Flow Velocities in Wetlands Adjacent to Canal C-111 in South Florida

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Wetlands between canal C-111 and the eastern panhandle area of Everglades National Park (ENP) are of particular concern to south Florida ecosystem restoration efforts in that they constitute a major pathway for fresh water to reach nearshore embayments of Florida Bay. Past construction features of the Central and Southern Florida Project are suspected of contributing to the reduction of marsh hydroperiods in the C-111 basin and to the development of hypersaline conditions in the subtidal embayments of central and northeast Florida Bay as a consequence of channeled and diminished freshwater flows. Changes in the hydraulic infrastructure and water management operations are being implemented to restore more natural temporal and spatial flow patterns through the wetlands. In 1996 and 1997, spoil mounds along the southwest bank of the C-111 canal between hydraulic-control structures S-18C and S-197 were removed to enable overbank flow from the canal to enhance sheet flow in the wetlands. In September 1997 and 1999, extensive sets of flow-velocity data, basic water-quality parameters, and information on vegetation characteristics were collected in the wetlands adjacent to the canal to determine flow patterns in the wetlands, to analyze canal/wetland flow exchanges, and to support the development of a model for this canal and wetlands ecosystem (Schaffranek, 1996).

In September 1997, near the conclusion of the spoil removal efforts, flow measurements were made at nine transects spaced at variable intervals along the 8-km overbank segment of the canal. Transects were spaced at variable intervals perpendicular to the canal and extended approximately 2 km into the adjacent wetlands. Measurements were repeated along similar transects in September 1999 and the spatial extent of wetland coverage was expanded to include two new transects—one oriented north-south and the other east-west—along the ENP Boundary. These new transects were added to evaluate inter-basin exchanges between Taylor Slough and the C-111 wetlands and to quantify other potential inflow sources. The north-south transect extended southward from canal L-31W along and parallel to the ENP Boundary to the point where the Boundary makes a 90˚ turn eastward. The east-west transect extended eastward from the southern end of the north-south transect along and parallel to the ENP Boundary and terminated at the C-111 canal.

Flow velocities were measured using portable SonTek[1] 10-MHz acoustic Doppler velocity (ADV) meters suspended from tripods. The meters were retrofitted with electronic compasses to geodetically reference flow directions to East, North, and Up (ENU) coordinates. The SonTek ADV meter measures flow in a 0.25 cm^3 remote sampling volume to a resolution of 0.1 mm/s (SonTek, 1997). Velocity data were typically collected at 0.2, 0.5, and 0.8 depths, measured from the water surface to the top of the litter layer. At each depth, two-minute burst samples were taken at a frequency of 10 Hz. Measured ENU velocity components were processed through a series of automated filters and plotted for visual inspection to identify anomalous data (Ball and Schaffranek, 2000). Examination of the component-velocity standard deviation and visual inspection of the plots generally identified suspect data not detected by the automated filters. Anomalous data were eliminated and depth-averaged velocity magnitudes and flow directions were computed and plotted for subsequent analyses (see fig. 1).

[1] Use of firm, trade, and brand names is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Flows in the wetlands adjacent to the C-111 overbank area were fairly consistently in south-southwest and south by west directions within and between measurement years averaging 205 and 191 degrees clockwise from magnetic north in 1997 and 1999, respectively. Flow velocities were slightly more variable within years but consistent between years averaging 0.8 and 0.5 cm/s in 1997 and 1999, respectively. In the wetlands adjacent to the canal, velocities were greatest in the immediate vicinity of the re-graded spoil mounds, but decreased rapidly and variably away from the canal. The spatial variability of the wetland flow velocities is likely due to the variable influence of overbank flows combined with local effects of the irregular topographic relief, wind effects on the flow, and frictional resistance of the heterogeneous vegetation. Several mangrove-lined channels extend southward from the canal and likely act to convey sheet flow away from the wetlands—additional monitoring is needed to identify sheet versus channel flow differences.

Flow directions measured along the north-south and east-west ENP Boundary transects in 1999 averaged 170 and 186 degrees clockwise from magnetic north, respectively, with average magnitudes of 1.9 and 0.7 cm/s. Along the north-south transect, velocities were greatest at the northern end near the L-31W canal outlet, where discharges were high due to the S-332D Pump Test (http://www.sfwmd.gov/org/erd/webboard/s332dtest.html) and to releases from the S-175 control structure related to tropical storm Harvey. Higher flow velocities along the north-south boundary indicate a significant inflow into the C-111 basin from a north by west direction likely originating from the L-31W canal or eastern Taylor Slough. Along the east-west transect, velocities were greatest near the U.S. Highway 1 end with significant flow toward the eastern part of Long Sound. Flows along the east-west transect from its western end to approximately the midpoint of the C-111 overbank area were consistently in the direction of Joe Bay, indicating that Joe Bay is the primary recipient of flows from the upstream part of the overbank segment of the C-111 canal. This indicates that a significant amount of fresh water from C-111 and potentially eastern Taylor Slough flows into Joe Bay which supports findings that discharges from Joe Bay are a major source of fresh water for northeastern Florida Bay (Patino, 1999).

Graphical representation of measured flow vectors from September 1999, overlaid on a satellite image for visual inspection, can be found in the What's New page of the Tides and Inflows in the Mangroves of the Everglades (TIME) website (http://time.er.usgs.gov). Un-edited velocity data collected during 1997 and 1999 along with associated correlation statistics, signal strength values, water-quality parameters, and vegetation characteristics are available at the South Florida Information Access (SOFIA) website (http://sofia.usgs.gov/). Site averaged data summaries, data-quality indicators, and velocity filtering results are available at the SOFIA website and presented in Ball and Schaffranek (2000).

References

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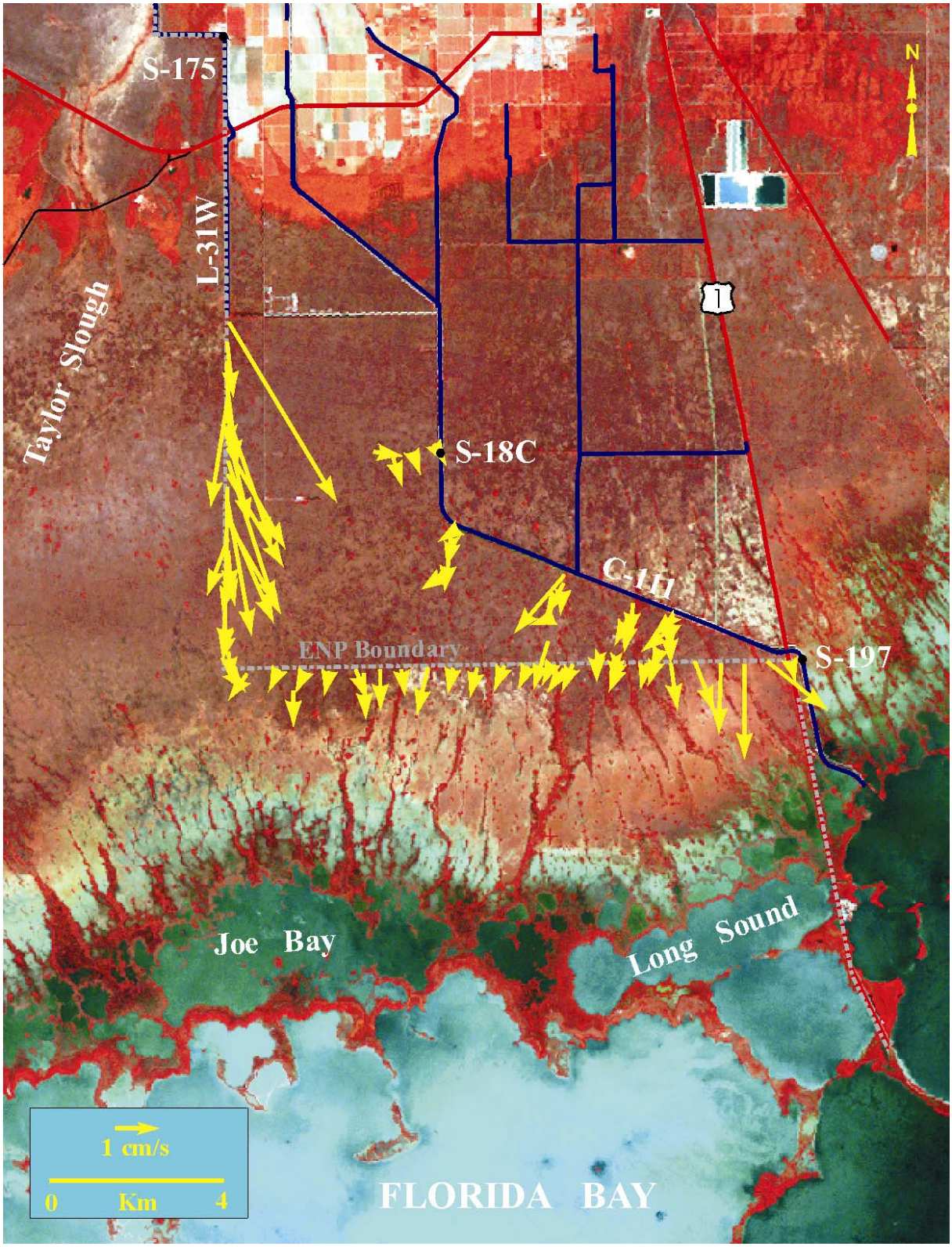

Satellite image courtesy Land Characteristics from Remote Sensing Project, J.W. Jones.

Figure 1. Flow velocities measured in C-111 wetlands on September 22-23, 1999.