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Evaluation of Flows in Wetlands Adjacent to Canal C-111 in the Southern Florida Everglades

By
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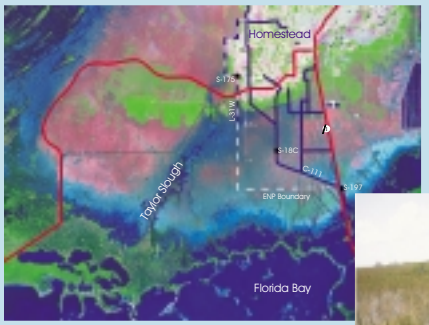
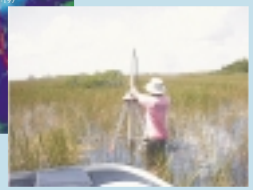
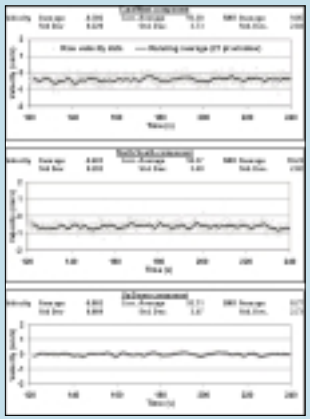
Introduction

Wetlands between canal C-111 and the eastern panhandle of Everglades National Park (ENP) are a major pathway for freshwater flow to nearshore embayments of Florida Bay. Overbank flows from C-111 are controlled by hydraulic structures S-18C and S-197. In 1996-7, spoil mounds along the southwest bank of C-111 were removed to increase overbank flow and enhance sheet flow in the wetlands. Flow data were collected in 1997 and 1999 to analyze canal/wetland flow exchanges and to develop a flow model of this connected canal/wetland ecosystem (Schaffranek, 1996).



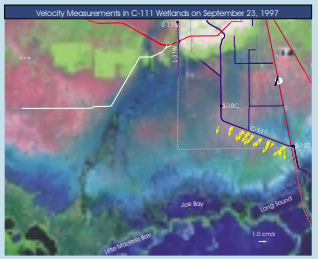


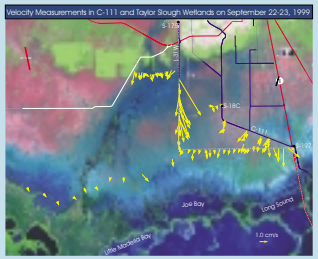
Data Collection



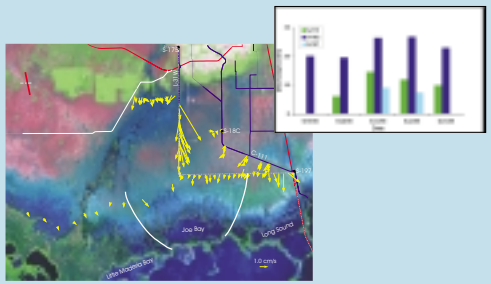
Flow velocities were measured using portable SonTek[1] 10-MHz acoustic Doppler velocity (ADV) meters suspended from tripods. The ADV meter measures flow velocity in a 0.25 cm^3 remote sampling volume to an accuracy better than 1 mm/s (SonTek, 1997). At sites with sufficient flow depth, velocities were measured at 0.2, 0.5, and 0.8 depths. Two-minute burst samples were taken at a frequency of 10 Hz resulting in 1200 geodetically-referenced velocity components. Measured velocity data were processed through a series of filters (Ball and Schaffranek, 2000) to remove spurious values. A sample plot of East, North, and Up (ENU) velocity components with 2-second running averages is shown for a mid-depth measurement at one site. Average and standard deviation of velocity, correlation (Corr), and signal-strength (SNR) values are shown for each velocity component. ENU velocity components are used to resolve the mean flow speed and direction, which are 0.72 cm/s and 212 degrees, respectively, at this site.

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





In September 1997, near the conclusion of spoil removal efforts, flow velocities were measured along nine transects originating at the C-111 canal and extending into the wetlands. These measurements were repeated in September 1999 and also made at two transects in Taylor Slough and at two new transects in the C-111 wetlands—one oriented north-south and the other east-west along the ENP Boundary—to evaluate inter-basin exchanges and other potential inflow sources.

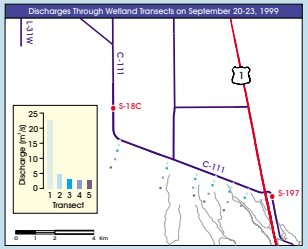


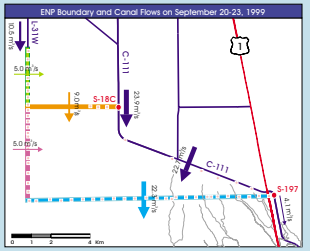
Flow Analyses

Flows in the C-111 wetlands were fairly consistently in the south-southwest direction during both measurement periods, averaging 205 and 191 degrees clockwise from magnetic north in 1997 and 1999, respectively. Flow velocities were variable within measurement periods but consistent between years, averaging 0.8 and 0.5 cm/s in 1997 and 1999, respectively. In the wetlands adjacent to the canal overbank the greatest flow velocities were measured very close to the canal, but velocities decreased rapidly and variably in the wetlands. Spatial variability in the wetland flow velocities is likely due to a combination of the variable influences of overbank discharges along the canal, local effects of the irregular topographic relief, and the heterogeneous vegetation of the wetlands. In the 1999 data set, flow velocities were greatest near the end of the L-31W canal due to S-175 control structure releases during and following a major hydraulic pump test and increased flows related to tropical storm Harvey on September 21, 1999. Between the two white lines drawn on the satellite image, measured flow directions along the east-west ENP boundary are in close agreement with the pattern of drainage channels and alignment of tree islands in the C-111 wetlands. This indicates that a significant amount of fresh water from the northern segment of C-111 and eastern part of Taylor Slough potentially 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).

Canal/Wetland Flow Exchanges

Discharges computed through five transects approximately parallel to the 8-km east-southeast segment of the C-111 canal reveal a significant rapid loss of sheet flow in the adjacent wetlands. The diminished sheet flow discharges are directly attributed to both a reduction in flow depths and velocities. Diversion of sheet flow to several mangrove-lined drainage channels that extend southward from the canal through the wetlands to Florida Bay and loss of surface flow to the highly permeable surficial aquifer are factors suspected of contributing to this flow attenuation.





Analyses of overbank discharges, ENP boundary flows, and structure releases reveals the complex interaction of sources contributing to C-111 sheet flows. The September 1999 data show a significant amount of surface-water exchange between the Taylor Slough and C-111 basins as evidenced by discharges along the north-south ENP boundary. The flow measurements also reveal inflow to the C-111 basin as sheet flow from wetlands northwest of structure S-18C and from L-31W canal discharges. These and all other potential inflow sources, e.g., road culverts, levee seepage, local precipitation, etc. must be further evaluated in order to completely assess C-111 sheet flow behavior.

Summary

Precise measurements of extremely low flow velocities have been made in the shallow wetlands adjacent to canal C-111. The results and findings of these efforts are intended to provide guidance for restoration actions needed to improve the timing, distribution, and quantity of sheet flows through the C-111 wetlands and into Florida Bay. These data are undergoing further analyses and are being used to develop a numerical flow model of the C-111 drainage system. The flow data collected during September 1997 and 1999 are available at the South Florida Information Access (SOFIA) website (http://sofia.usgs.gov). Plots of flow vectors from the September 1999 data-collection effort can be found at the Tides and Inflows in the Mangroves of the Everglades (TIME) website (http://time.er.usgs.gov/).

References

Ball, M.H., and Schaffranek, R.W., 2000, Flow-velocity data collected in the wetlands adjacent to canal C-111 in south Florida during 1997 and 1999: U.S. Geological Survey OFR-00-56, 42 p.

Patino, Eduardo, 1999, Estimating freshwater flows into northeastern Florida Bay, *in* U.S. Geological Survey OFR-99-181, pp. 82-3.

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