A Survey of Salinity Levels in the Indian River-Banana River Complex

by Diane McCall, J. G. Cook, J. A. Lasater, and T. A. Nevin
University Center for Pollution Research
Florida Institute of Technology
Melbourne, Florida

Previous studies (1) have shown that variations in the chemical and biological species occurred both laterally and vertically in a segment of the Indian River in Brevard County. These studies also indicated that variations occurred longitudinally; however, the initial choice of observation sites were such that longitudinal variations were minimized.

An expanded and coordinated series of measurements have been conducted along essentially all of the navigable portions of waterways of the Indian River/ Banana River Complex. Although a wide variety of measurements were made, this presentation has been limited to the observed variations in the salinity of surface samples.

These studies have shown it desirable to subdivide the Indian River/Banana River Complex into four distinct segments. These segments are:

1. The Indian River from the Eau Gallie Causeway (State Road 518) aouth to the Sebastian Inlet
2. The Indian River north of the Eau Gallie Causeway
3. The Banana River
4. Sykes Creek and New Found Harbor.

All of the waters of these segments are appropriately classified as saline.

DESCRIPTION OF AREA:

The geophysical features of the Indian River/ Banana River Complex contribute significantly to the variations observed. In general, the south Indian River and Banana River are classical examples of lagoons separated from the ocean by a barrier beach (2). However, the south Indian River has a substantial inflow of fresh water; therefore, there is an estuarine character to this portion of the Complex (3,4). On the other hand, the influx of fresh water is divided among four principal streams and several minor ones; thus, the estuarine features are diffused.

North of the Eau Gallie Causeway, Merritt Island is interposed between the Indian River and the Banana River. Sykes Creek and New Found Harbor may be considered as a poorly connected arm of the Banana River, which splits the southern part of Merritt Island into two peninsulas. These geographical differences do not alter the fact that both the north Indian River and Sykes Creek are lagoonal.

Natural fresh water inflow into the north Indian River is derived from three relatively minor streams. Two of these streams are in the near vicinity of the Eau Gallie Causeway and the third is at the northern terminus of the lagoon. Storm sewers are common in the populated areas; there are also a number of storm sewers which drain portions of the less populated areas. An important storm sewer, emptying into the north Indian River, is located in the Frontenac area.

There are seven causeways crossing the Indian River, three of which also cross the Banana River. All of these causeways have a central span, from one-quarter to one-half mile in length, and usually one or two small relief bridges in the vicinity of the original shoreline. The intervening spaces are dredged landfilled roadways. It is notewrthy that the original width of the river, at the causeway crossing point, is generally grom two to three miles.

One of the important man-made feature is the Intracoastal Waterway which extend along almost the entire length of the Indain River. This, 100 foot wide, waterway was originally dredged to a depth of 12 feet, with the dredged material deposited as a series of spoil areas. The bulk of these spoil areas form islands south of the Melbourne Causeway (State Road 516); whereas, north of this point only relatively few spoil areas reach the surface.

North of Titusville the Haulover Canal, 100 feet wide and 12 feet deep, connects the Intracoastal Waterway to Mosquito Lagoon. Another dredged feature is the Canaveral Barge Canal, 125 feet wide and 12 feet deep, which extends from the Indian River to the Banana River immediately north of the Bennett Causeway (State Road 528). This canal also leads to a set of locks which provide direct access to the Atlantic Ocean via Port Canaveral.

Extensive dredging operations have been carried out within the confines of Cape Kennedy - Kennedy Space Center, and this portion of the lagoonal system has been substantially altered by the construction of the crawlerway from the Vehichle Assembly Building (VAB) to the Saturn V Launch Pads. This crawlerway completely severed a natural, if somewhat temuous, connection between the southern reaches of Mosquito Lagoon and the headwaters of the Banana River.

Natural mixing processes between saline and fresh water are primarily effected by the prevailing south-east/south winds. However, it appears probable that natural mixing processes are substantially modified by extensive utilization of the various waterways by pleasure and commercial craft. The boating effects are more significant during the late fall and mid spring periods; however, a significant number of larger craft and innumerable small boats ply these waters throughout the year.

PROCEDURE:

All samples were collected in clean plastic bottles from the top six inches of the water in the center of the marked waterways. In unmarked waters, the samples were taken approximately midstream. Water temperatures were measured simultaneously with the sample acquisition using standard laboratory thermometers. The usual procedure was for one boat to sample the Banana River, a second to sample the south, and a third, the north Indian River segments. Sample runs were initiated between 9 and 10 a.m., and sampling was completed within six hours. No rainfall occurred during the sampling interval. The samples were returned to the laboratory and equilibrated to ambient conditions (c. 25° C) prior to measuring salinity. Sample locations and distances were determined from appropriate nautical charts published by the U.S. Department of Commerce (Coast and Geodetic Survey, ESSA).

Salinity was determined with an Industrial Instruments (induction type) Salinometer (Model RS-7B). The instrument was standardized using Standard Sea-Water P_{49} (11-12/11 1967) prepared bu the I.A.P.O. Standard Sea-Water Service (Denmark). A four gallon sample of sea water was also simultaneously established as a secondary reference for subsequent measurements.

EXPERIMENTAL RESULTS:

Three general longitudinal sampling runs were made on July 17, 24, and 31, 1969. The July 17 run was accomplished the day before the summer rains began. Despite the occurrence of rain (from July 18 until mid August almost daily thundershowers occurred in the area) the data for the Indian River acquired on July 17 and 31 were almost identical except in a few locations where there was a substantial inflow of fresh water. The July 17 run was not as extensive as planned due to mechanical problems with the boat operating on the north Indian River. Accordingly, it seems appropriate to combine the data on July 17 and 31, as well as that of a partial run across the minimum salinity portion of the Indian River (July 22) in order to establish a baseline curve for the Indian River. This approach may be viewed as somewhat arbitrary; however, it is apparent that the saline distribution in these waters is highly variable and is a consequence of diverse meterological and physical parameters. That is, somewhat different saline conditions can be expected in those years when the precipitation and/or wind patterns are measurably different from those prevailing in the first half of 1969. It should also be pointed out that since the bulk of the salinity measurements fall

below 30 o/oo, they probably should be considered comparative, rather than absolute values (5). The composite curve, which has been selected as the baseline curve for the Indian River is shown in Figure 1.

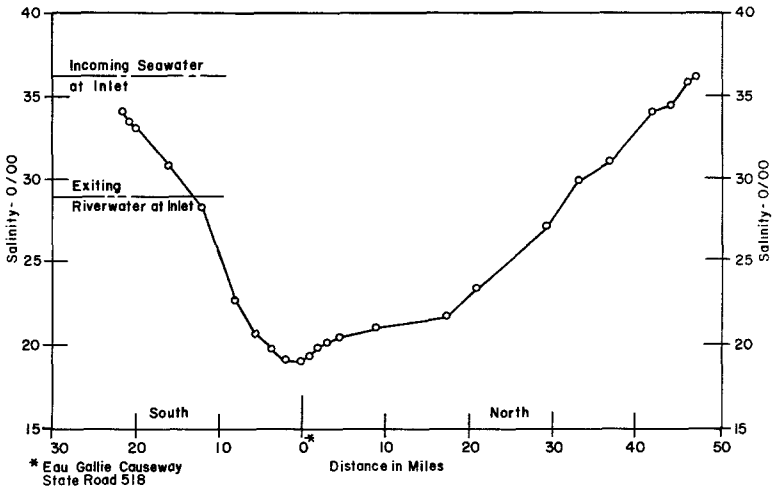

Figure 1. Saline Distribution in the Indian River.

The Sebastian Inlet area represents a special problem area in that it is a major source of saline water (ocean), as well as an exit for excess water from the south Indian River. Extensive variations in currents are known to occur in the Inlet during the tidal cycle. The Inlet is approximately 250 yards wide with a depth of less than one fathom over the sandbar on the river side. During rising tides, inflow currents up to six knots are not uncommon, and even higher currents have been experienced during the outflow cycle. Due to the relatively narrow barrier beach, the tidal effects can extend west of the Intracoastal Waterway during inflow.

The tannin-rich water of Sebastian Creek did not diffuse into the blue-green ocean water. Instead, there developed a distinct interface with lagoonal (Indian River) water, wheras the brown color disappeared, and the lagoonal water appeared grey-green and turbid. The turbid zone extends eastward for varying distances, depending upon the tidal direction, and terminates in a second interface with the clear, blue-green ocean water. The zonal phenomenon with its distinct interfaces was readily visible during the sampling period. The effect of prolonged rains on this phenomenon has not yet been assessed.

At high tide, the maximum invasion of sea water usually extends west of the Intracoastal Waterway, retreating to the east of this location during the outflow period. This is distinctly evident from a comparison of the data for July 17 and 31 with that recorded for July 24. For example, during the incoming tide, the observed salinity at channel marker 59 (opposite Sebastian Creek) was 33.48 o/oo (7/17 and 7/31) while a salinity of 22.23 o/oo (7/24) was measured in the Inlet proper were 36.24 o/oo and 28.82 o/oo respectively.

It also is appropriate to note that the only surface water temperature differentials encountered were in the Sebastian Inlet area. The measured river water temperature generally ranged from about 30 to 33° C depending on the relative cloud cover present. It was rare to observe water temperature bariations as much as 1° C during a sampling run except at Sebastian Inlet. The mean river water temperature was about 31° C, whereas the incoming ocean water was consistently at 28° C. The lower temperature and higher salinity of the ocean water indicate the existence of the necessary conditions for more saline water to be present at depth. Other incomplete studies suggest that a high saline lens at depth may persist as for north as the Melbourne-Eau Gallie Causeway areas.

From the Sebastian Inlet area to the Eau Gallie Causeway (figure 1), a decrease in the salinity was observed at a rate that approaches 0.8 o/oo per mile. The actual minimum (based on the 7/22 data) appears to be in the vicinity of the Eau Gallie River (i.e., 0.5 mile south of the causeway).

Inflow from the streams south of the Eau Gallie Causeway was particularly evident in the data acquired on July 24. In all instances the observed salinity was less than the baseline curve; however, mixing processes essentially erased these differences in the July 31 data.

The July 31 data indicates that the amount of inflowing fresh water was relatively small compared to the volume of the south Indian River. This aspect is currently being explored.

North of the Eau Gallie Causeway a somewhat different saline variation is encountered. In the immediate vicinity of the Eau Gallie Causeway the rate of change in the salinity is approximately that to the south; however, a "plateauing" is observed from channel marker 98 to 82, followed by a much more rapid increase to the north. In the plateau area the ratio of change of salinity is 0.09 o/oo per mile; wheras the change north of channel marker 82 is o.5 o/oo per mile.

One of the unexpected results of this study is

the contribution of the Haulover Canal to the salinity of the north Indian River. The saline conditions of the Mosquito Lagoon was essentially that of the ocean (36.12 o/oo); however, the inflow of saline water form Mosquito Lagoon more likely results from combination of density gradients and wind driven currents rather than the tidal influences as encountered at Sebastian Inlet. Although the Haulover Canal is twice the depth of the Sebastian Inlet, it is less than one-sixth as wide. Thus, the salinity levels observed in the Titusville area were higher than anticipated form geophysical factors. Accordingly, a more detailed investigation of the Haulover Canal area is planned in order to develop an understanding of the phinomena involved. It appears that the Haulover Canal presents a special problem comparable to the Sebastian Inlet in its effect on the saline distribution of the Indian River.

The data for the north Indian River reflect the comparatively smaller inflow of fresh water. In proximity to the Eau Gallie Causeway, saline levels decreased with the advent of precipitation; however, the rainfall effect was progressively less the the north. For example, the salinity at State Road 528 (Bennett Causeway) for the three general survey were 23.48, 23.46, and 23.39 o/oo respectively. In contast, a small plateau in the salinity developed (after the rains began) north of channel marker 60 (Frontenac Area) In addition, some variations were encountered that may be attributed to inflow from Trumbull Creek. Salinities determined by the July 24 samples were usually less than on the other dates, but the variations were considerably smaller than were observed in the south Indian River on the same date.

The Banana River, Sykes Creek-New Found Harbor, and the Canaveral Barge Canal represent other areas that may be classed as special problem areas due to the geophysical character of these regions. These waters will be described separately, but each is a significant part of the lagoonal complex being considered. Salinity data were obtained for the Banana River on each of the general sampling runs; but only one sampling, each, was made of Sykes Creek (7/17) and the Canaveral Barge Canal (7/31).

Salinity data for the Banana River obtained on July 17, do not agree with that acquired on July 31, as observed for the Indian River. This difference in the character of the data appears to be a consequence of the lower river volume to land drainage area ratio. Thus, the data for July 17 has been selected as the baseline data and the corresponding baseline data

for the Indian River are shown in Figure 2. As a general comparison, the variations in salinity of the Banana River (with distance) are quite similar to the Indian River except near its southern and northern extremes. The variation at the south end of the Banana River probably arises from the narrow and shallow nature of this water. Those at the north end are believed to be a consequence of this portion of the lagoon having become an area where the evaporation rate exceeds that of the inflow of fresh water. However, there is a possibility that airborne transfer of sea salt and/or barrier beach diffusional processes may contribute significantly. The plateauing observed at the north end in the base data (7/17) was definitely established when samplings were taken to the northern end of the Banana River (VAB Canal). The effect of land drainage is evident since the last point falls to 23.93 o/oo as compared to 24.87 o/oo at the preceeding point (distance 2.4 miles) as is shown in Figure 2.

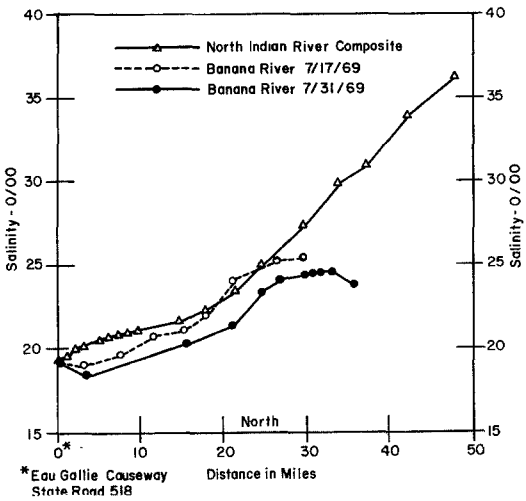

Figure 2. Saline Distribution in the Banana River.

Sykes Creek salinities appear to be dominated by land drainage and effluent from sewer treatment plant outfalls. The mean salinity in this area was 21.1 o/oo with only two of six stations differing more than 1 o/oo. Similar data obtained for the Canaveral Barge Canal were strikingly uniform except in one instance. At either terminus of the canal the salinities were very close to those of the respective rivers. Where the canal crosses the upper reaches of Sykes Creek the salinity fell to 19.7 o/oo, as compared to a mean of 24.0 o/oo for the other stations.

A series of measurements (6) were made in the vicinity of the Titusville Causeway and the southern end of Mosquito Lagoon in July-August, 1964. These authors observed substantially lower salinities than those reported herein; however, very similar trends in the variations in the surface salinity were encountered. They also found a tongue of more saline water at a depth of four feet.

ACKNOWLEDGEMENT

This work was supported, in part, by the National Science Foundation grant number GW-3978, Secondary Student Science Training Program, and utilized equipment provided under U. S. Naval Oceanographic Office contract N62306-69-C-0172. The authors gratefully acknowledge this support.

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