UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

EFFECTS OF MINERALIZED ARTESIAN WATER ON THE FRESH-WATER BIOTA OF TAYLOR SLOUGH, EVERGLADES NATIONAL PARK, FLORIDA

By

Milton C. Kolipinski and Aaron L. Higer

OPEN-FILE REPORT

Prepared by the
U.S. GEOLOGICAL SURVEY
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Tallahassee, Florida

July 1969


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ABSTRACT

The feasibility of using water from the Floridan aquifer during periods of drought to maintain water levels in the aquatic communities at the Royal Palm Visitor Center in Everglades National Park was tested.

The Royal Palm test well, 1,333 feet deep, yielded a maximum of about 2.3 million gallons per day from the Floridan aquifer. The water from this well has a higher chloride and dissolved solids content than that from other artesian wells in southern Florida. The Royal Palm well artesian water contained an average concentration of 2,835 mg/l chloride and 5,460 mg/l dissolved solids, based on four analyses. Surface water in Taylor Slough near the visitor center contained concentrations of chloride and dissolved solids of only 15 mg/l and 190 mg/l, respectively.

If full-strength water from the Floridan aquifer were introduced to the aquatic communities of the Royal Palm area more than half of the plant species would probably perish. Animals apparently would adapt to the mineralized water, at least for short periods, but reproduction in some species may be inhibited.

The water from the Floridan aquifer in southern Florida is generally unsuitable as a life medium for fresh-water plants or animals.

INTRODUCTION

The Royal Palm Visitor Center on the western edge of Taylor Slough is a prime attraction in Everglades National Park. It is surrounded by alligator holes, marshes, wet prairies, willow heads, and a tropical hardwood hammock. Many types of invertebrates, fishes, amphibians, reptiles, birds, and mammals inhabit the area. The center is about 37 miles southeast of Miami, Fla. (fig. 1).

Figure 1. Belongs near here. Caption on next page.

The Royal Palm area has been of interest for many years because of its natural beauty. Historically, the State of Florida dedicated Paradise Key (fig. 2) together with the

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adjacent marshland as a public park in 1915 (Safford, 1919). Until 1947, when it was incorporated into Everglades National Park, the tract was named Royal Palm State Park.

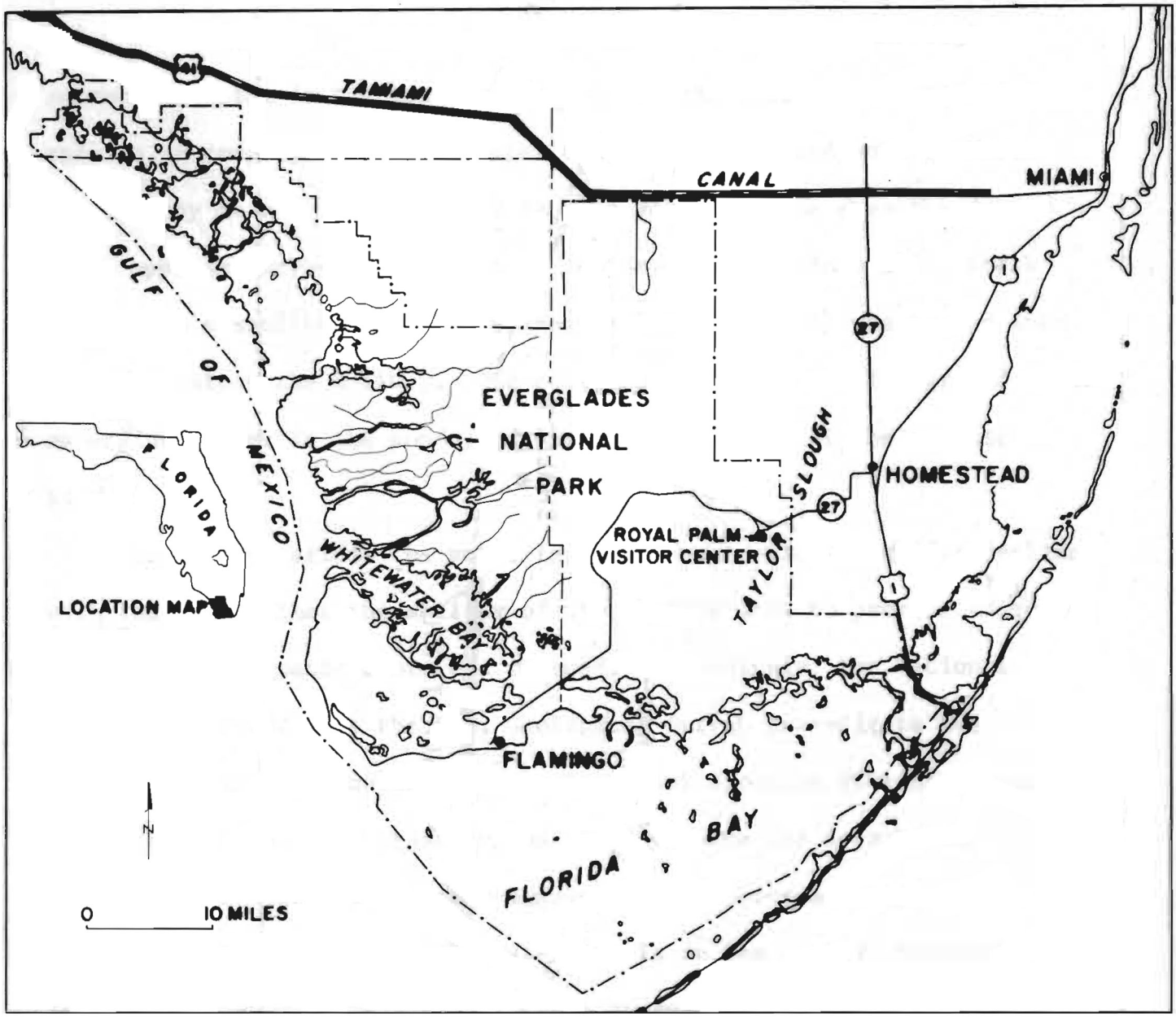


Figure 1.--Map of southern Florida showing location of Taylor Slough and the Royal Palm Visitor Center.

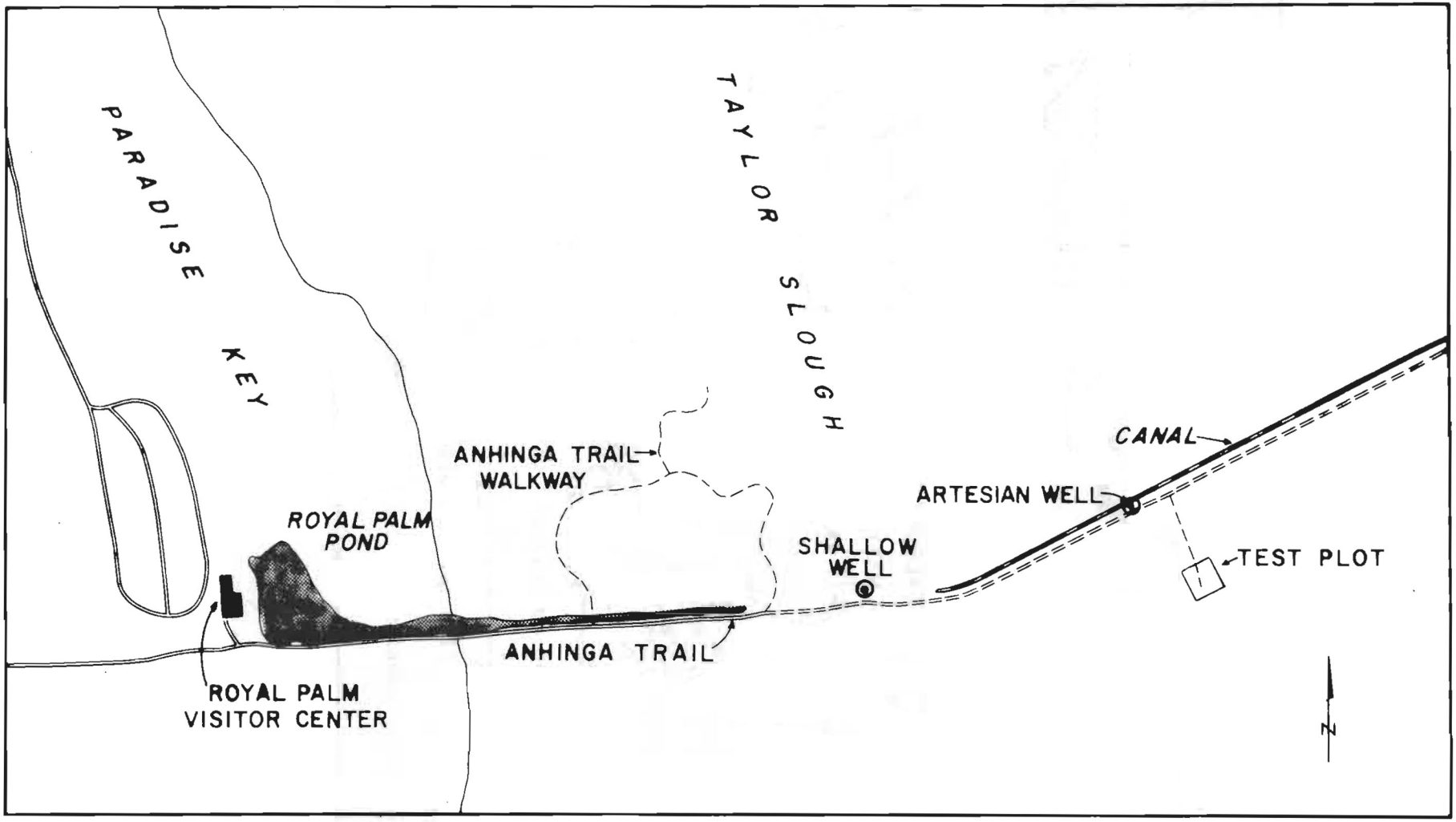


Figure 2.--Royal Palm Visitor Center and vicinity, showing location of artesian well and test site in Everglades National Park. The artesian well was drilled east of the ponds in the visitor area.

During the rainy season, June through October, plant and animal productivity in the aquatic communities near the Center is at a maximum. Water levels normally remain high through December, and then begin a seasonal decline in the marshes and wet prairies causing the aquatic animals to congregate in the deeper alligator holes and ponds. March through May is a critical period in some years because even the deeper ponds approach dryness. In most of the dry periods since 1960, fresh water from a shallow well at the Anhinga Trail (fig. 2) was pumped into the ponds along the walkway. The addition of pumped shallow ground water maintained water in the ponds and permitted survival of the aquatic biota.

During dry periods the water level in the surficial aquifer declines with the result that the ability of the shallow well to provide adequate water for the aquatic biota was reduced. Accordingly, the National Park Service requested that the U.S. Geological Survey investigate the characteristics of mineralized artesian water from the Floridan aquifer in south Florida. The objective was to determine the feasibility of using the Floridan aquifer as a supplementary source of water during periods of drought to maintain water levels in the aquatic communities at the Royal Palm Visitor Center. The approaches were:

(1) To compare the quality of the mineralized water from the Floridan aquifer with the fresh water in Taylor Slough at the Royal Palm Visitor Center.

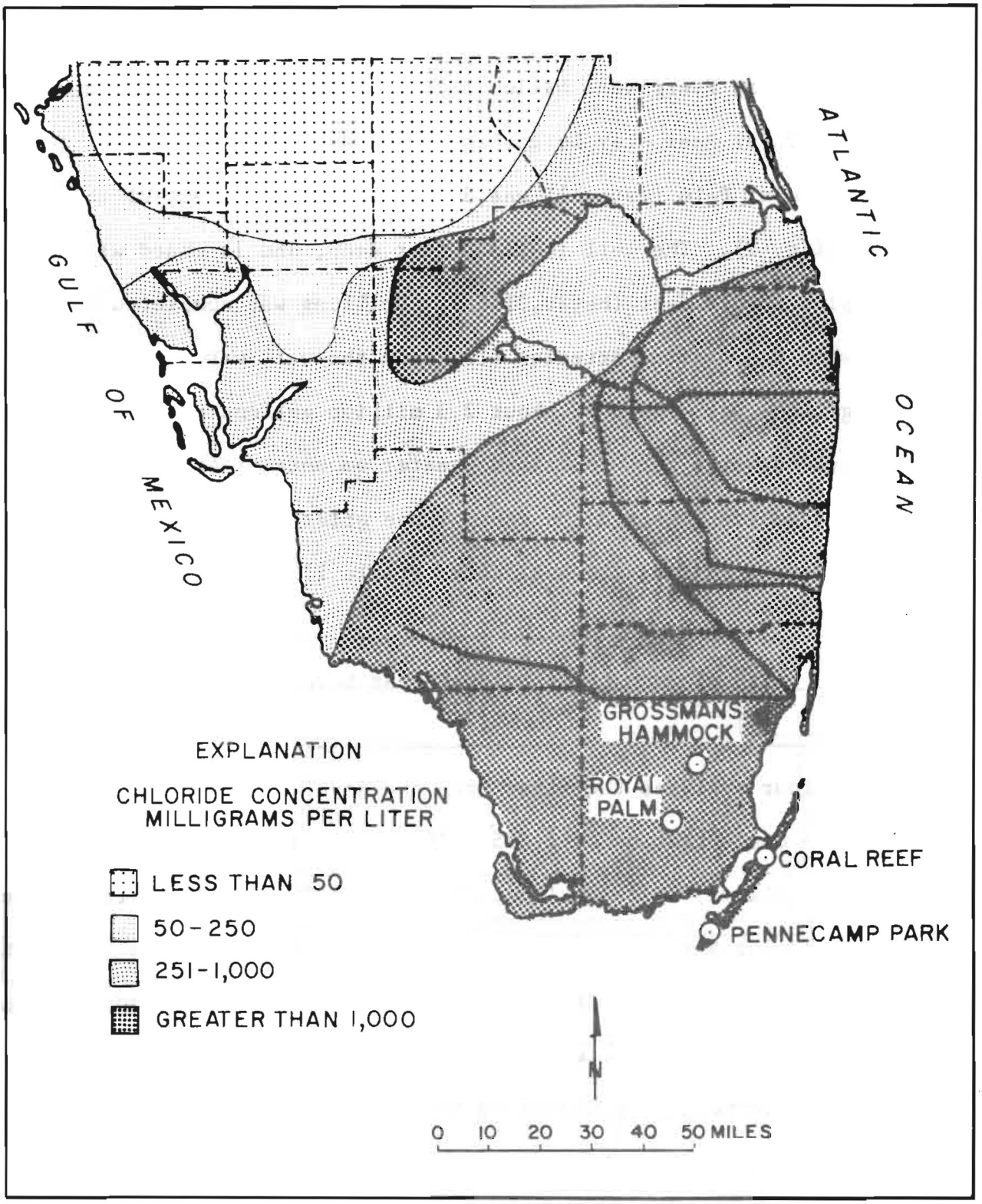
(2) To ascertain whether the artesian water will have deleterious effects on the indigenous plants and animals.

SOURCE OF MINERALIZED WATER

The Floridan aquifer underlies all of Florida. Water in the aquifer contains small amounts of chloride in most of the state but in the south and along most of the east coast it contains large amounts of chloride (Shampine, 1965). In south Florida the Floridan aquifer is overlain by about 600 feet of materials of low permeability that confine the water in the aquifer.

In southwestern and southern Florida the water from the Floridan aquifer contains large amounts of calcium sulfate which apparently is derived from gypsum or anhydrite in the aquifer (Stringfield, 1966). Two schools of thought exist on the source of the saline water in the aquifer. According to Stringfield the artesian water in southern Florida and some of the coastal areas is a mixture of fresh water with remnants of sea water that have not been flushed from the aquifer. On the other hand, Kohout (1967) proposed that cold, dense sea water flows inland through the cavernous dolomite in the deep part of the aquifer, where it becomes progressively warmed by upward geothermal heat flow. The resulting reduction in density produces an upward convective circulation that brings the sea water into contact with the fresher water moving southward through the aquifer from the recharge area in central Florida. In either case the water of the Floridan aquifer has the characteristics of diluted sea water which increases in chloride content southward (fig. 3).

Figure 3. Belongs near here. Caption on next page.



(Adapted from Shampine, 1965)

Figure 3.--Map of southern Florida showing chloride concentration in water from the upper part of the Floridan aquifer and the location of artesian wells in southeast Florida.

The chemical quality of waters from the Floridan aquifer has been determined at the following locations in south Florida: Royal Palm Visitor Center, Everglades National Park; Grossman's Hammock, southwest of Miami; Coral Reef, Key Largo; and Pennekamp Park, Key Largo (fig. 3).

The Royal Palm test well was drilled 2,000 feet east of the Visitor Center (fig. 2). The well is 1,333 feet deep, and is cased with 8-inch steel pipe to 620 feet (Meyer, 1966). Drilling was completed July 7, 1965, when the maximum artesian flow from the well was determined to be 1,570 gallons per minute or about 2.3 million gallons per day. This well yielded water that contained greater amounts of chloride and dissolved solids than did the other three artesian wells in southeast Florida for which data are available (table 1).

Table 1. Pg. of manuscript belongs near here.

Based on four analyses the water from the Royal Palm well contained an average concentration of 2,835 mg/l of chloride and 5,460 mg/l of dissolved solids. By comparison, analyses of 30 samples of the surface water at Taylor Slough near the visitor center indicated that the median values for chloride and dissolved solids were only 15 mg/l and 190 mg/l, respectively. Magnesium, sodium, potassium, and sulfate were also many orders of magnitude higher in the artesian water than they were in the fresh, surface water of the slough as indicated in Figure 4.

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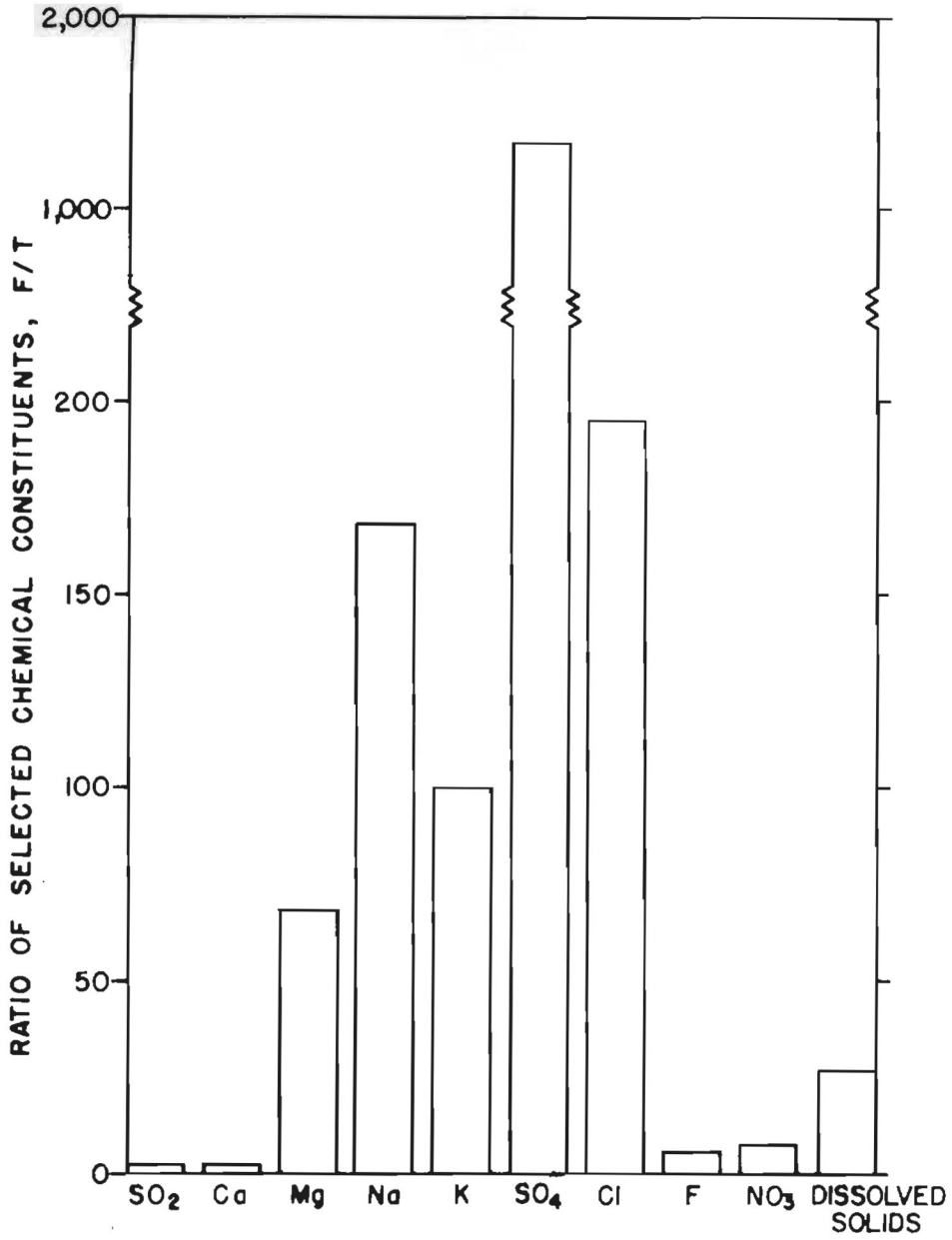

Median Values, milligrams per liter

Chemical Constituents	Taylor (T) Slough	Royal Palm (F) Artesian Well
Silica (SiO_2)	3.8	10.5
Iron (Fe)	.01	.03
Calcium (Ca)	58	158
Magnesium (Mg)	2.7	182
Sodium (Na)	9.0	1,560
Potassium (K)	.6	61
Sulfate (SO)	.4	500
Chloride (Cl)	15	2,835
Fluoride (F)	.2	1.2
Nitrate (NO_3)	.4	3.5
Phosphate (PO_4)	.02	.00
Dissolved solids	190	5,460
Specific conductance	308	9,650
Color	10	1.2

Figure 4.--A comparison of chemical constituents between the water in the Floridan aquifer and the surface water at Taylor Slough. Bars represent the ratio of selected chemical constituents that were of larger magnitude in the aquifer (F) than in the surface water (T).

Table 1.--Concentrations of selected water-quality constituents of water from the Floridan aquifer in southeast Florida.

Artesian well name and number	Sampling period	Depth of well (feet)	Range, milligrams per liter			
			Chloride	Sulfate	Nitrate	Dissolved solids
Royal Palm (NP 100)	1965-67	1,333	2620-3040	492-516	3.3-4.9	5160-5760
Pennekamp Park (G 1273)	1965-67	1,333	2150-2450	470-522	0.3-3.5	4430-4950
Grossman's Hammock (S 524)	1964	1,200	1280	490	2.2	3110
Coral Reef (S 1447)	1965-67	1,074	2250-2440	500-556	0.3-3.4	4530-4940
Average value for southeast Florida (18 samples)			2370	509	2.0	4680

METHODS OF INVESTIGATION

Studies were conducted both in the field and in the laboratory to determine the tolerance to mineralized water of selected aquatic plants and animals that are indigenous to the area at the Royal Palm Visitor Center.

A test site 100 feet square was established near the Royal Palm artesian well (fig. 5) for the purpose of observing the effects that

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Figure 5. Belongs near here. Caption on next page.

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the mineralized water would have on the indigenous plants. The organisms in this part of Taylor Slough normally live in fresh-water environments but some are capable of adapting to brackish conditions. Many of the plants in the test site are common to the communities in the adjacent visitor center.

Five plots, each 39.4 inches (one meter) square (fig. 5), within the test site were selected to monitor the effects of artesian water on established communities. The plants (table 2) in each plot were

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identified and counted on the following days:

(1) On December 13, 1965, two weeks before the study plot was inundated by artesian water.

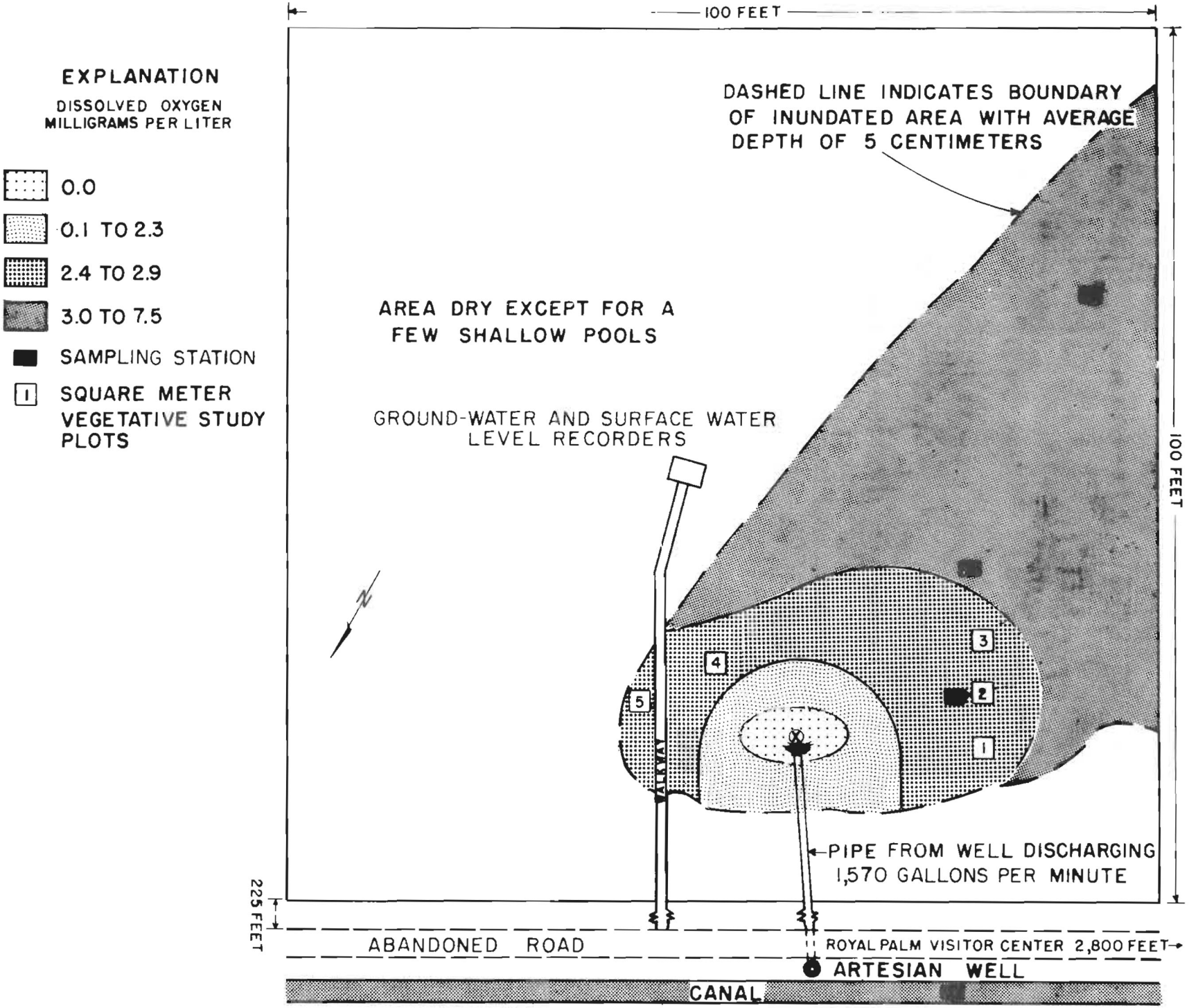

Figure 5.--Map of test area showing location of study plots.

Table 2. Common aquatic and semi-aquatic plants of Taylor Slough* (only the higher plant forms are listed)

DISTRIBUTION		
100 FOOT SQUARE TEST AREA IN TAYLOR SLOUGH (Uncommon in aquatic communities at Royal Palm Visitor Center)	AQUATIC COMMUNITIES AT ROYAL PALM VISITOR CENTER (Uncommon in 100 foot square test area in Taylor Slough)	COMMONLY FOUND AT BOTH
Andropogen sp.	Annona glabra	Cyperus sp.
Aster tracyi	Cephalantus oxidentalis	Eleocharis cellulosa
Bacopa caroliniana	Ceratophyllum demersum	Ficus aurea
Centella sp.	Chrysobalanus icaco	Mariscus jamaicensis
Crinum americanum	Nymphaea flava	Panicum condensum
Erianthus giganteus	Persea borbonia	Panicum hemitomon
Eupatorium leptophyllum	Phragmites sp.	Panicum sp.
Muhlenbergia capillaris	Polygonum sp.	Paspalum distichum
Oxypolis filiformis	Scirpus sp.	Pontederia lanceolata
Pluchea foetidae	Utricularia spp.	Sagittaria lancifolia
Rhynchospora corniculata		Salix amphibia
Rhynchospora tracyi		Taxodium distichum
Setaria sp.		

* The authors extend thanks to Dr. Frank Craighead, Sr. for assisting in the identification of these plants.

(2) On April 14, 1966, while artesian water was still flowing on the plot (fig. 6);

Figure 6. Belongs near here. Caption on next page.

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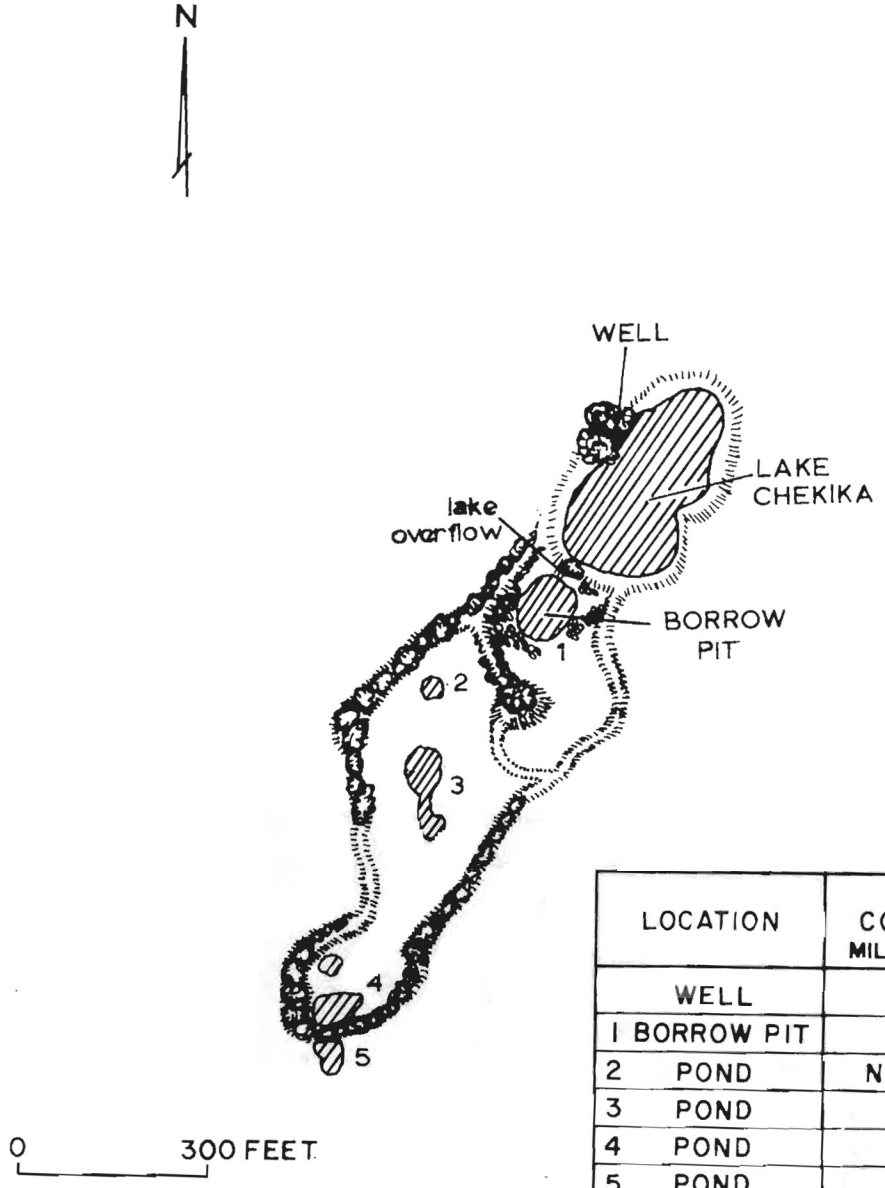
(3) On May 28, 1967, approximately three months after the flow of artesian water on the plot was discontinued.

Tolerances of common fishes and aquatic invertebrates to the artesian water were determined from aquarium studies in the laboratory and from field observations at Grossman's Hammock, the site of an artesian well about 15 miles north of the Royal Palm Visitor Center (fig. 3). The water from this well contains about 50 percent less chloride than the water from the Royal Palm well (table 1). At Grossman's Hammock, water flows from the well into Lake Chekika, and then overflows to a borrow pit and a series of shallow ponds (fig. 7).

Figure 7. Belongs near here. Caption on next page.

The Grossman's Hammock area is within the fresh-water Everglades, and the fresh water dilutes the artesian water from the flowing well. Dilution of the chloride concentration is especially noticeable in pond no. 5, which is the farthest removed from the well.

Figure 6.--Water from the Floridan aquifer discharging on the test area in Taylor Slough. The white region near the pipe orifice is a filamentous bacterium that uses hydrogen sulfide from the artesian water.



LOCATION	CHLORIDE CONCENTRATION MILLIGRAMS PER LITER
WELL	1280
1 BORROW PIT	1230
2 POND	NOT MEASURED
3 POND	1050
4 POND	1110
5 POND	510

(From Rodney Grantham, U.S. Geological Survey, written communication)

Figure 7.--Artesian well near Grossman's Hammock. The water flows into Lake Chekika, spilling over into a borrow pit and series of ponds.

Animals were collected on February 13, 1964 by pulling a trawl through ponds 1, 3, and 4 that had chloride concentrations of 1230, 1050, and 1110 mg/l respectively. The trawl, with a 1/8-inch mesh size, was probably effective in capturing most of the species of macroscopic aquatic animals in the sampled ponds. It was assumed that the environment in these ponds would be similar to what could be expected in the Royal Palm aquatic communities, if fresh water from the shallow limestone aquifer were mixed with the artesian water. If the method proved feasible, the blended water could be used to maintain ponds for the survival of the aquatic communities during unusually dry periods.

Several species of fresh-water fishes and other aquatic animals from Taylor Slough were placed in laboratory aquaria containing water from the Royal Palm artesian well for 48-hour periods to determine whether these animals could survive in the mineralized water without the benefit of gradual adaptation.

EFFECTS OF ARTESIAN WATER ON BIOTA OF TAYLOR SLOUGH

Field Investigations

The aquatic fauna and flora in the Royal Palm area consist of a heterogeneous assemblage in terms of physiological tolerance to saline or mineralized waters. Some organisms require fresh water, many tolerate brackish conditions,and a few can tolerate marine conditions. The most common members of the assemblage are planktonic organisms, rushes, sedges, grasses, trees that become partially inundated, molluscs, insects, crustaceans, fishes, amphibians,and reptiles. It is important to include all levels of the food chain, when considering the effects that water of relatively high osmotic pressure will have on the inhabitants of an aquatic community. The scope of the field and laboratory studies in this investigation was limited to the common macroscopic plants and animals that inhabit the Royal Palm area.

Of the 25 common plant species within the 100-foot square test area (table 2) six were definitely affected by inundation with the artesian water (table 3). The foliage, stems, and, apparently, the roots of

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these aquatic plants were killed, probably by the increased osmotic pressure of the mineralized water. The extent of the destruction is shown by the photograph in figure 8.

Figure 8. Belongs near here. Caption on next page.

The maximum tolerable chloride content in water for many of the plants that inhabit the communities in the Royal Palm Visitor Area are compiled from Chamberlain (1960) and others in table 4. Based on

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these data most of the common aquatic species in the visitor area would be adversely affected by inundation with artesian water. The following plants would either probably or certainly be killed by full-strength artesian water: Najas sp., Nuphar advena, Panicum hemitomon, Pontederia cordata, Sagittaria lancifolia, and Utricularia spp.

Table 3.--Aquatic plants damaged by artesian water in test plots near Royal Palm Visitor Center.

Plants	Number of plants present in the five square-meter plots (chloride content of water in the test plot, mg/1)		
	Pre-flow 1/ conditions (< 20 mg/1)	During 2/ flow conditions (Range: 2,775 to 2,975 mg/1)	Post-flow 3/ conditions
Sagittaria lancifolia	30	19	0
Panicum condensum	10	0	0
Lippia stoechadifolia	101	0	0
Paspalum notatum	10	0	0
Panicum sp.	13	1	1
Bacopa caroliniana	25	0	0

Note: Flow of the artesian water on the 100-foot square plot began December 28, 1965 and continued until February 1967.

1/ December 13, 1965

2/ April 14, 1966

3/ May 28, 1967

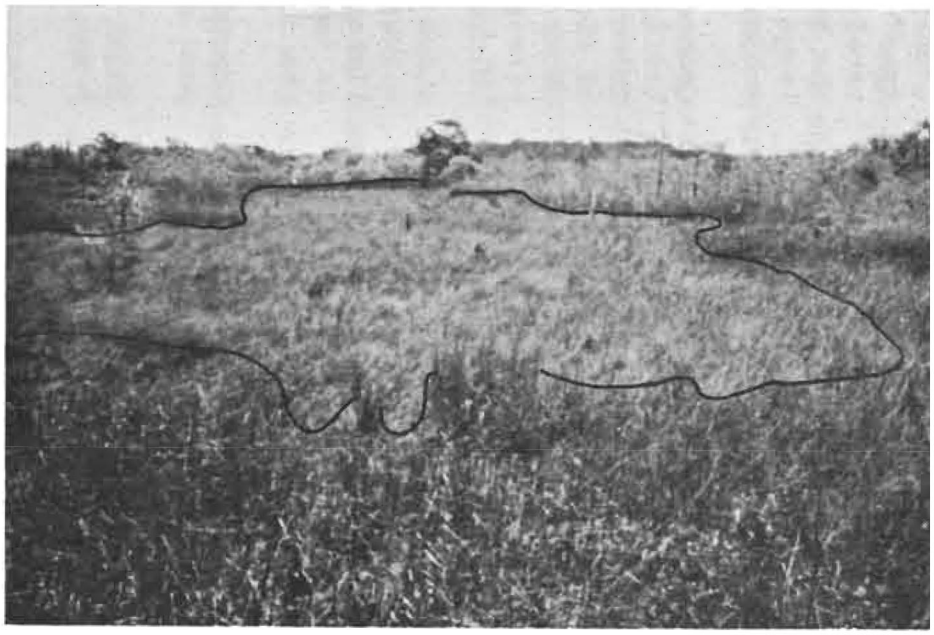

Figure 8.--Western half of study site near Royal Palm Visitor Center. Much of the vegetation was killed (outlined area) probably by the high osmotic pressure of the artesian water.

Table 4. Salinity tolerances of selected plants in vicinity of Royal Palm Visitor Center

PLANT SPECIES	MAXIMUM TOLERANCE CHLORIDE CONTENT, mg/l *	REFERENCE	COMMENTS	EFFECT OF FULL STRENGTH ARTESIAN WATER
Annona glabra	Undetermined	F. Craighead (Oral communication)	Common plant of the fresh-water glades rarely found within the salt line; several large trees along the Anhinga trail	possibly lethal
Chara spp.	10,700	E. Chamberlain, Jr.	Common along Anhinga trail; found in inland salt springs of Florida that run about 10% of sea strength (1,940 mg/l chloride content)	no effect
Eleocharis cellulosa	2,100	E. Chamberlain, Jr.	a few plants near main walkway; F. Craighead lists this species as an important plant of the mangrove belt	probably no effect
Mariscus jamaicensis	11,300	E. Chamberlain, Jr.	Common in Royal Palm pond area	no effect
Najas guadalupensis	2,020	E. Chamberlain, Jr.	Najas sp. common in Royal Palm pond area	probably lethal
Nuphar advena	970	E. Chamberlain, Jr.	present in area of Anhinga Trail	lethal

* The chloride content of artesian water from the Floridan aquifer near Anhinga Trail is approximately 3,000 mg/l.

Table 4.--Salinity tolerances of selected plants in vicinity of Royal Palm Visitor Center--cont.

Plant species	Maximum tolerance chloride content,[1] mg/l	Reference	Comments	Effect of full strength artesian water
Panicum hemitomon	700	E. Chamberlain, Jr.	A few plants in area of Anhinga Trail	probably lethal
Pontederia cordata	2,320	E. Chamberlain, Jr.	Common in Royal Palm area	probably lethal
Sagittaria lancifolia	970	E. Chamberlain, Jr.	Common in Royal Palm area	lethal
Salix amphibia	?	Authors	Abundant in Royal Palm area. Occurs in brackish waters of river-bank forests in southern Florida	probably no effect
Typha dominguensis	11,300	E. Chamberlain, Jr.	Typha sp. in Royal Palm area	probably no effect
Utricularia spp.	540	E. Chamberlain, Jr.	A few plants in Royal Palm area	lethal

[1] The chloride content of artesian water from the Floridan aquifer near Anhinga Trail is approximately 3,000 mg/l.

The aquatic animals in the elevated region of Lake Chekika and the borrow pit (fig. 7) are always isolated from the aquatic communities in the surrounding glades, but the water in the intermittent ponds (2, 3, 4, and 5 in fig. 7) becomes blended with that in the glades during the wet season when water levels rise.

The animals collected from the artesian-water communities at Grossman's Hammock consisted of four invertebrates and nine fishes (table 5). Most of the fishes collected from the borrow pit and observed

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in Lake Chekika were adults indicating that they not only survived but grew in these isolated communities. Whether the rate of growth in the brackish water was normal is, of course, open to question. The presence of bass fingerlings, Micropterus salmoides, and young redear sunfish, Lepomis microlophus, in the borrow pit indicates that reproduction of some centrarchid fishes was at least partially successful in these bodies of water. However, conditions at Grossman's are believed to be marginal and it is unlikely that reproduction of the centrarchids would be successful in the more mineralized artesian water at Royal Palm.

Table 5. Animals in samples from mineralized water at Grossman's Hammock, February 13, 1964

Common Name:	Scientific Name:
INVERTEBRATES:	
Fresh-water prawn	Palaemonetes paludosus
Crayfish	Procambarus alleni
Dragonfly nymph	(unidentified)
Fish louse (parasite)	Argulus n. sp.
FISHES:	
Golden topminnow	Fundulus chrysotus
Mosquitofish	Gambusia affinis
Brook silversides	Labidesthes sicculus
Flagfish	Jordanella floridae
Largemouth bass fingerlings	Micropterus salmoides
Bluegill	Lepomis macrochirus
Redear sunfish or shellcracker	Lepomis microlophus
Spotted sunfish or stumpknocker	Lepomis punctatus
Warmouth	Chaenobryttus coronarius

Tarzwell (1957) has stated that it is not known whether a typical fresh-water fish can complete a normal life history in water of relatively high osmotic pressure. Tebo and McCoy (1964) conducted extensive bioassay studies with various concentrations of sea water on the eggs and fry of largemouth bass and bluegill. Their results suggest that the chloride content of the artesian water at Royal Palm (2,670 mg/l) will inhibit the development of fry. In water with a chloride concentration of 2,931 mg/l chloride (15 percent of sea water) and suitable conditions of dissolved oxygen, pH, etc., the hatching success of bass eggs was only 24 percent, compared to 60 percent in fresh-water control tanks; however, after 12 days all the fry were dead from the eggs that did hatch in the high-chloride water. At a concentration of 10 percent sea water, 24 percent of hatched eggs survived, compared to 51 percent success in the fresh-water controls. Bluegill fry underwent 99 percent mortality in 11 days in 10 percent sea water.

Probably most of the cyprinodont and poeciliid fishes in the Royal Palm aquatic communities would survive and reproduce in undiluted artesian water because those fishes show higher tolerances to osmotic pressure than do the centrarchids, as indicated by table 6.

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Laboratory investigations:

Tests with artesian water from the Royal Palm well indicated that a wide variety of aquatic animals from the Royal Palm communities would survive for at least two days (table 7) in the undiluted artesian

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water. Based on salinity tolerances indicated in table 5 and in more extensive tabulations by Briggs (1957) they would probably survive longer. The problem seems to be more in the lack of reproductive success than in the survival of adults.

Table 6.--Upper lethal range of salinity for representative species of marsh fish along the Florida and Gulf Coast regions according to various investigators. These fishes are common in the Royal Palm aquatic communities.

	Fishes	Chipman (1959)	Simpson & Gunter (1955)	Kilby (1955)	Tabb & Manning (1961)	Springer & Woodburn (1960)
Cyprinodontidae	Lucania parva	11.9 °/oo	48.2 °/oo	28.2 °/oo	28.0 °/oo	---
	Fundulus confluentus	---	---	---	6.0 °/oo	20.4 °/oo
	Fundulus chrysotus	13.7 °/oo	---	24.7 °/oo	3.0 °/oo	25.0 °/oo
	Cyprinodon variegatus	20.9 °/oo	142.0 °/oo (80.0)*	---	26.0 °/oo	---
Poeciliidae	Heterandria formosa	13.7 °/oo	---	15.0 °/oo	4.0 °/oo	0.0 °/oo
	Mollienesia latipinna	35.0-38.1 °/oo	53.9 °/oo	37.6 °/oo	33.0 °/oo	---
	Gambusia affinis	11.9-13.7 °/oo	20.6 °/oo	25.2 °/oo	30.0 °/oo	---
Centrarchidae	Micropterus salmoides	---	---	11.5 °/oo	---	5.0-7.6 °/oo
	Lepomis macrochirus	11.9 °/oo	---	5.6 °/oo	---	3.7-4.2 °/oo
	Lepomis microloph	---	---	12.3 °/oo	---	---
	Lepomis punctatus	---	---	11.8 °/oo **	---	---

* Voluntary upper limit, higher figure tolerated if fish stranded in hypersaline environment.

** Extremes, the species are usually found in water having salt content less than 5.0°/oo.

Note: 1 °/oo = 1 part per thousand salinity

(From Tabb, 1963)

Table 7. Survival test (48 hours) of selected Taylor Slough animals in artesian water*. The animals were removed from fresh water (chloride, 35 mg/l) and placed into artesian water (chloride, >2500 mg/l). All animals, both in the test and control aquaria, survived.

Animals Tested	Number of Individuals in Test and control Tanks	Chloride content of water, mg/l
Mosquitofish, *Gambusia affinis*		
3 day old fry	12	2600
adults	40	2600
Sailfin molly *Mollienisia latipinna*	10	3000
Redfin killifish *Lucania goodei*	3	3000
Flagfish *Jordanella floridae*	5	2500
Warmouth *Chaenobrittus coronarius*	6	2600
Stumpknocker *Lepomis punctatus punctatus*	1	3000
Shellcracker *Lepomis microlophus*	2	3000
Florida spotted Gar *Lepisosteus platyrhincus*	12	2900
Channel catfish *Ictalurus punctatus*	2	3000
Crayfish *Procambarus alleni*	2	2600
Snail *Helisoma scalare*	12	2800
Apple snail *Pomacea paludosa*	4	3000
American Alligator *Alligator mississippiensis*	1	2500

* Characteristics of the artesian water in the aquarium during tests: Temperature 75° F, pH 8.3-8.5, and dissolved oxygen 4.0 to 8.5 mg/l.

SUMMARY AND CONCLUSIONS

The water from the Floridan aquifer underlying the southeastern part of the Everglades National Park is mineralized, having a concentration of dissolved solids 30 times greater than the fresh, surface waters of Taylor Slough. The osmotic pressure of the artesian water is equal to that of approximately 15 percent sea water. The artesian water lacks oxygen and contains hydrogen sulfide gas. If full strength water from the Floridan aquifer flooded the aquatic communities of the Royal Palm Visitor Area, much of the flora would suffer adverse effects, and more than half of the plant species would probably perish. Animals appear to adapt to the artesian water, at least for short periods; however, reproduction in some species is inhibited in the artesian water at full strength. The artesian water could be mixed with fresh water from the shallow aquifer at a one-to-one ratio and the resulting quality at the Royal Palm area would be similar to that at Grossman's well. However, the blend would probably increase in mineralization with time because of infiltration and recirculation of the blended water within the shallow aquifer. The resulting concentration might approach that of full strength artesian water.

The water from the Floridan aquifer in extreme southern Florida appears generally unsuitable as a life-medium for fresh-water plant or animal communities.

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ARTESIAN WATER -- AN EMERGENCY WATER SUPPLY FOR EVERGLADES NATIONAL PARK [1]

By

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During the summer of 1965, the U.S. Geological Survey, in cooperation with the U.S. National Park Service drilled a deep test well in the Everglades National Park in Taylor Slough near the Royal Palm Ranger Station. The purpose of the well is to supply sufficient mineralized artesian water to a nearby 2-acre experimental plot where effects on the fresh-water biota can be examined. If no material changes in the biota result from the inundation then consideration will be given to the use of artesian water in small critical areas as an emergency supply during prolonged droughts.

Drilling of the well began in June 1964 and funds were exhausted in September 1964 at a depth of 1,126 feet without producing the required flow for the study. In July 1965 the well was deepened to 1,333 feet and flowed at a rate of about 2.3 million gallons per day from the 8-inch casing at ground level.

Due to difficulties in maintaining circulation in the top hundred feet of limestone, the drilling contractor elected to drive the standard 8-inch black iron casing to a depth of 620 feet where it was seated in a moderately hard layer of sandy limestone of the Tampa Formation. Then, a 7 5/8-inch open hole was drilled with a rotary rig to a depth of 1,333 feet. Samples of the rock were collected and filed with the Florida Geological Survey (W-7363). Measurements were also made of hydrostatic pressure and water quality at various depths in the well during drilling.

Various types of hydrogeologic logs (see fig. 1) show some of the physical and chemical characteristics of the stratigraphy penetrated by the well. It was generally assumed that large quantities of artesian water containing less than 1,200 ppm (parts per million) chloride could be obtained at depths less than 1,200 feet. Data from this well contradicts this assumption and indicates that the Tampa and Suwannee are part of the aquiclude and the Avon Park Limestone or Ocala Group form the top of the Floridan aquifer.

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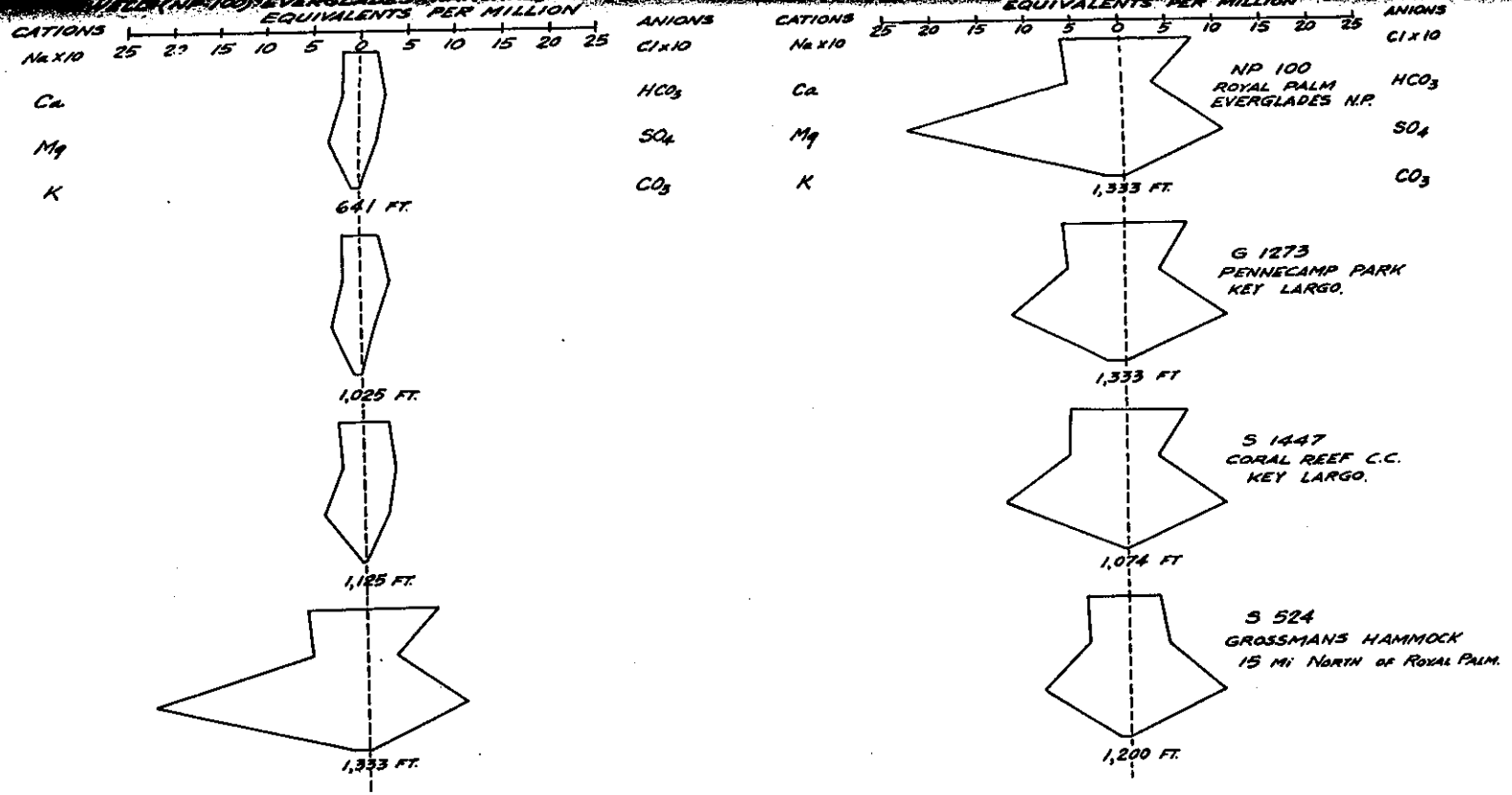
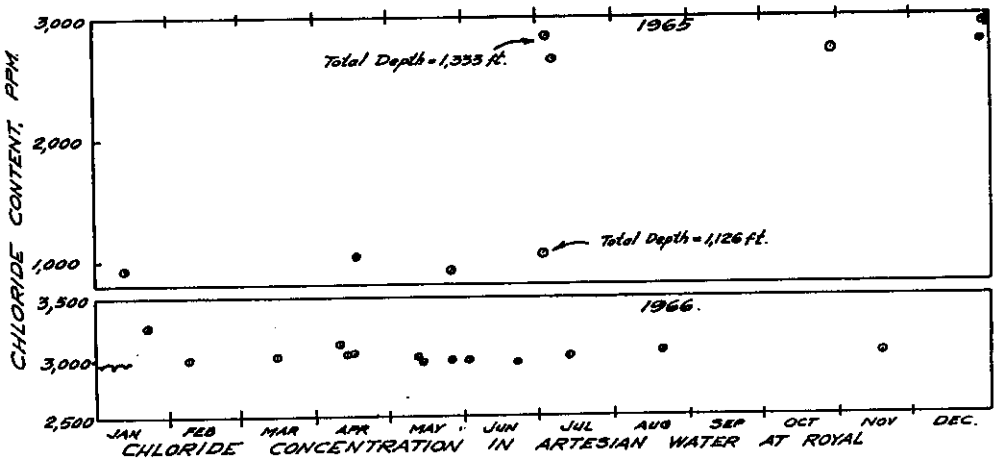
[1] Data is provisional and subject to revision.

Stiff diagrams (see fig. 2) of the artesian water from 641 to 1,063 feet indicate most of the flow originated from an aquifer in the Tampa Formation and confirms the presence of at least two artesian aquifers in the area. The high concentration of magnesium in the artesian water from 1,333 feet could be related to deep circulation of sea water. This, however, is improbable because the artesian water at Key Largo contains less magnesium. Comparison of the diagrams indicate that the artesian well at Grossman's Hammock obtains only half its flow from the Floridan aquifer. This infers an increase in the permeability in the Tampa/Suwannee section toward the north.

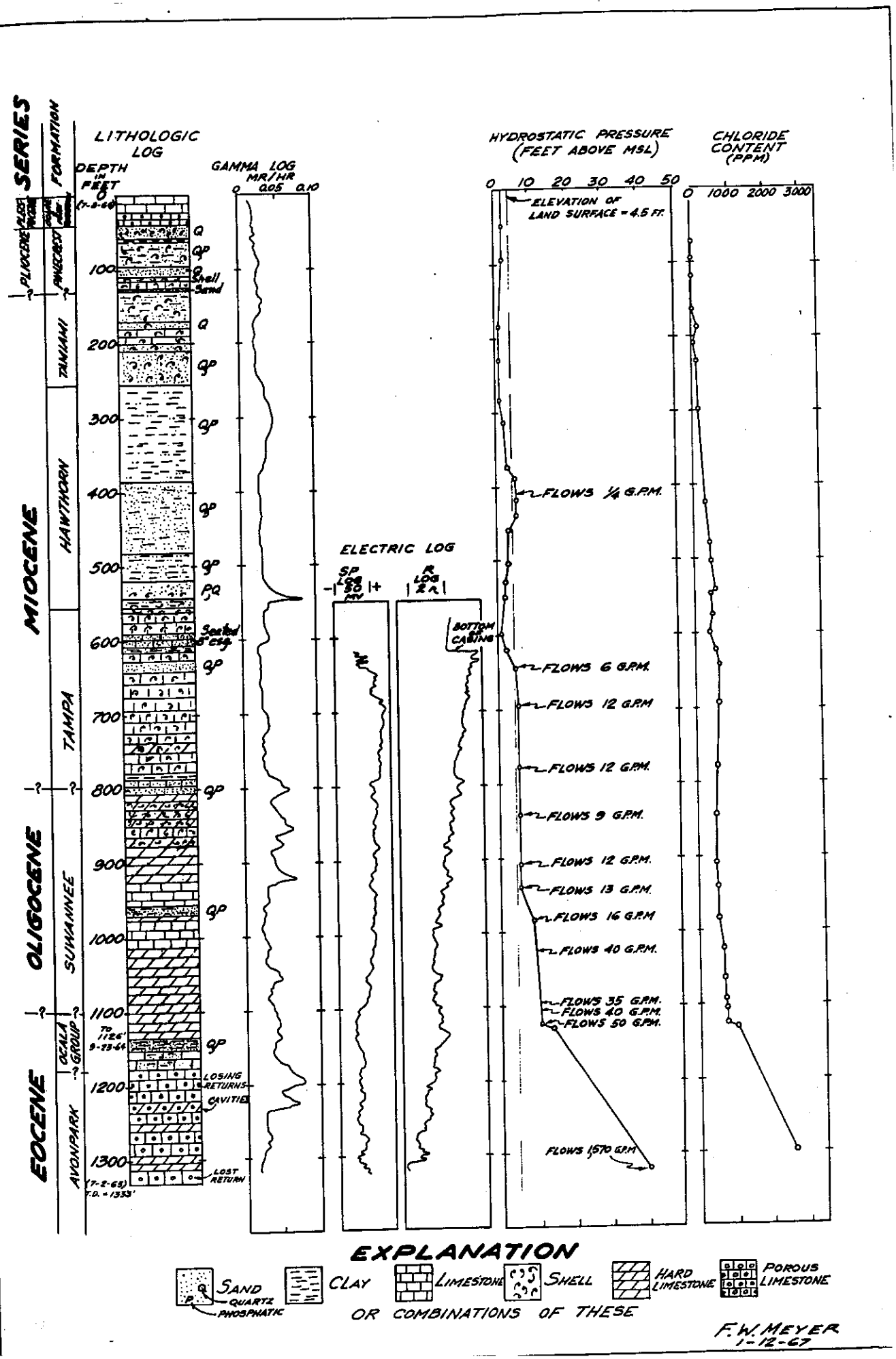
Only minor amounts of relatively fresh artesian water can be obtained from the Tampa Formation in the area. Perhaps the yield of a well in this formation could be increased by acidizing techniques.

During 1966, artesian water flowed into the experimental area at a rate of about 2 acre feet per day with no significant increase in salinity (see fig. 2).





CHLORIDE CONCENTRATION IN ARTESIAN WATER AT ROYAL PALM RANGER STATION.


SERIES
FORMATION
LITHOLOGIC LOG
DEPTH IN FEET
GAMMA LOG MR/HR 0 0.05 0.10
HYDROSTATIC PRESSURE (FEET ABOVE MSL)
0 10 20 30 40 50
CHLORIDE CONTENT (PPM)
0 1000 2000 3000
ELECTRIC LOG
SP LOG 50 mv
R LOG 2Ω
PLIOCENE
PLIO-MIOCENE
PANACEA
MIOCENE
TAMIAMI
HAWTHORN
TAMPA
OLIGOCENE
SUWANNEE
EOCENE
OCALA GROUP
AVON PARK
Q
QP
Shell Sand
PQ
Sealed 8" csg.
LOSING RETURNS
CAVITIES
LOST RETURN
(7-2-64) T.D. = 1353'
To 1126' 9-23-64
BOTTOM OF CASING
ELEVATION OF LAND SURFACE = 4.5 FT.
FLOWS 1/4 G.P.M.
FLOWS 6 G.P.M.
FLOWS 12 G.P.M.
FLOWS 12 G.P.M.
FLOWS 9 G.P.M.
FLOWS 12 G.P.M.
FLOWS 13 G.P.M.
FLOWS 16 G.P.M.
FLOWS 40 G.P.M.
FLOWS 35 G.P.M.
FLOWS 40 G.P.M.
FLOWS 50 G.P.M.
FLOWS 1570 G.P.M.
EXPLANATION
SAND
QUARTZ
PHOSPHATIC
CLAY
LIMESTONE
SHELL
HARD LIMESTONE
POROUS LIMESTONE
OR COMBINATIONS OF THESE
F.W. MEYER
1-12-67