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South Florida Place-Based Program

Magnitude and Distribution of Flows into Northeastern Florida Bay

Concerns with Florida Bay Ecosystem

Changes in water-management practices have been made to accommodate a large and rapidly growing urban population along the Atlantic Coast and to meet the demand for intensive agricultural activities. These changes have resulted in a highly managed hydrologic system consisting of numerous canals, levees, control structures, and pumping stations that have altered the hydrology of the Everglades and Florida Bay ecosystems. Over the past decade, Florida Bay has experienced sea-grass die-off and algal blooms, which are indicators of ecological change attributed primarily to the increase in salinity and nutrient content of bay waters. Because plans are to restore sheetflow in the Everglades wetlands to its natural state, water managers anticipate a change in the magnitude and timing of freshwater exiting the mainland through the creeks that cut through the embankment or as sheetflow into Florida Bay.

Flow through the mangrove zone into northeastern Florida Bay is controlled by water levels in the Everglades wetlands, regional wind patterns, and to a minor extent, tidal fluctuations. Restoration of the Florida Bay ecosystem requires an understanding of the linkage between the salinity, quality of the bay environment, and the amount of freshwater flowing into the bay.

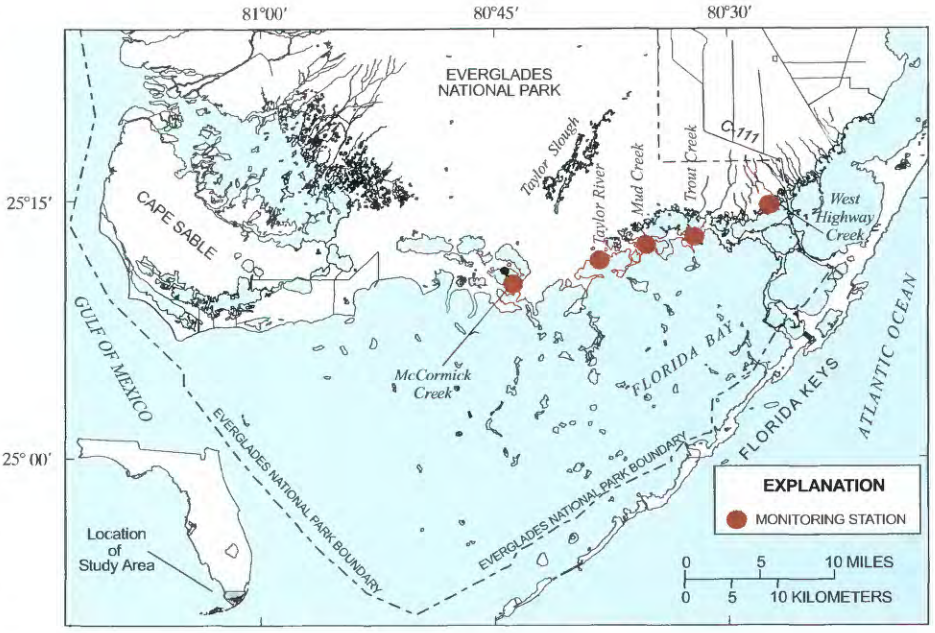

Figure 1. Location of monitoring stations in northeastern Florida Bay.

In 1995, the U.S. Geological Survey (USGS) initiated the South Florida Ecosystem Program (now known as the South Florida Place-Based Program). This program was established as a collaborative effort by Federal agencies working with State and local agencies to resolve land-use demands and water-supply issues in southern Florida. As part of this program, the USGS is presently conducting a study to measure flows into Florida Bay from the mainland through the major creeks along the northeastern coast. The results of this study will provide scientists with essential information from along the mangrove zone where data were not previously available.

Monitoring Stations

Freshwater flow into northeastern Florida Bay is mostly confined to several creeks, except during extreme high-water conditions when sheetflow could occur in low-lying mangrove areas between the creeks. Five monitoring stations in the mangrove zone along the northeastern coast of Florida Bay (fig. 1) were selected to determine the magnitude and distribution of flows into the bay. The West Highway Creek, Trout Creek, Mud Creek, Taylor River, and McCormick Creek stations are located along a mangrove zone, spanning about 20 miles across the northeastern edge of Florida Bay.

Stage, water velocity, temperature, and salinity data were collected from these stations. Figure 2 shows a typical USGS monitoring station (Taylor River) in Florida Bay.

Acoustic Velocity

Time-series records of acoustic velocity were collected and used with discharge measurements to establish an acoustic-velocity to mean-velocity relation for the creeks. The technique used to describe the velocity relation is a least squares regression model in the single or multiple form, depending on the number of identified significant variables. The model uses the following equation:

$$\bar{V} = V_l(X_1 + HX_2) + C$$

where $\bar{V}$ is mean channel water velocity, V_l is acoustic line velocity, X_1 and X_2 represent regression coefficients, H is stage, and C is a constant.

The acoustic line velocity is the predominant variable, and in most cases, the only variable needed for the description of the velocity relation. Occasionally, stage plays a significant role in describing the relation and needs to be included in the above equation. A typical acoustic-to-mean velocity relation for one of the monitoring stations (Trout Creek) is shown in figure 3.

Figure 2. U.S. Geological Survey monitoring station (Taylor River) in Florida Bay.

Flows into Northeastern Florida Bay

Velocity and area relations developed for each monitoring station were used to calculate 15-minute time-series discharge data for all gaged creeks along the coastline. In other areas, most estuarine creeks present flow patterns that include the reversal of flow direction during flood and ebb tides. In the creeks that discharge into Florida Bay, this typical tidal signature is either nonexistent or substantially altered by wind forces. The flow direction for stations monitored in northeastern Florida Bay is mainly dictated by the wet- or dry-season conditions of the Everglades wetlands and the regional wind speed and direction. Commonly used data filters were not used for net flow calculations because of these flow patterns. Monthly mean values of discharge were used to account for storage and to determine net flows for all monitoring stations.

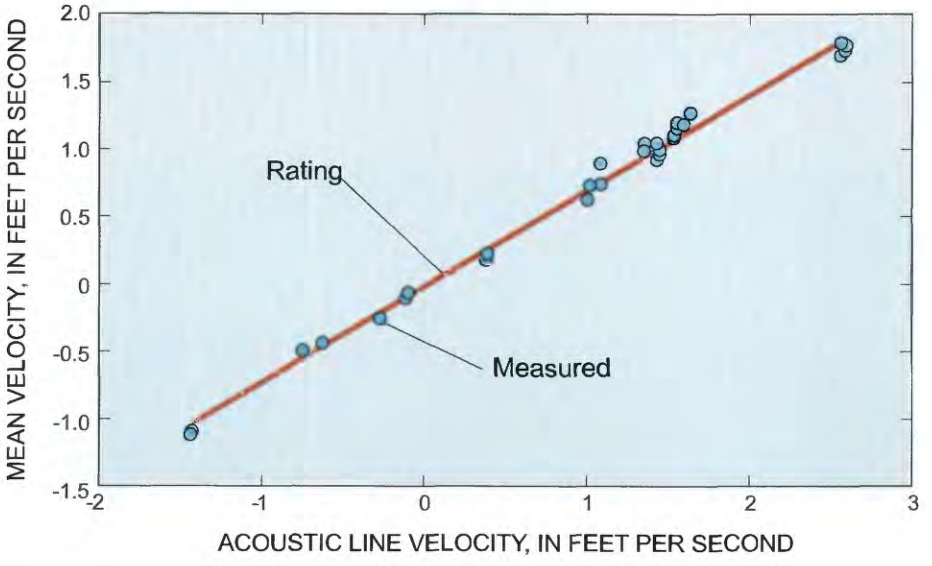

Figure 3. Velocity relation for Trout Creek monitoring station.

East-West Flow Distribution

Discharge results for the five stations indicated that the majority of flow into Florida Bay occurs east of the Taylor Slough drainage area. Discharge was least for McCormick Creek (3 percent of total) and greatest for Trout Creek (67 percent of total) during May 1996 through April 1998. The percentages of freshwater contributions for the five monitoring stations are shown in figure 4.

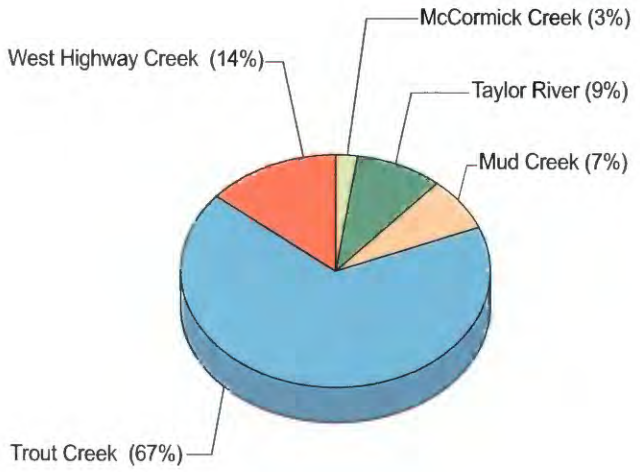

Figure 4. Estimated freshwater contribution of stations monitored in northeastern Florida Bay.

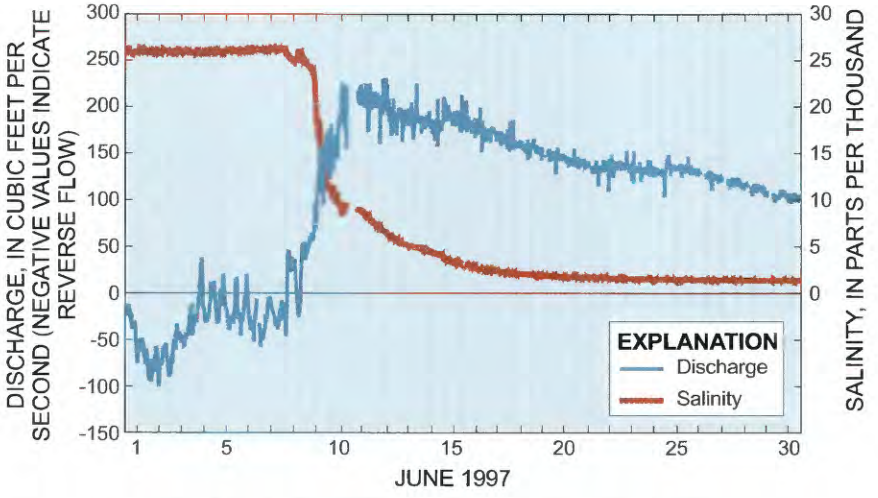

Figure 5. Brackish water (dry season) to freshwater (wet season) transition at the Taylor River monitoring station, June 1-30, 1997.

Seasonal Flow Variations

About 80 percent of the total freshwater discharge into northeastern Florida Bay occurs during the wet season (May-October). A very distinct transition between brackish water and freshwater occurs at the mangrove zone near the beginning of the wet season. This brackish-water/freshwater transition period was apparent at the Taylor River monitoring station in June 1997 (fig. 5). Substantial El Niño effects on dry-season flows at all of the monitoring stations in northeastern Florida Bay are evidenced by a mean discharge increase from about 41 cubic feet per second in 1996-97 to 273 cubic feet per second (average for all stations) in 1997-98. Regional wind patterns and shallow water depth in the Everglades wetlands following El Niño are the probable cause for a divergence in flow pattern between McCormick Creek and the other monitoring stations. The wet- and dry-season freshwater discharges (1996-97 and 1997-98) for each of the five monitoring stations are shown in figure 6.

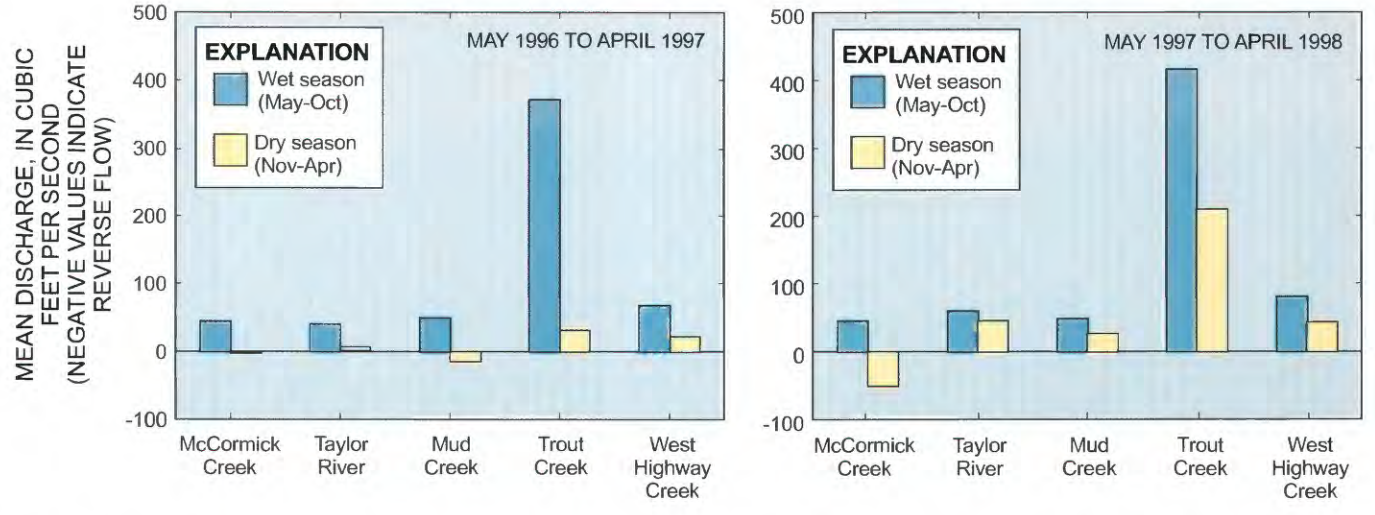

Figure 6. Wet- and dry-season freshwater discharges through all monitoring stations in northeastern Florida Bay.

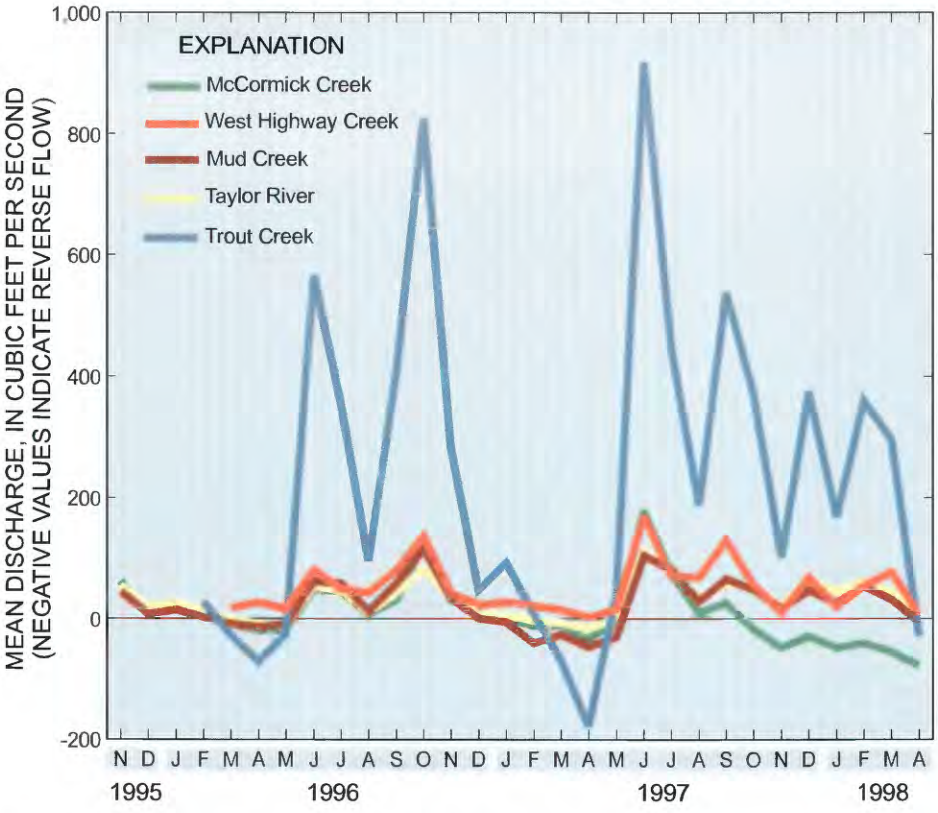

Figure 7. Mean monthly flows for all monitoring stations in northeastern Florida Bay, November 1995 to April 1998.

Three main flow signatures were identified when comparing flows at the monitoring stations in northeastern Florida Bay (fig. 7). The most important is the magnitude of discharges at Trout Creek, which carries about 67 percent of the total freshwater entering northeastern Florida Bay (fig. 4). The other two signatures are the drifting of McCormick Creek following the El Niño event of 1997-98 and the absence of net negative flows at West Highway Creek. McCormick Creek probably disconnects from the Taylor Slough drainage basin during low-water conditions in the wetlands. The observed east-west flow distribution, and especially the magnitude of flows through Trout Creek, suggest that freshwater flow in the Everglades wetlands along Taylor Slough may be farther to the east than previously thought. Further evaluation of discharge and salinity patterns would be necessary to extend the analysis period beyond the influence of extreme hydrologic events (such as El Niño) and to assess both short- and long-term flow trends in northeastern Florida Bay.

Data Releases

Mean daily values (of ninety-six 15-minute-interval readings) of discharge, stage, water velocity, temperature, and salinity for the five monitoring stations are posted on the USGS Sofia Web Page for public use and retrieval (http://sofia.er.usgs.gov). Records will be updated on a quarterly schedule for the duration of the project. Any questions or requests should be directed to the USGS Miami Subdistrict office.

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Discharge measurement at Trout Creek

Monitoring station inspection