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A STUDY OF THE EFFECT OF FRESH WATER WITHDRAWAL ON THE LOWER PEACE RIVER, DESOTO COUNTY, FLORIDA

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SUMMARY

Introduction

The General Development Corporation plans to construct a regional public water supply system capable of serving Port Charlotte and the adjacent area. The surface water portion of the supply will be drawn from the Peace River near its crossing by State Road No. 761. The intake is located south of the road on a small bay on the west side of the River. Inasmuch as considerable storage is to be provided and ground water sources utilized, rates of withdrawal can be varied to minimize its impact on the River's environment. While the proposed withdrawal rates are usually only a small portion of the river flow, in times of drought the withdrawal might cause a significant reduction in the fresh water discharge below the intake. This in turn could cause increases in salinity which might alter the natural system. It is therefore necessary to study the system in order to determine rates of withdrawal that can be tolerated under various conditions of river discharge.

Purpose and Scope of the Study

The University of Miami project accomplished by RSMAS* personnel was designed to study the Peace River between S.R. No. 761 and its mouth in order to develop a system for the prediction and monitoring of the effects of the planned withdrawals on the water quality and its consequent impact on the biological community. Tasks consisted of (1) the collection of baseline biological and physical data for future comparison; (2) the establishment

*Rosenstiel School of Marine and Atmospheric Science of relationships between fresh water discharge and tides on the water quality (mainly salinity); (3) the relation of the biological community to the water quality; (4) the prediction of the effects of the planned withdrawals and (5) the establishment of a monitoring system for use after the construction of the system so as to foresee and prevent adverse effects.

General Description of Data Collected

Data from the field have been collected continuously since 9 January 1974 when recording tide gauges were installed. Investigations of hydrodynamic data were made during nine field trips between 19 December 1973 and 8 November 1974. Biological studies were conducted during a series of 6 field trips between May 1974 and November 1974.

Extremely low river flows during the spring of 1974 followed by heavy rains during the summer provided extremely valuable biological and physical data for a wide range of conditions. The value of these data for drought conditions in particular is demonstrated by the fact that flow in the Peace River at Arcadia as recorded by the U. S. Geological Survey were the third lowest for any three-month and six-month period during 38 years of record. This permitted observation of the system during a period of exceptionally great saline intrusion as well as in flood when the water was essentially fresh all the way to the River's mouth.

Findings

Observations of the physical data and their subsequent analyses showed strong tidal influences as far up the River as the intake structure with a diurnal range of approximately 2.0 feet at that location. This is approximately the same as at the mouth of the River although there is a phase lag of approximately 2 hours at the upstream site. Salinity patterns naturally were very strongly affected by the fresh water discharge, but even during the severe drought essentially no saline water came as far upstream as the intake. On 1 May 1974 during the worst of the drought while the measured discharge at Arcadia was 62 ft^3/s (43 MGD), salinities varied nearly linearly from a value of about 27.5 °/oo (parts per thousand) at the Punta Gorda Bridge to 0.2°/oo at the intake. On the basis of observations made earlier during discharges of 96 ft^3/s (62 MGD) the isohalines can be expected to move with the tide such that salinities vary 1 to 4 °/oo from ebb to flood. The range of salinities at the river mouth is about 1°/oo, but farther upriver they will vary by 2 to 4 °/oo during the tidal cycle at any station. The vertical pattern showed only slight variation from surface to bottom indicating good mixing. This considerably simplified the problem as a one-dimensional model can be employed.

Only one series of data was taken during a period of relatively high fresh water discharge of 10,000 ft^3/s (6463 MGD) at Arcadia. The data show that there is practically no tidal variation at the intake site and that the salinity is practically constant at about .1 °/oo from the intake to the Barron Collier Bridge.

The numerical model after calibration was capable of accurately depicting salinity, water level and discharge conditions as they existed along the River. This inspires a high degree of confidence in the predictive capabilities of the model.

For the aquatic animals, the emerging picture is one of extreme seasonal salinity change in which the permanent residents must be those species adapted to such stress, while the remaining residents are transient of two classes: those which have enough mobility to move in response to changing salinities and those which invade as eggs or larvae, grow for a while, and are then killed off at the end of the season (wet or dry).

For the aquatic and shoreline plants, there has been apparent damage to only a few species along the water line in the mid-reaches of the study area, and there is no certainty that salinity alone caused this damage. Upstream some trees near Station B7 (Figure 7) showed possible signs of temporary stress, but no permanent harm. The plants of the more brackish environment of the lower river appeared normal, with the exception of some leather ferns, which are considered normally to tolerate quite brackish water. These ferns did not appear to be severely damaged, and complete recovery is expected. The greatest value of the upper reaches of the study area is its scenic beauty. In this area we have seen no evidence of damage to any of the plants during the study period. Observed salinity values of approximately 0.5^{o}/oo at Station B5, 1.7^{o}/oo at Station B6, and 10.0^{o}/oo at Station B7 seem to have had little effect on the flora at these stations. However, damage to the flora may ultimately occur if such salinity values, especially the latter, are sustained for periods of time exceeding their naturally occurring time-spans during the 1974 low flow period. Unfortunately, the durations of those highest recorded values are not known, for field data was gathered for each station only once monthly. The salinity at Station B7 was only 4.8^{o}/oo in April before biological sampling was begun. The only observed damage to the flora due to the heavy rains was the toppling of a considerable number of trees from bank undercutting and the dislodgement and washing downstream of thousands of water hyacinths and mats of Paspalum fluitans. At no time during the period of low flow was the water level observed low enough to expose the substrate from which emergent aquatic plants were growing.

Conclusions

As a result of having had the opportunity to observe the reversal system during high and low extremes of fresh water discharge and of the excellent reproduction of the system by the numerical model, the following conclusions are presented with a high degree of confidence.

1. At the time of low fresh water discharge, vertical mixing is good and no saline wedge or other form of stratification exists.

2. Even during periods of discharge as low as 50 ft^3/s at Arcadia the effect of the withdrawal of 12 MGD (18.6 ft^3/s) at the proposed intake site will have a small effect on salinity patterns as compared with diurnal tidal effects. Increases in salinities on the order of approximately 0.0 ppt (at the downstream most station) to 1.7 ppt (at the upstream most station) above those maximum values encountered during no-withdrawal situations can be expected.

3. During dry periods, the fresh water net flow is essentially the same at any point in the study area (from Arcadia, downstream); thus the flow at Arcadia is the fresh water net flow. If fresh water withdrawal

were allowed to equal the net discharge , then the salinity values* would become dependent solely on water from Charlotte Harbor. Eventually, salinities would reach the same value as those found in the Harbor. At a 30 MGD (46.4 ft^3/s) withdrawal rate and a 50 ft^3/s flow at Arcadia, salinities would rise 6.6 ppt above the maximum no-withdrawal salinities after 35 tidal cycles. However, with a 100 ft^3/s upstream inflow, the resulting salinity values with a 30 MGD (46.4 ft^3/s) withdrawal essentially reproduced a no-withdrawal 50 ft^3/s upstream inflow situation. Additionally, with a 30 MGD (46.4 ft^3/s) and a 75 ft^3/s upstream inflow, the system approached a 12 MGD (18.6 ft^3/s) withdrawal with a 50 ft^3/s net flow situatio This therefore, indicates that with withdrawal at the intake site, the salinity distribution below the withdrawal point closely resembles a no-withdrawal situation with the upstream inflow equal to the actual upstream input minus withdrawal.

4. Using the predicted data from the numerical model for 5 selected stations located downriver from the intake site, the approximate salinity increases above maximum no-withdrawal values are indicated in Figure 1 based on a withdrawal rate of 12 MGD (18.6 ft^3/s) with an upstream inflow of 50 ft^3/s. The increase at station 1 is approxiamtely 0.00^o/oo; 0.45^o/oo at station 5; 0.80^o/oo at station 7; 1.60^o/oo at station 11; and 1.70^o/oo at station 15. Additionally, for upstream inflows of 100 ft^3/s, 30 MGD

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*Because it would be impossible to withdraw only fresh water, these values could only be reached if all water moving downstream above the withdrawal point was removed. However, the model can consider only fresh water inflow or withdrawal and this simply adds a conservative factor to the predictions.

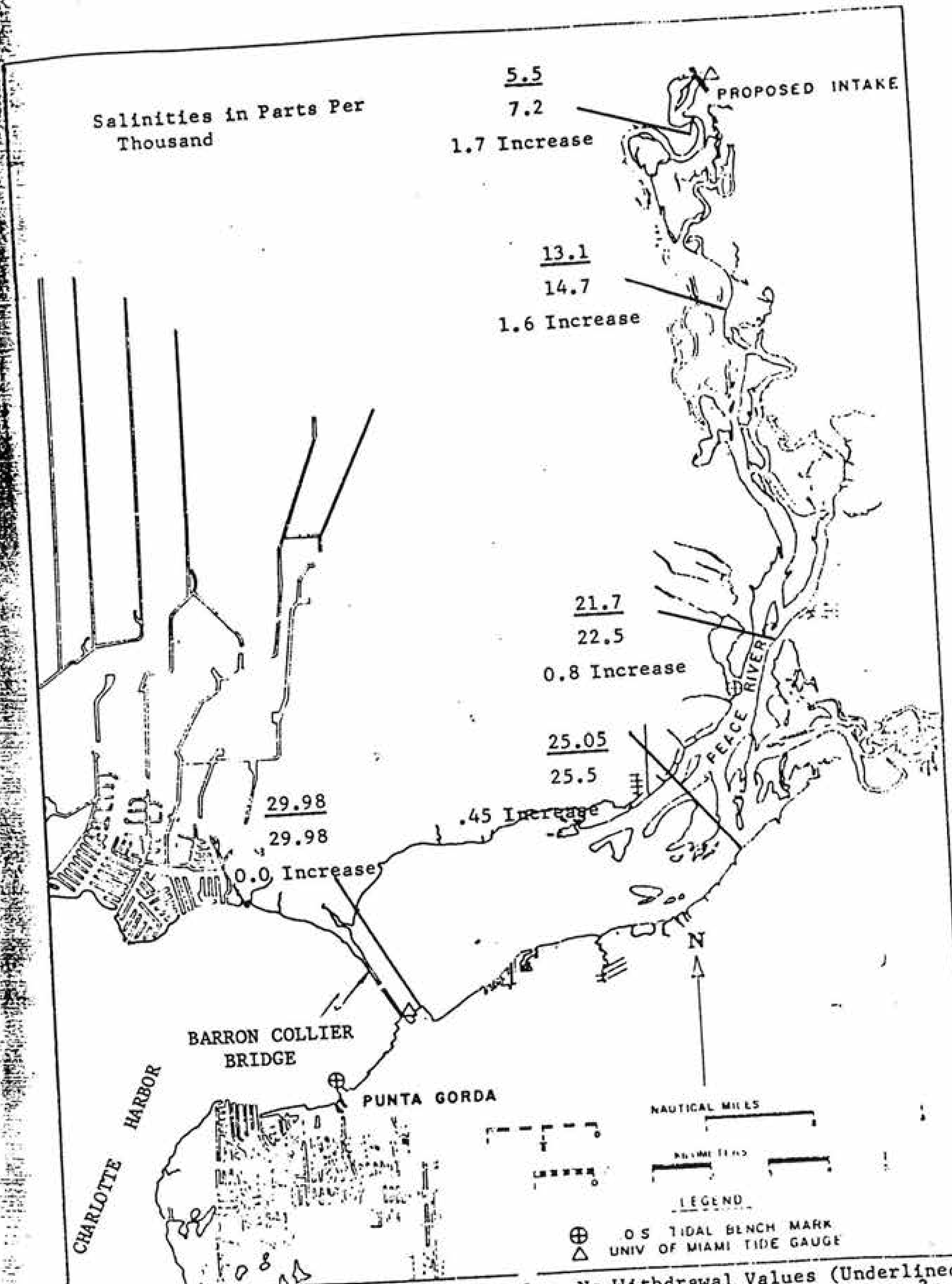

FIGURE 1. Increases in Salinities from No Withdrawal Values (Underlined) to 12 MGD (18.6 ft^3/s) Withdrawal; Upstream Inflow = 50 ft^3/s

(46.4 ft^3/s) withdrawals would essentially create a 50 ft^3/s no-withdrawal system, a system which can occur naturally. With a 75 ft^3/s upstream inflow and 30 MGD (46.4 ft^3/s) withdrawal, a 50 ft^3/s and 12 MGD (18.6 ft^3/s) withdrawal system is approached. Under these conditions of flow and withdrawal, biological data indicated that such slight salinity increases, above the naturally occurring values of low flow periods, should add little additional stress on the plants and animals of the study area. This is not to be construed that total stress under such conditions could not ultimately be harmful to the biota; a major factor is the unpredictable time-spans of these naturally occurring low flow periods.

Recommendations

1. That the intake be constructed as planned.

2. That a monitoring program should be established and operated during periods of low flow (e.g. - March, April, and May).

3. During the first dry season after the plant is in operation surveys be made to further verify the model during actual peak withdrawal.

DESCRIPTION OF THE AREA

The area under study as shown in Figure 2 is centered about 7 miles northeast of Punta Gorda, Charlotte County, Florida at Latitude 27°01' North, Longitude 82°00' West. It consists of low terrain having very little relief traversed by shallow drainage ways. The climate is typical of southwest Florida with a mean temperature of 73.8°F. January is the coldest month with an average of 64.37°F, and August is the hottest at 82.9°F. The prevailing winds are from the easterly quadrant with east

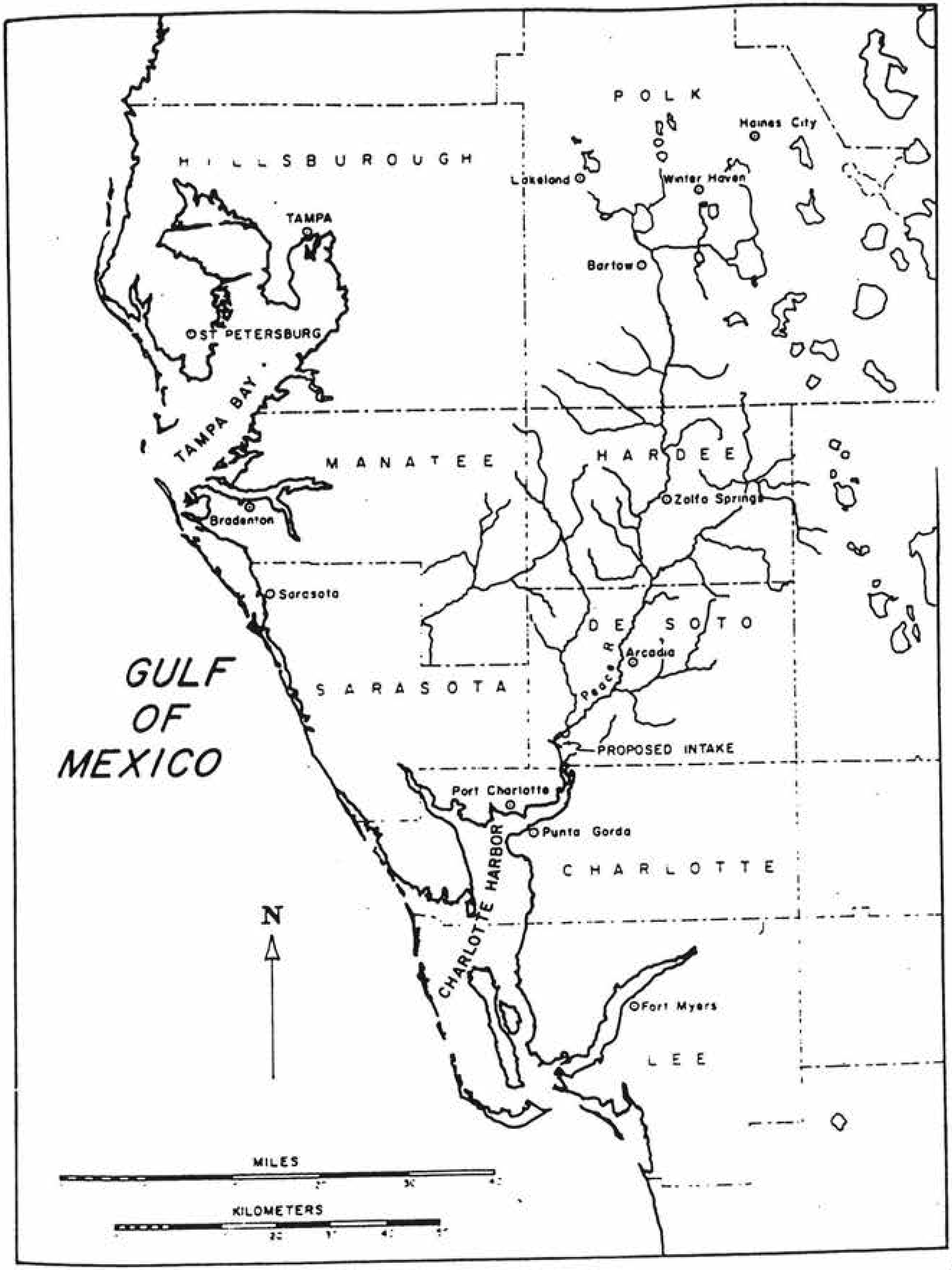

FIGURE 2
LOCATION MAP