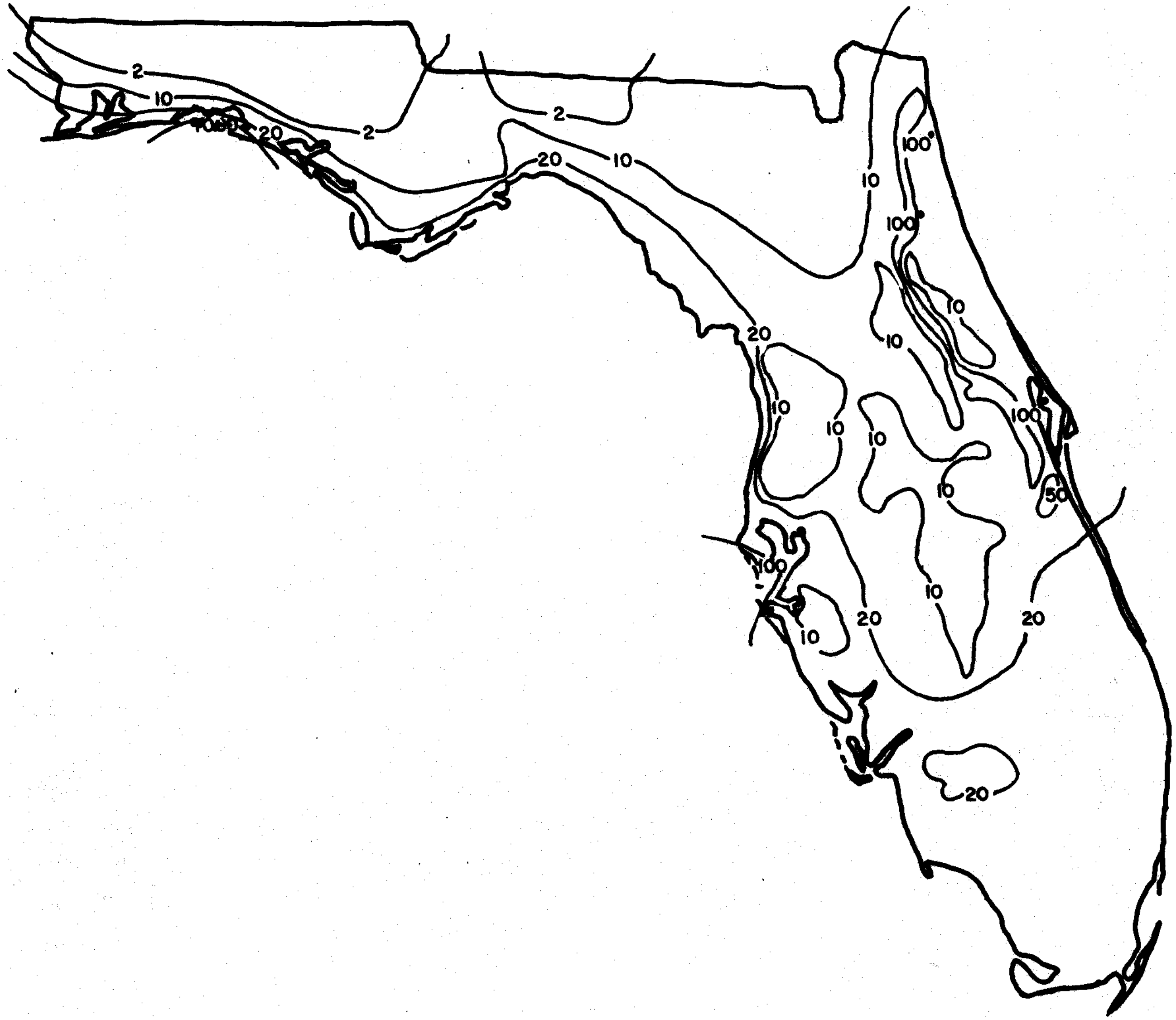

Figure 10. Distribution of lake sodium concentrations (mg/l) in Florida. Isograms represent maximum values except where ♦ occurs then isograms represent minimum values.

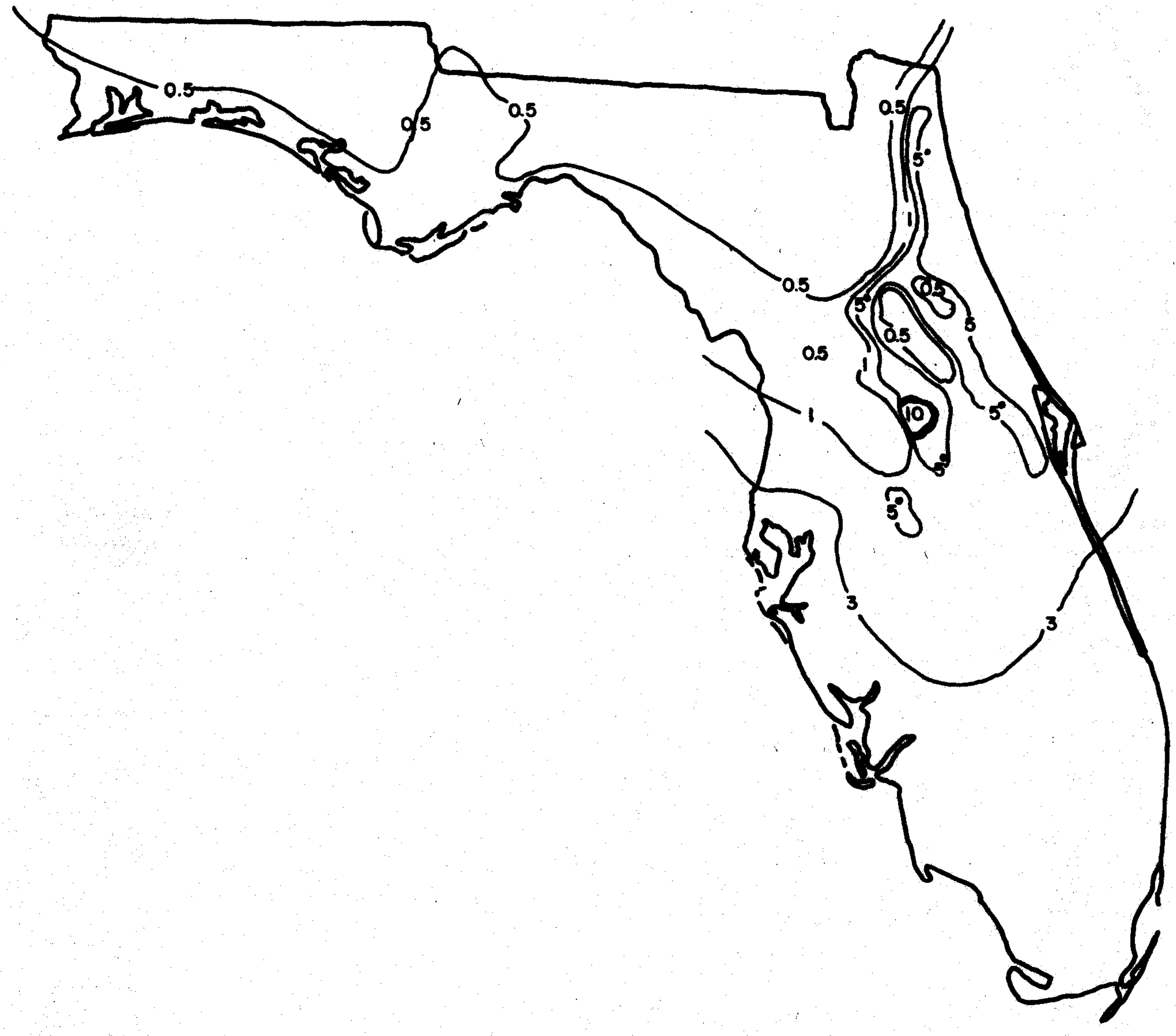

Figure 11. Distribution of lake potassium concentrations (mg/l) in Florida. Isograms represent maximum values except where • occurs then isograms represent minimum values.

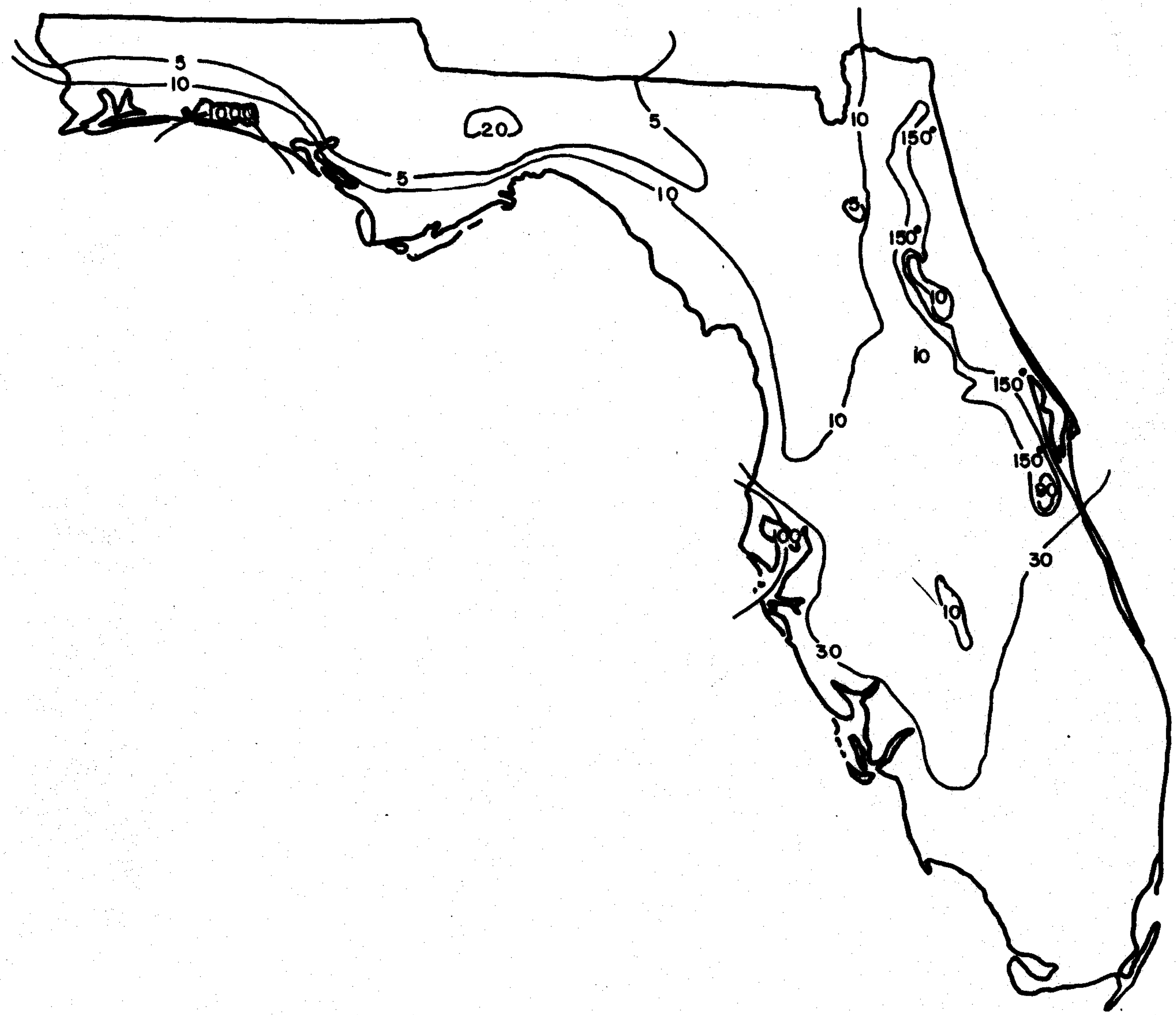

Figure 12. Distribution of lake chloride concentrations (mg/l) in Florida. Isograms represent maximum values except where • occurs then isograms represent minimum values.

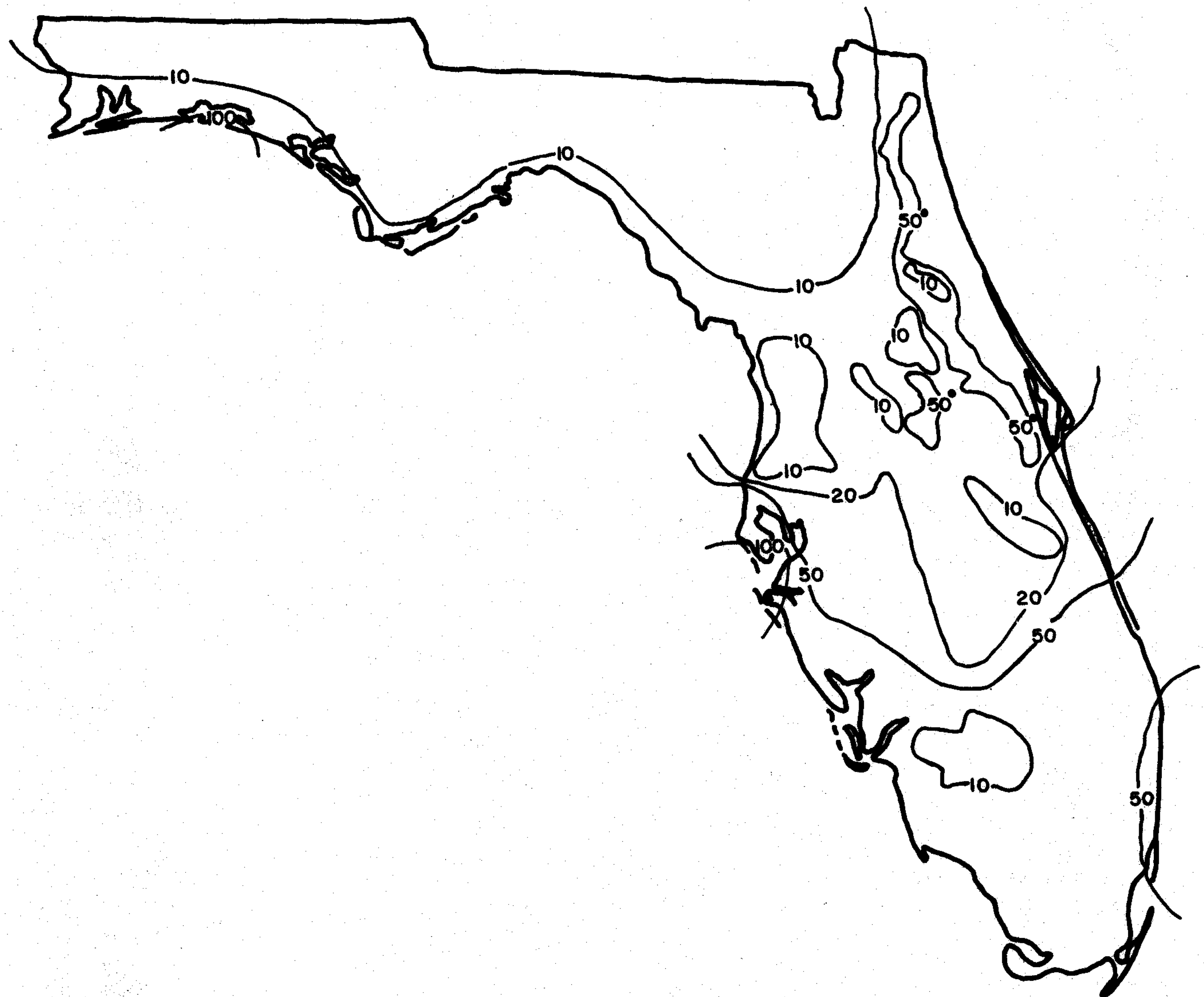

Figure 13. Distribution of lake sulfate concentrations (mg/l) in Florida. Isograms represent maximum values except where • occurs then isograms represent minimum values.

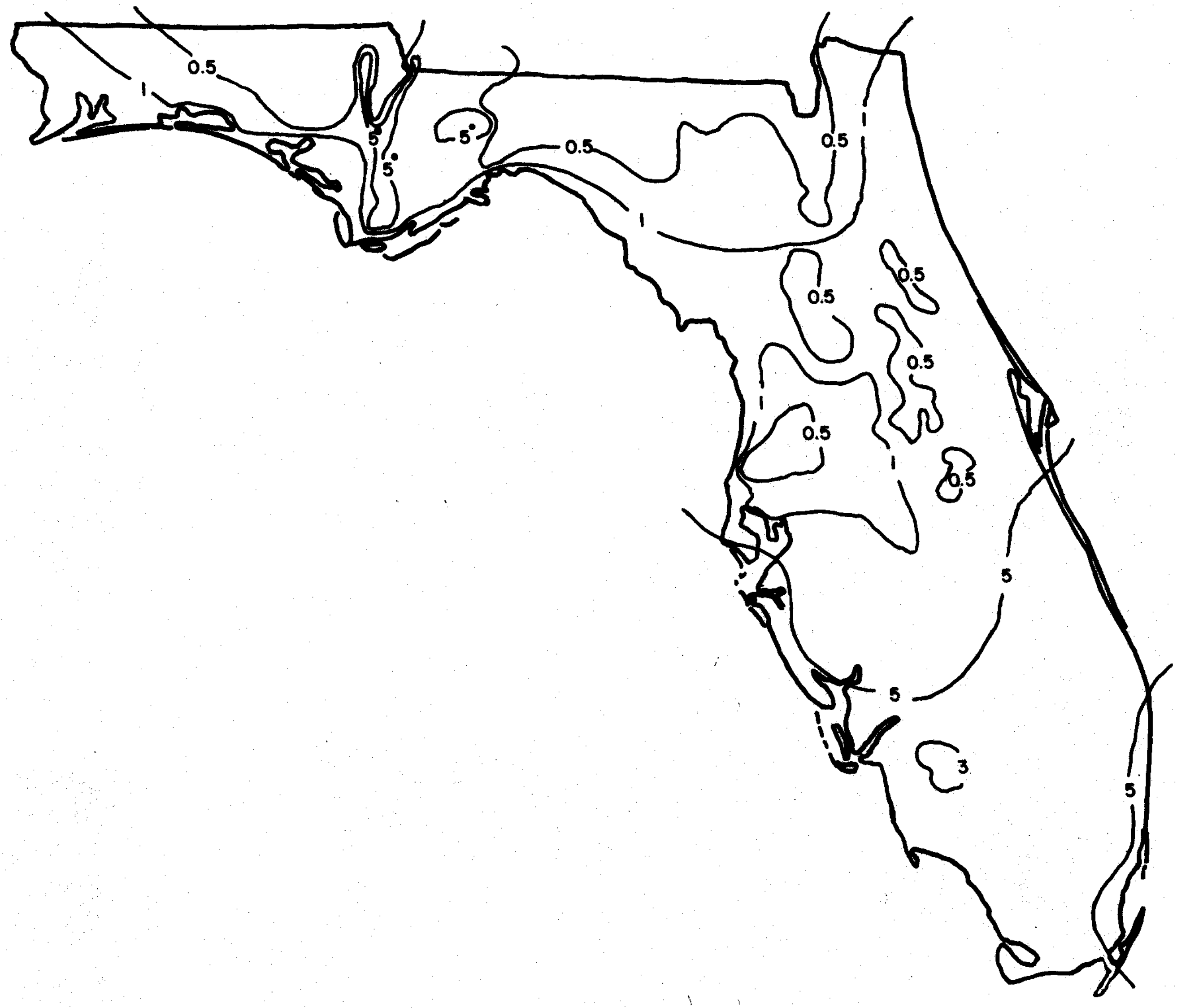

Figure 14. Distribution of lake silica concentrations (mg/l) in Florida. Isograms represent maximum values except where • occurs then isograms represent minimum values.

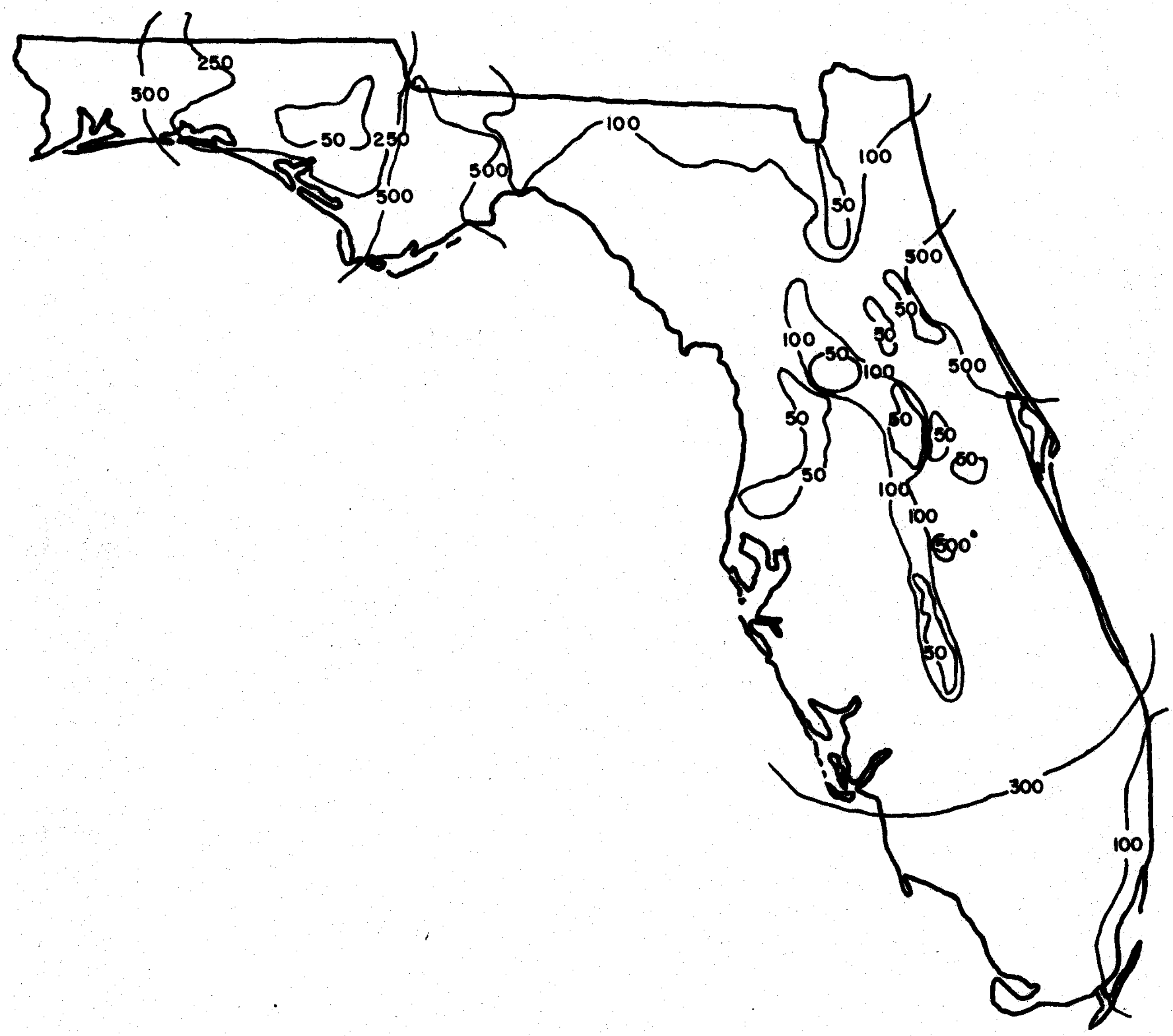

Figure 15. Distribution of lake total iron concentrations (mg/m^3) in Florida. Isograms represent maximum values except where • occurs then isograms represent minimum values.

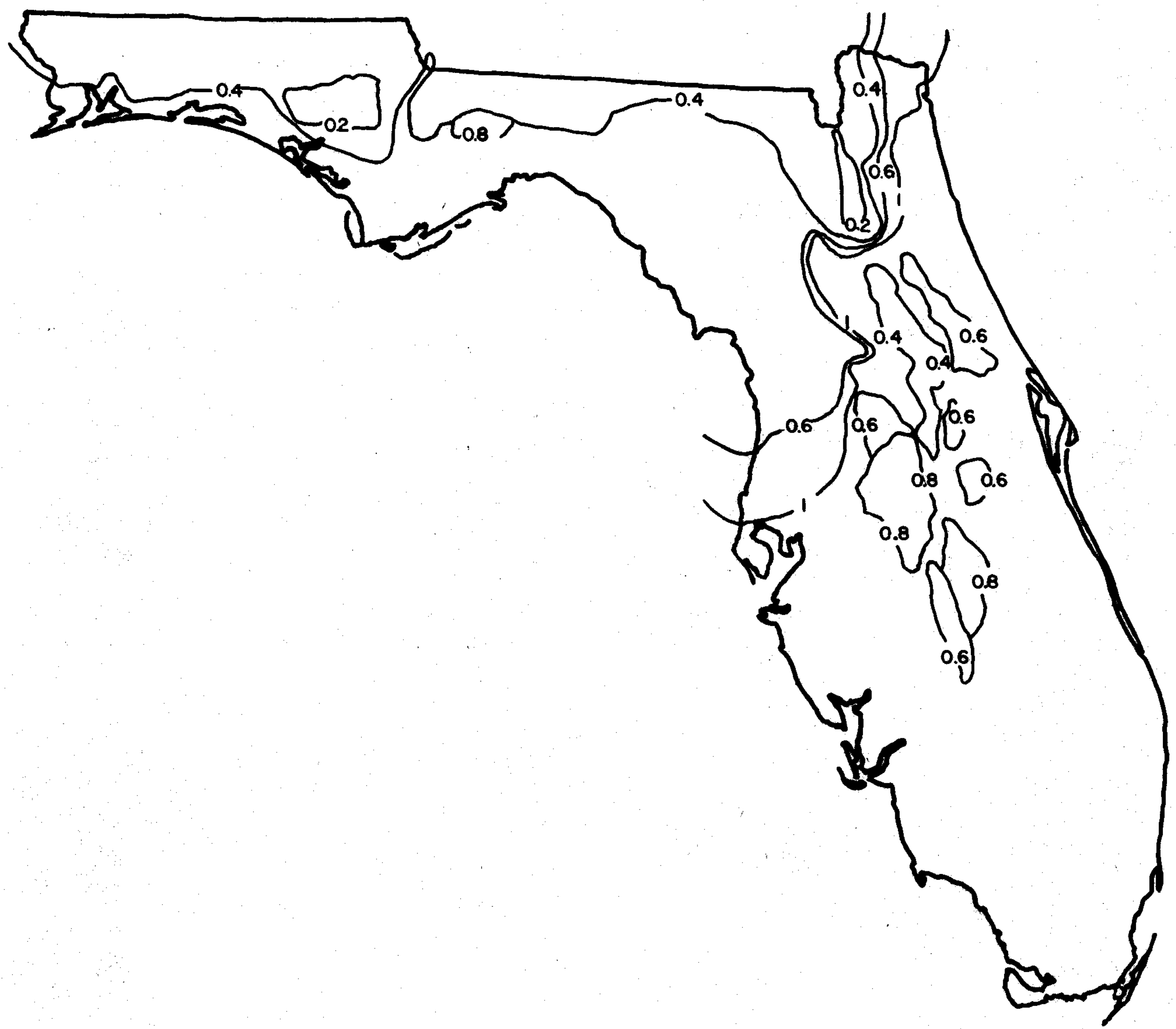

Figure 16. Distribution of lake total nitrogen concentrations (mg/m^3) in Florida. Isograms represent maximum values except where • occurs then isograms represent minimum values.

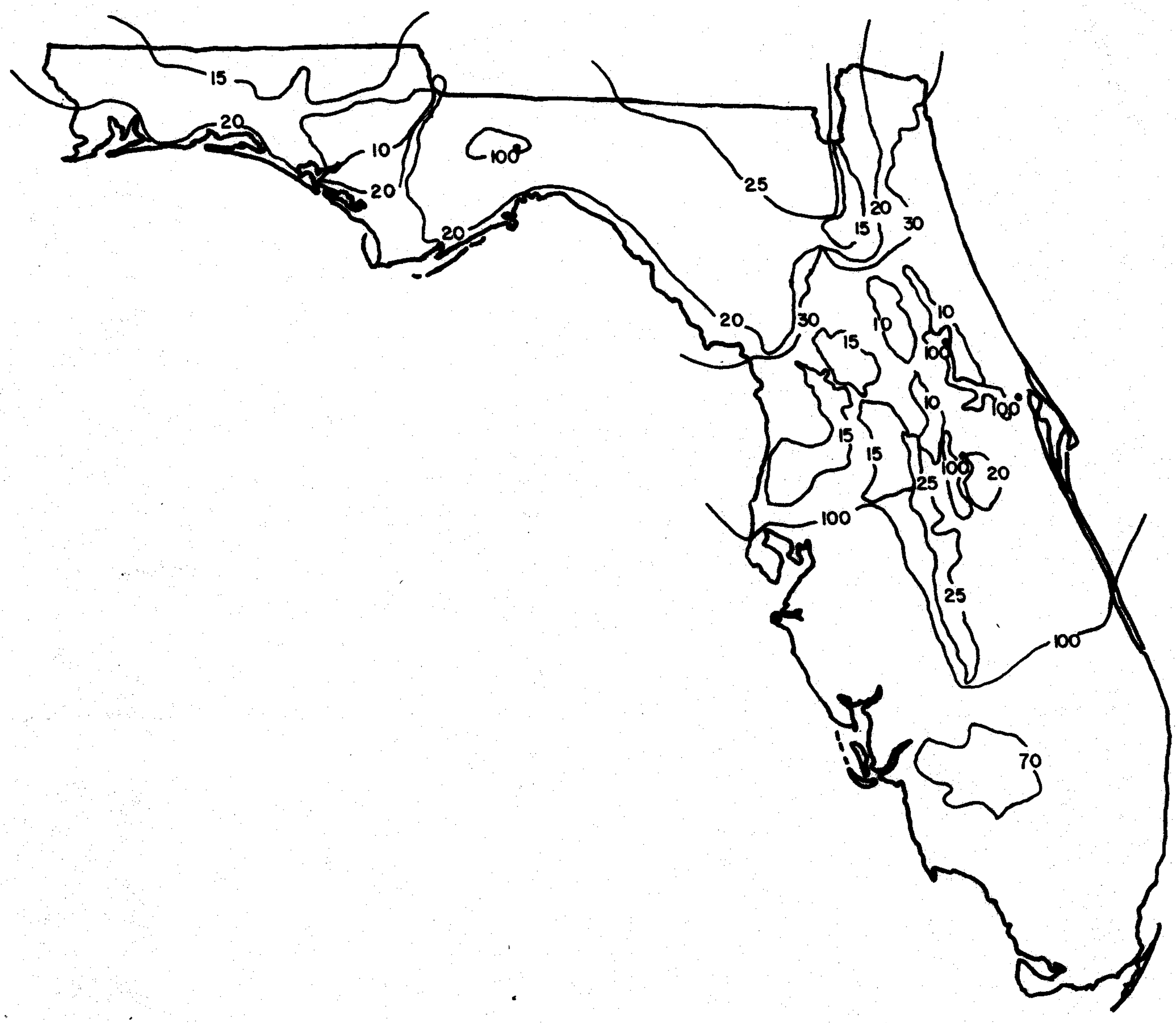

Figure 17. Distribution of lake total phosphorus concentrations (mg/m^3) in Florida. Isograms represent maximum values except where • occurs then isograms represent minimum values.

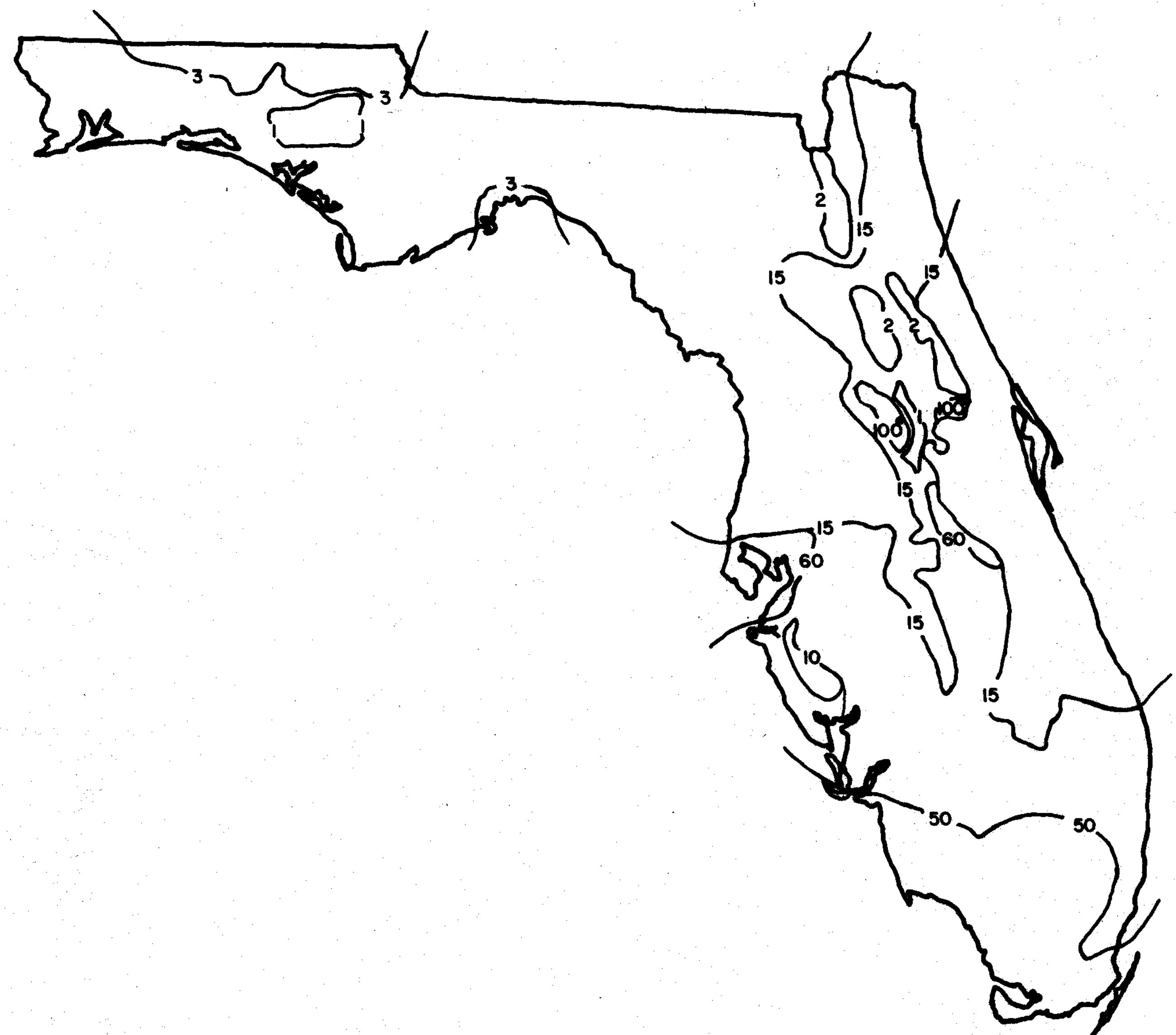

Figure 18. Distribution of lake chlorophyll a concentrations (mg/m^3) in Florida. Isograms represent maximum values except where ● occurs then isograms represent minimum values.

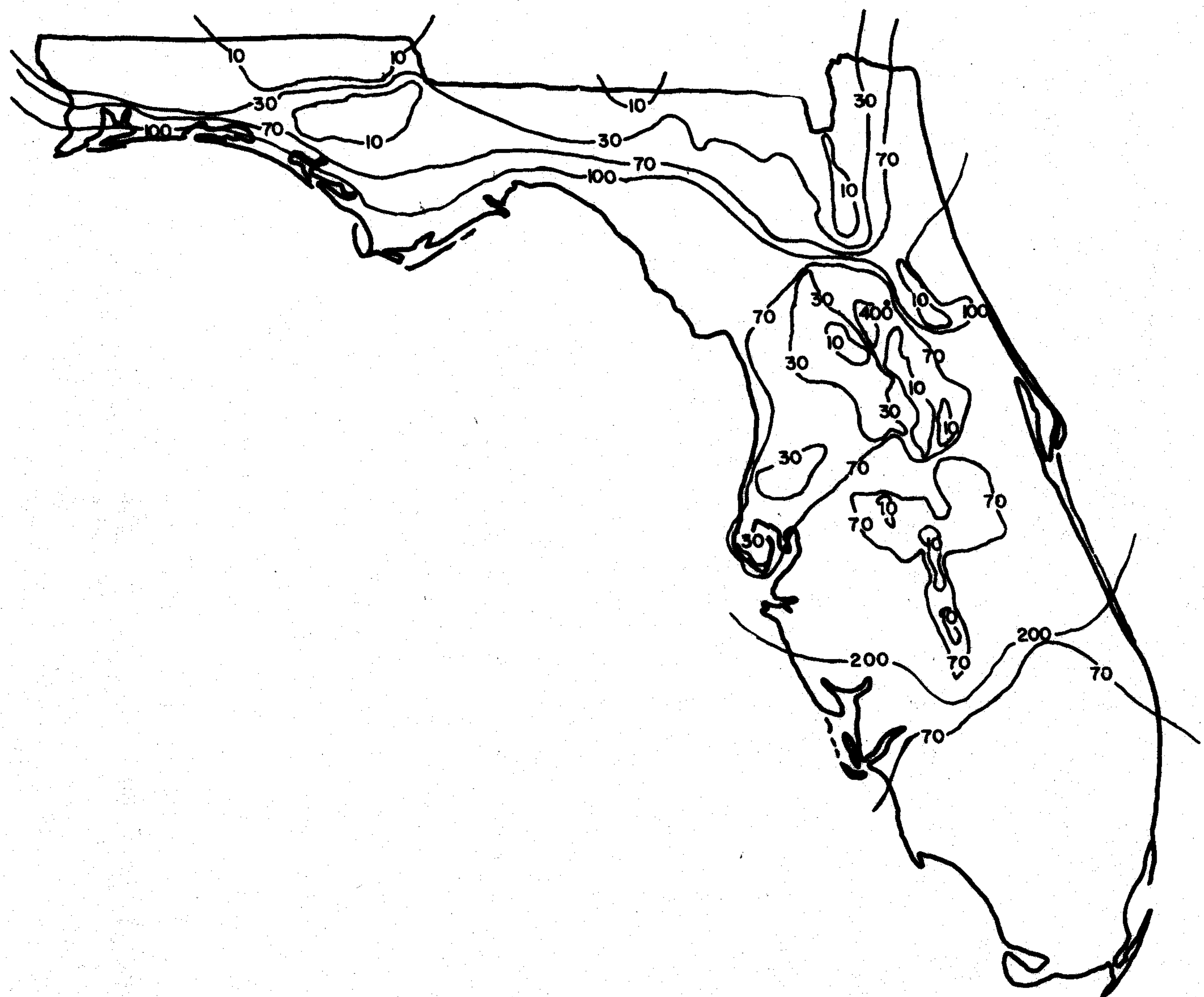

Figure 19. Distribution of lake color values (mg/l as Pt) in Florida. Isograms represent maximum values except where • occurs then isograms represent minimum values.

in the figures must be considered as approximate. There are, however, two noteworthy trends which probably will remain valid even after additional data become available. First, the physiographic region with the greatest variability in water quality is the Central Zone. This is because regional geology (Figure 3) and physiography are diverse. Second, with the exception of total iron concentrations (Figure 15) and water color (Figure 19), there is a general increase in pH values and chemical concentrations as one moves from northwest to southeast and from highland areas to lowland areas. The northwest to southeast gradient usually increases abruptly along the boundary between the Northern and Central physiographic zones. This corresponds to a change from the North Gulf Coast sedimentary province, which consists mainly of clastic sediments, to the Florida Peninsula sedimentary province, which consists mainly of carbonate, phosphate, and anhydrite sediments (Pressler 1947; Puri and Vernon 1964). Consequently, with the exception of select lakes located in remnant highlands of the Central Zone and barrier lagoon lakes of the Northern Zone, unpolluted lakes in the Northern Zone tend to have lower pH values, chemical concentrations and biological productivities than lakes in the Central and Southern physiographic zones. As can be seen from the distribution of total nitrogen concentrations (Figure 16), total phosphorus concentrations (Figure 17), and chlorophyll a concentrations (Figure 18), eutrophic conditions exist primarily in peninsular Florida.

2. Overall Water Quality: Table 84 summarizes the limnological data collected during this study. As can be seen from this table, a wide range of limnological conditions were encountered in Florida. Mean pH ranged from 4.1 to 9.2 and mean total alkalinity concentrations ranged

Table 84. Summary of average limnological data collected on Florida lakes between September 1979 and August 1980.

VARIABLE	MINIMUM	1ST QUARTILE	MEDIAN	3RD QUARTILE	MAXIMUM
pH	4.1	5.8	6.8	7.8	9.2
TOTAL ALKALINITY (mg/1 as $CaCO_3$)	0	3	10	35	204
PHENOL ALKALINITY (mg/1 as $CaCO_3$)	0	-	-	0	18
SPECIFIC CONDUCTANCE (µmhos/cm 25 C)	11	50	97	187	5600
TOTAL HARDNESS (mg/1 as $CaCO_3$)	2	12	25	63	730
CALCIUM HARDNESS (mg/1 as $CaCO_3$)	1	6.4	14	41	215
SODIUM (mg/1)	1	4.9	7.6	13	1200
POTASSIUM (mg/1)	0	0.3	1.3	3.2	51
CHLORIDE (mg/1)	1.7	7.0	14	22	2300
SULFATE (mg/1)	3.4	6.5	11	20	186

Table 84. (cont.).

VARIABLE	MINIMUM	1ST QUARTILE	MEDIAN	3RD QUARTILE	MAXIMUM
SILICA (mg/1)	0	0.3	0.9	2.4	12.6
TOTAL Fe (mg/m^3)	6.6	37	114	240	1200
TOTAL N (mg/m^3)	63.5	370	600	1100	4600
TOTAL P (mg/m^3)	3.4	13	20	46	834
TOTAL N / TOTAL P	1.7	17	26	37	98
CHLOROPHYLL *a* (mg/m^3)	0.5	2.8	5.7	17.4	157
COLOR (mg/1 as Pt)	0	10	30	68	416
Secchi (m)	0.1	0.7	1.3	2.6	8.1

from 0 to 204 mg/l as $CaCO_3$. Total hardness concentrations averaged between 2 and 730 mg/l as $CaCO_3$ and mean specific conductance ranged from 11 to 5600 µmhos/cm. Total nitrogen concentrations averaged between 63 and 4600 mg/m^3 and total phosphorus concentrations averaged between 3 and 834 mg/m^3. Mean chlorophyll a concentrations ranged from 0.5 to 157 mg/m^3 and mean water transparency ranged from 0.1 to 8.1 m. Lake trophic states ranged from ultra-oligotrophic to hyper-eutrophic. Shannon and Brezonik (1972) in their analysis of 55 north-central Florida lakes used cluster analysis to separate their lakes into four distinct groups: acid colored; alkaline colored; alkaline clear; and soft, slightly acid clear. Although these conditions existed in this study, cluster analysis did not separate the study lakes into similar distinct groups because a continuum of limnological conditions existed. Despite this variability, however, many Florida lakes are chemically and biologically similar.

As a group, Florida lakes can be characterized as soft-water lakes. Moyle (1945) suggested lakes having a total alkalinity concentration less than 40 mg/l as $CaCO_3$ and a total hardness concentration less than 75 mg/l as $CaCO_3$ be classified as soft-water lakes. Lakes having a total alkalinity less than 20 mg/l as $CaCO_3$ would be classified as very soft-water lakes. In Florida, over 75% of the lakes (Table 84) have total alkalinity concentrations below 40 mg/l as $CaCO_3$ and total hardness concentrations below 75 mg/l as $CaCO_3$. Close to 60% of the lakes have total alkalinity values below 20 mg/l as $CaCO_3$. The softness of the water in Florida lakes might seem surprising given the presence of large, limestone deposits in the State, but, as noted by Shannon and Brezonik (1972), few Florida lakes are spring-fed and most receive the bulk of their water directly from rainfall or surface/subsurface runoff which originates in sandy, non-calcareous soils. In addition, many Florida lakes have relatively high sulfate concentrations,which suggests mineral acidity may be an important factor reducing lake alkalinities.

Although soft-water lakes are often unproductive, Florida lakes are generally productive. Limnological research in other regions (Sakamoto 1966; Dillon and Rigler 1974; Jones and Bachmann 1976; Canfield 1979; Bachmann 1980) has shown strong correlations between total phosphorus and total nitrogen concentrations and algal biomass as measured by chlorophyll a concentrations. Generally, this research and whole-lake experiments (Schindler 1975) have suggested phosphorus is the element most likely limiting algal biomass. Therefore, to maintain oligotrophic conditions, phosphorus values must be kept below 10 mg P/m^3 (Table 4; Vollenweider 1968, 1976). In Florida, strong correlations between total nitrogen concentrations and chlorophyll a concentrations (Figure 20; $r = 0.85$) and total phosphorus concentrations and chlorophyll a concentrations (Figure 21; $r = 0.76$) were found. These relationships can be empirically described by:

$$\ln(\text{chlorophyll } \underline{a}) = -7.22 + 1.43 \ln(\text{Total N}) \quad (1)$$

and

$$\ln(\text{chlorophyll } \underline{a}) = -1.17 + 0.97 \ln(\text{Total P}) \quad (2)$$

Although there is a stronger correlation between total nitrogen concentrations and chlorophyll a concentrations, phosphorus is probably still the most important limiting element in Florida lakes. The ratio of N to P in aquatic plant material is approximately 7:1 (Vallentyne 1974). Over 75% of the lakes in this study had N/P ratios greater than

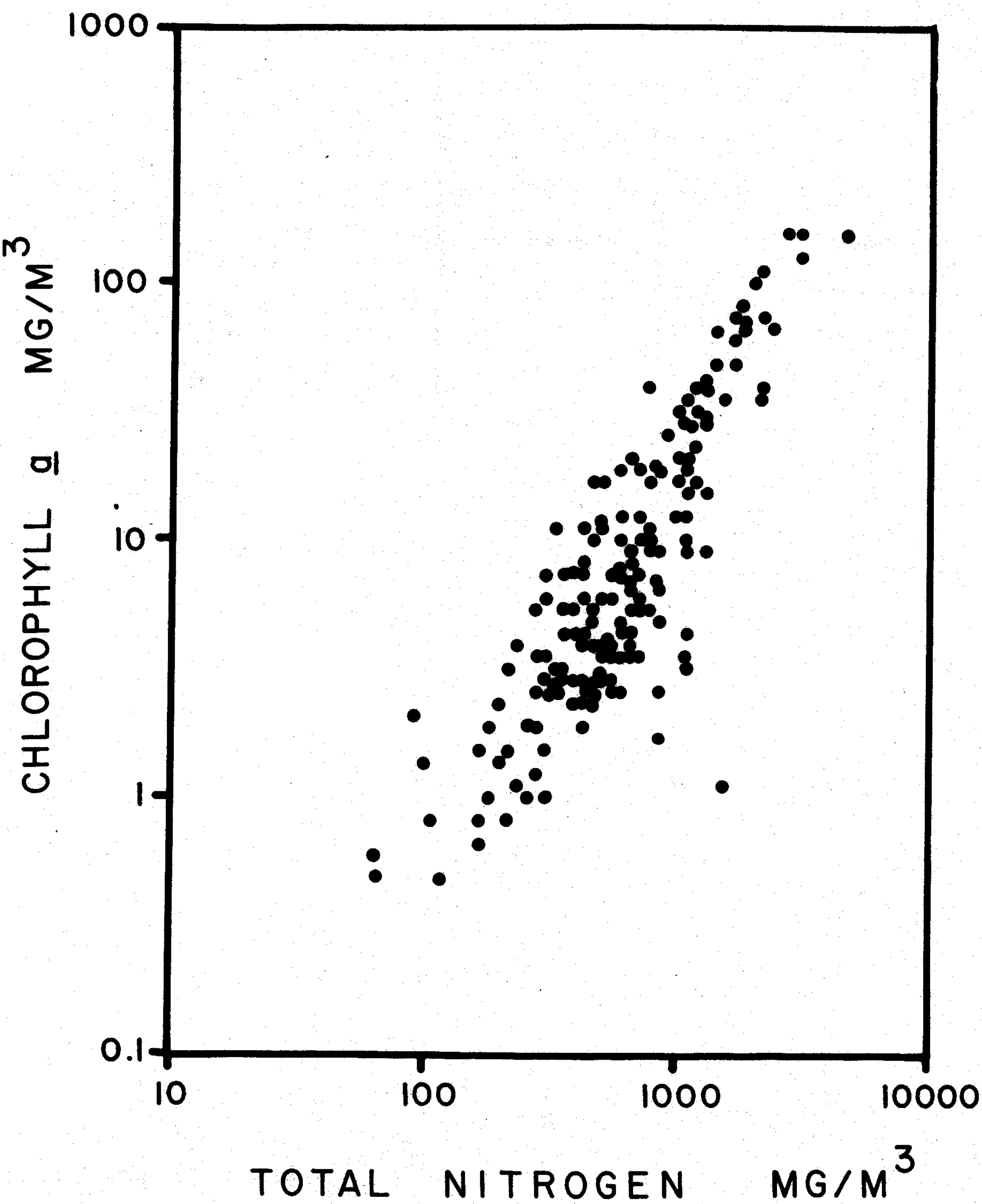

Figure 20. Relationship between chlorophyll a concentrations and total nitrogen concentrations in Florida lakes.

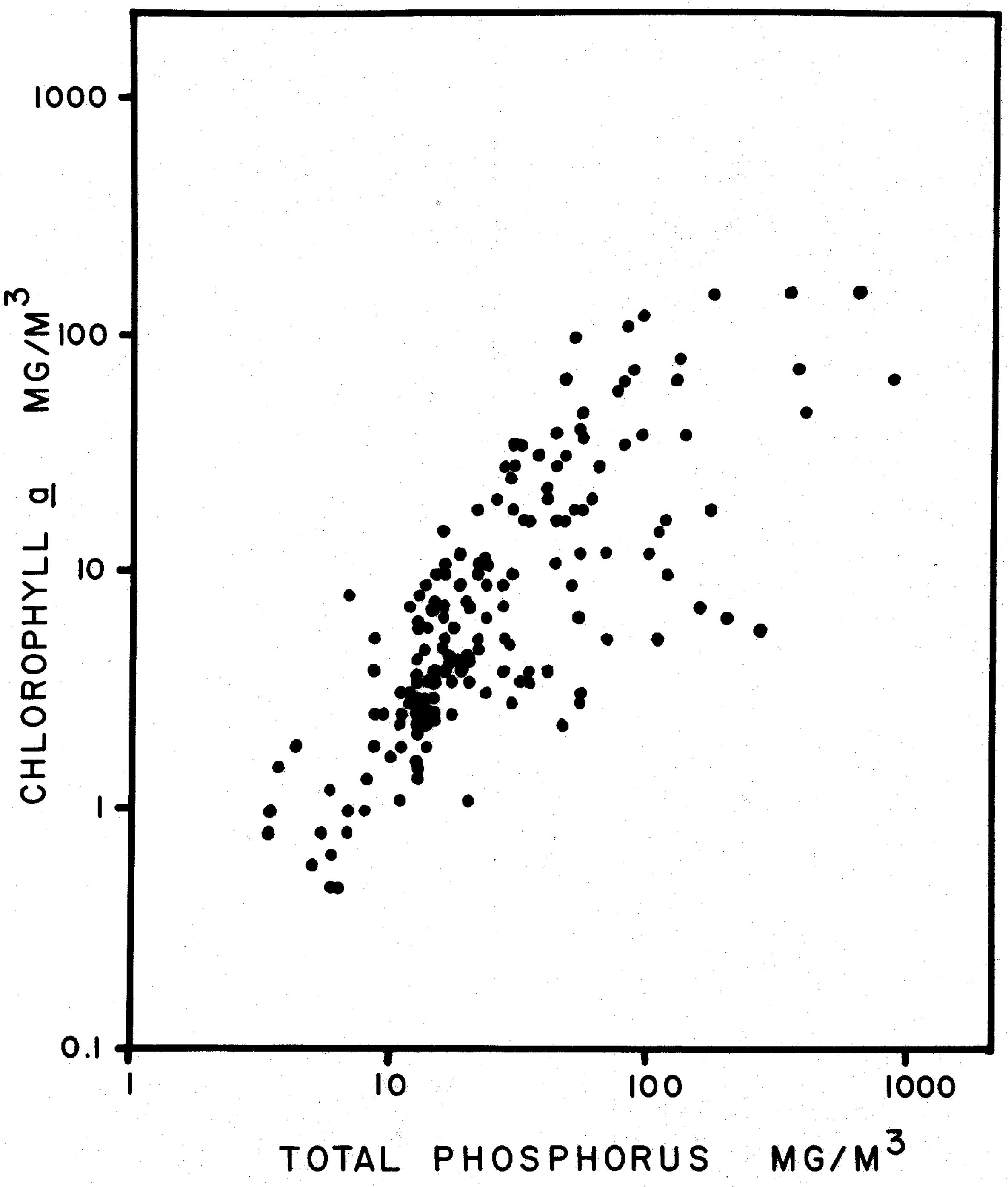

Figure 21. Relationship between chlorophyll a concentrations and total phosphorus concentrations in Florida lakes.

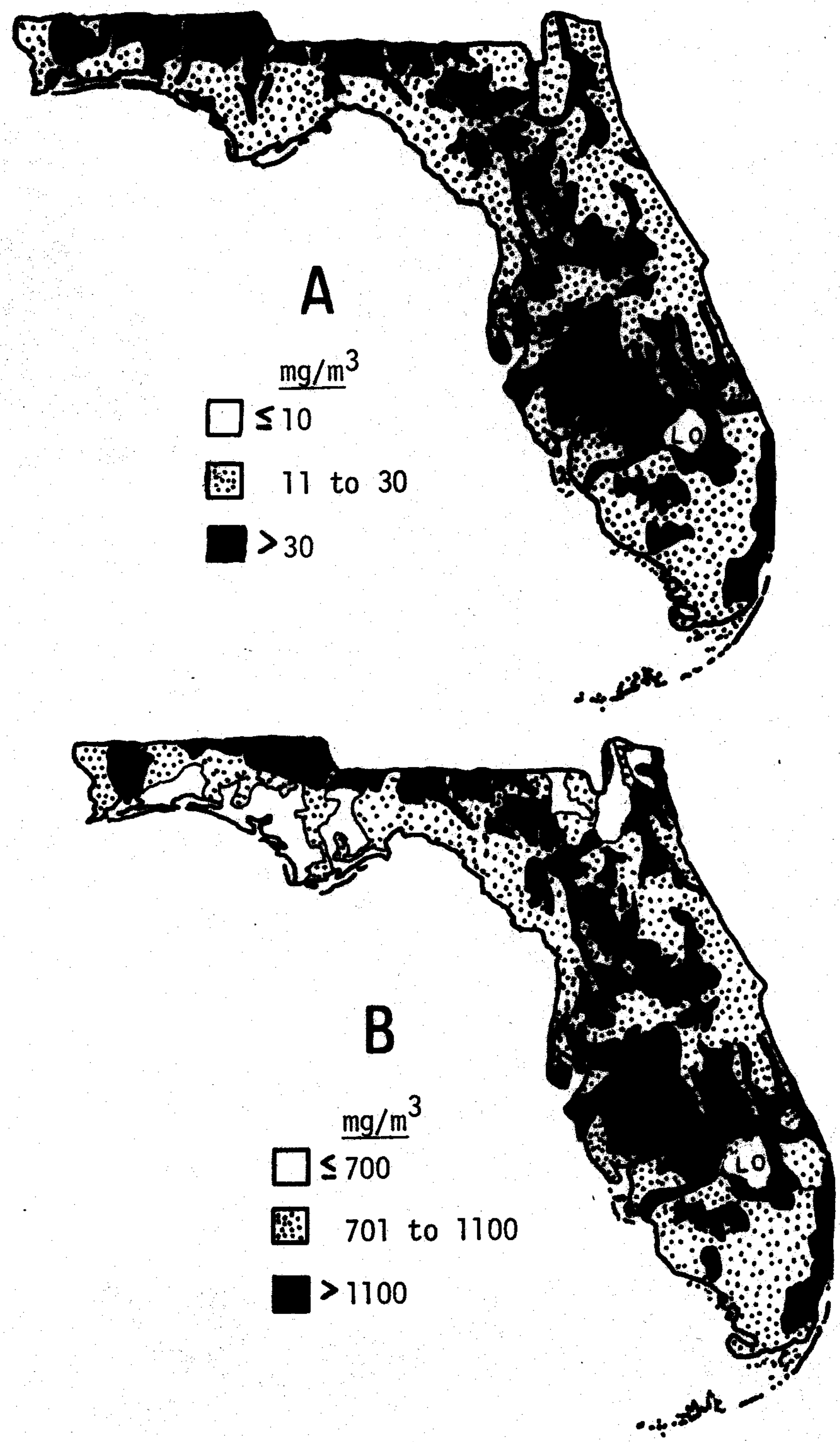

Figure 22. Generalized distribution of total phosphorus concentrations (A) and total nitrogen concentrations (B) in Florida streams. Modified from Omernik (1977). LO = Lake Okeechobee.

17:1 (Table 84). Only 7% had N/P ratios less than 7:1 which suggests nitrogen is present in nonlimiting amounts in most Florida lakes. Assuming that phosphorus is the limiting element and that a concentration less than 10 mg P/m^3 is needed to maintain oligotrophic conditions, over 75% of the sampled Florida lekes are either mesotrophic (42%) or eutrophic (35%). Only 13% of the sampled lakes are oligotrophic. The predominance of mesotrophic and eutrophic lakes, however, is not surprising because considerable quantities of phosphorus were deposited in Florida over geologic time. Consequently, most non-point source nutrient concentrations in Florida streams are sufficiently high to maintain Florida lakes in a natural mesotrophic or eutrophic condition (Figure 22).

High densities of planktonic algae resulting from high total phosphorus and total nitrogen concentrations constitute a major water quality problem in many Florida lakes. This is manifest in poor water transparency. Edmondson (1972) and Jones and Bachmann (1978) pointed out that there is a hyperbolic relationship between Secchi disc transparencies and chlorophyll a concentrations. Water clarity of lakes with chlorophyll a concentrations below 10 mg/m^3 are extremely sensitive to changes in algal abundance, whereas transparencies of lakes with chlorophyll a values above this value differ little. A similar hyperbolic relationship was also found for Florida lakes (Figure 23). This relationship can be empirically described by:

$$\ln(\text{Secchi}) = 1.29 - 0.5 \ln(\text{chlorophyll } a) \quad (3)$$

The correlation coefficient is -0.79 Because 65% of the Florida

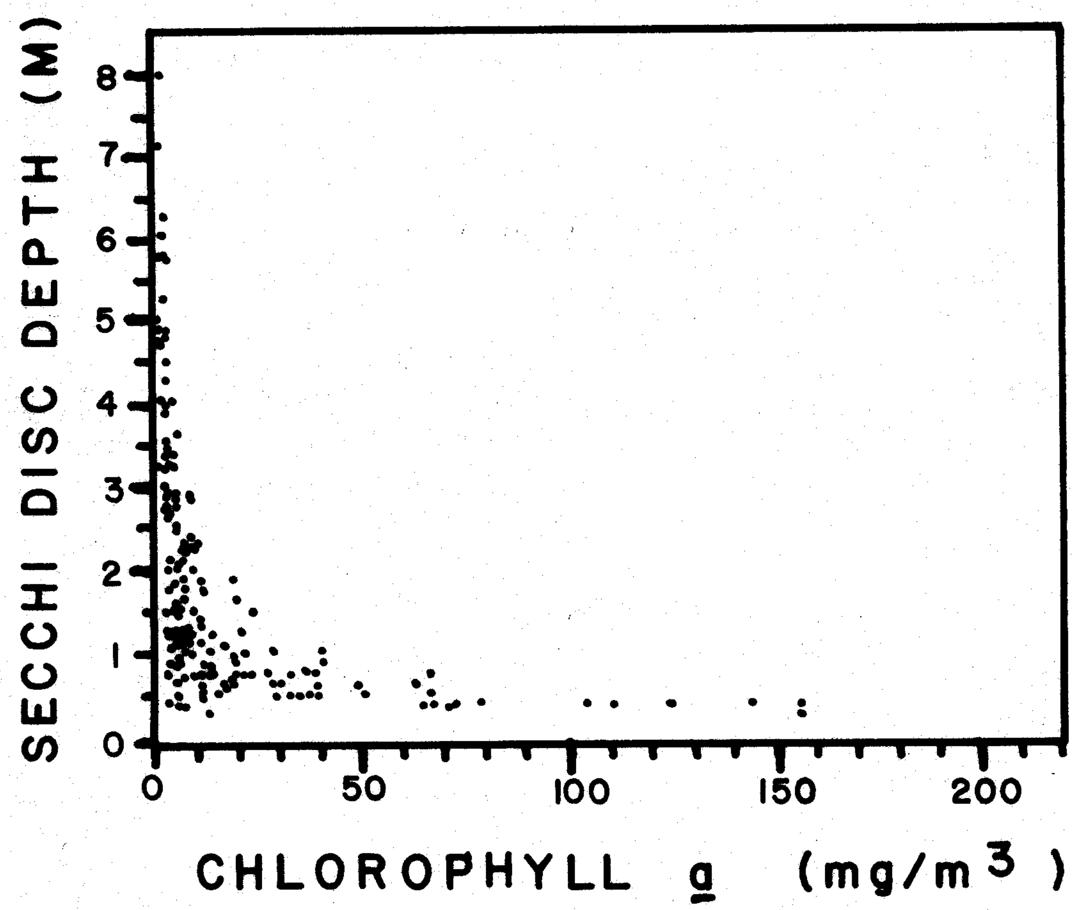

Figure 23. Relationship between Secchi disc transparency and chlorophyll a concentrations in Florida lakes.

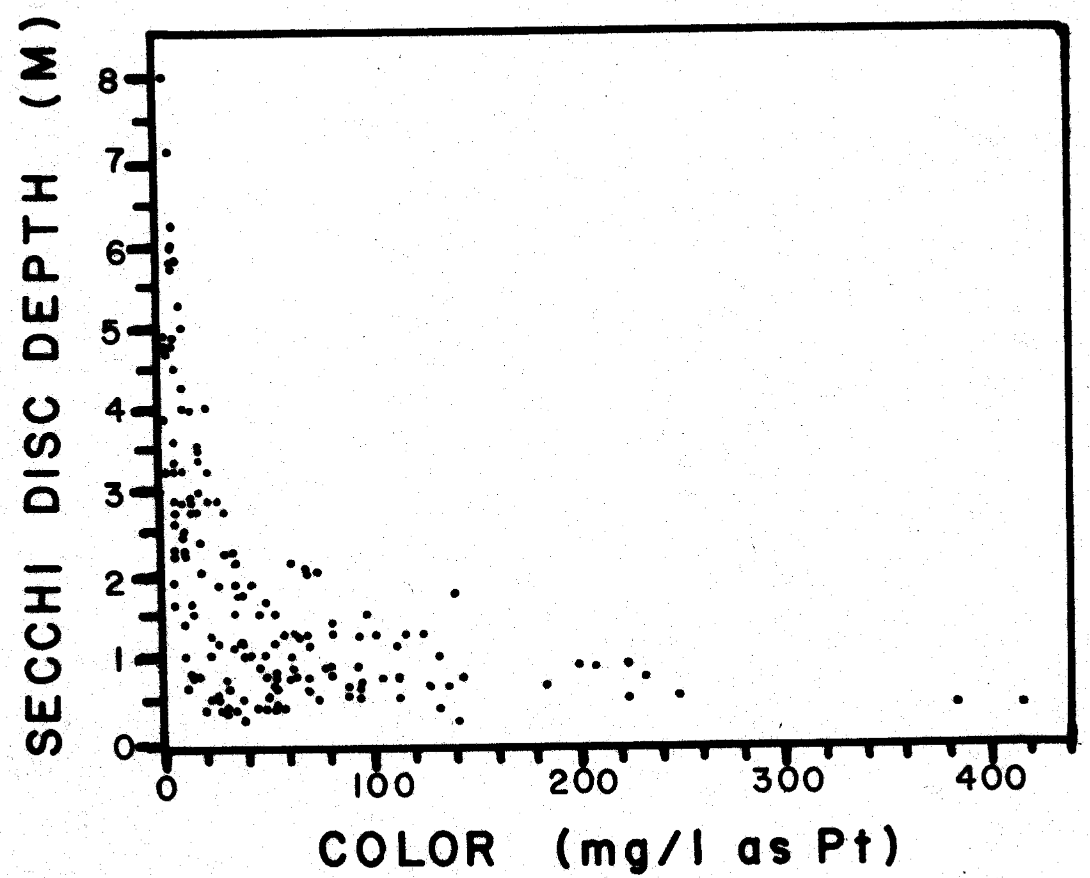

Figure 24. Relationship between Secchi disc transparency and water color in Florida lakes.

lakes (Table 84) have chlorophyll a concentrations below 10 mg/m^3, significant increases in nutrient inputs could greatly decrease water clarity in many lakes.

Water color can also affect lake transparencies. Over 75% of the sampled Florida lakes (Table 84) had color levels above 10 mg/l as Pt. Like the Secchi-chlorophyll a relationship, a hyperbolic relationship exists between Secchi disc transparencies and water color (Figure 24). This relationship can be empirically described by:

$$\ln (\text{Secchi}) + 1.63 - 0.41 \ln (\text{color}) \qquad (4)$$

The correlation coefficient is -0.67. As can be seen from Figure 24, water clarity in lakes with color values below 30 mg/l as Pt is extremely sensitive to color increases. Consequently, predictions of Secchi disc transparencies is best done by considering both color and chlorophyll a data. By use of multiple regression analysis, this relationship can be empirically described by:

$$\ln (\text{Secchi}) = 2.0 - 0.40 \ln (\text{chlorophyll } \underline{a}) - 0.28 \ln (\text{color}) \qquad (5)$$

The correlation coefficient is -0.89. There is no strong correlation between color and chlorophyll a concentrations ($r = 0.36$) thus color and chlorophyll a concentrations probably act independently in determining Secchi disc transparency.

CONCLUSIONS

A wide range of limnological conditions occur in Florida. However, similar to the findings of other regional limnology studies (Naumann 1932; Deevey 1940; Moyle 1954; Bachmann 1965; Jones and Bachmann 1978), there is a strong relationship between the mineral composition of Florida's freshwater lakes and surface geology and physiography. For example, in the northern Central Valley of Florida, there are major deposits of the phosphatic Hawthorn Formation. Consequently, lakes such as Lochloosa Lake, Orange Lake, Newnans Lake, and Lake Wauberg are naturally eutrophic. In contrast, lakes located on the Greenhead Slope and New Hope Ridge lie in nutrient-poor sandy soils and are naturally oligotrophic. For this reason, edaphic factors must be strongly considered when developing management plans for Florida's lakes. Information from this regional limnology study should provide a basis for understanding the general limnological capabilities and potentials of Florida lakes.

Concern over the impact of cultural eutrophication has increased greatly over the past two decades. In response to this concern, research was conducted to determine the factors influencing lake productivity. Limnological research on north-temperate lakes demonstrated a strong relationship between nutrient concentrations, especially total phosphorus concentrations, and algal biomass as measured by chlorophyll _a_ concentrations (Sakamoto 1966; Dillon and Rigler 1974; Jones and Bachmann 1976; Canfield 1979). This suggested phosphorus was the element most likely limiting algal biomass. Because subsequent research confirmed this hypothesis and demonstrated that phosphorus loading rates greatly influence lake phosphorus concentrations (Vollenweider 1968, 1969, 1976; Schindler 1975; Jones and Bachmann 1976), a number of simple empirical phosphorus loading models were developed. These models predict lake total phosphorus concentrations given basic information on lake mean depth, hydraulic flushing rates and annual phosphorus loading rates (Chapra 1975; Jones and Bachmann 1976; Larsen and Mercier 1976; Canfield 1979; Canfield and Bachmann 1981). By using these empirical models in conjunction with the empirical models developed for the total phosphorus-chlorophyll a relationship and the water transparency-chlorophyll a relationship (Jones and Bachmann 1976), lake managers could, for the first time, quantitatively assess the impact of increasing or reducing plant nutrient loadings, especially phosphorus loadings, on lakes.

Similar relationships between total phosphorus concentrations and chlorophyll a concentrations and between water transparency and chlorophyll a concentrations were found for the Florida lakes during this study. This and data from Canfield (1979) strongly suggest that, while Florida Lakes are basically subtropical lakes, empirical relationships developed for north-temperate lakes can be used equally well in Florida. However, the use of these relationships, particularly the simple empirical phosphorus loading models, is greatly hindered by a lack of requisite data. Plant nutrient losses from Florida soils under natural conditions are virtually unknown. Other than the work of Kenner (1964), which provided bathymetric maps for 76 lakes, and that of a few others, good bathymetric maps and other morphometric data for Florida lakes is lacking. Consequently, hydraulic flushing rates under different climatic conditions are virtually unknown. Lake mapping projects, should be initiated as soon as possible to obtain this data, as Florida's lake managers are currently unable to use effectively some very valuable management tools.

Although excessive algal growths and reductions in water clarity are easily seen by the general public, good management of lakes requires a consideration of the impact of nutrient increases or reductions on factors that are not readily seen by the general public. For example, the impact of changing nutrient inputs on aquatic macrophyte and fish populations must be considered. To date, there is very little information on these relationships. Moyle (1954) showed a relationship between size and structure of fish populations and total phosphorus concentrations in Minnesota lakes. Recently, Kautz (1980), by using data from 22 Florida lakes, suggested sport-fish biomass and densities suffered adverse effects when chlorophyll a concentrations exceeded 11 mg/m^3. Since over 35% of Florida's lakes exceed this value and many, like Orange Lake, Lochloosa Lake and Newnans Lake, still maintain good fish populations, the validity of the 11 mg/m^3 value must be questioned. However, the approach taken by Kautz (1981) is generally correct and should be expanded to include a much greater number of lakes. Lakes ranging from ultra-oligotrophic to hyper-eutrophic should be selected for study. In addition, within each trophic state category, lakes ranging from plankton algae-dominated to aquatic macrophyte-dominated, should be selected for study. From this type of study, the impact of plant nutrient concentrations on algae, aquatic macrophytes and fish, as well as interactions among these variables, could be determined. This major research is needed in Florida as well as nationally. Without this type of information, the practical management of lakes is hindered.

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