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Fire Effects on Flow in Vegetated Wetlands of the Everglades

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Unburned Site

Figure 3. Flow-velocity monitoring site SQUB.

Site SQUB (Squawk Creek unburned) is located in an area of dense sawgrass not affected by the Squawk Creek fire (fig. 3).

Table 1. SQUB flow measurements.

Date	Time	Total depth (cm)	Velocity mean (cm/s)	Direction mean (deg)
11/8/2001	1256 - 1334	39	0.8	230
12/5/2001	1136 - 1200	30	0.7	222
1/24/2002	1033 - 1059	22	0.6	226
6/26/2002	1208 - 1255	42	0.8	234
7/24/2002	1137 - 1215	30	1.0	265
8/27/2002	0952 - 1054	27	1.1	267
9/26/2002	1153 - 1221	31	1.0	268
10/29/2002	1230 - 1301	32	0.8	275
12/3/2002	1129 - 1352	22	1.1	267

Data from 9 sets of vertical velocity profiles covering depths of 16 to 42 cm reveal mean velocities ranging from 0.6 to 1.1 cm/s at the SQUB site (Table 1). The vertical velocity structure is uniform with velocities near the water surface similar in magnitude to those in the lower part of the water column (fig.4). Velocities measured at the SQUB site in the 2001 and 2002 wet seasons have remained consistent (fig. 5).

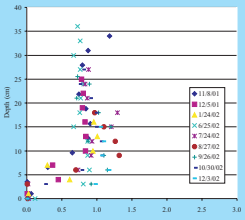

Figure 4. All flow profiles measured at SQUB.

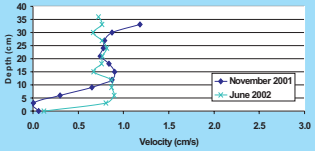

Figure 5. Two flow profiles measured at SQUB.

The dominant emergent vegetation at SQUB was sawgrass during all sampling events (fig. 6). Plant heights were consistent during the study, ranging from 1.50 (+/- 0.04) to 1.89 (+/- 0.20) m, while mean percent volume occupied by vegetation increased from 0.69 (+/- 0.08) to 1.14 (+/- 0.06) %. Stem spacing was measured in the top 10 cm of the water column and, as the water level dropped from June 2002 to January 2003, spacings were taken farther down the sawgrass stems. Over this time period, spacings ranged from 2.50 (+/- 0.18) to 3.89 (+/- 0.16) cm (Table 2).

Figure 6 . Vegetation sampling quadrat at SQUB in June 2002.

Table 2. Summary of vegetation sampling at SQUB.

Date	Species composition	Mean plant height (m)	Mean volume w/ periphyton (%)	Mean volume w/out periphyton (%)	Mean stem spacing in top 10 cm of water (cm)	Mean # stems in water column	Mean stem diameter (cm)	Site water level (cm)
January 2002	medium dense sawgrass	1.89	N/A	N/A	2.70	54.67	0.50	22
June 2002	medium dense sawgrass	1.60	0.69	0.69	2.50	40.67	0.67	42
October 2002	medium dense sawgrass	1.50	1.14	1.14	3.64	20.78	0.76	32
January 2003	medium dense sawgrass	1.53	1.03	1.03	3.89	20.00	0.60	16

Introduction

Fires are a critical, but not well-understood, dynamic occurrence that randomly and variously affect the Everglades ecosystem. However, the impacts of fire on subsequent surface-water (sheet) flow behavior have never been investigated. A fire in June 2001, described below, afforded the opportunity to quantify the effects of fire on sheet flow and to investigate flow behavior during vegetation recovery. Flow velocities and vegetation properties have been monitored over a three-year period. The panels to the left and right describe the flow and vegetation data collection at unburned and burned sites, respectively. The central panel illustrates initial findings relating flow behavior to vegetation characteristics between sites and over time.

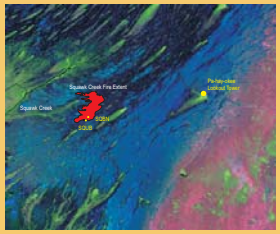

Figure 1. Squawk Creek fire extent and sampling locations (fire boundary provided by ENP).

Squawk Creek Fire

- On June 2, 2001, lightning ignited a fire about 8 km west of the Pa-hay-okee Lookout Tower near Squawk Creek, a narrow creek in the general vicinity of Rookery Branch (fig. 1).
- The fire burned though the next day until it was extinguished by a late afternoon rainstorm.
- Flow velocities and vegetation properties have been monitored in burned (SQBN) and unburned (SQUB) areas about 280 m apart within the vicinity of the Squawk Creek fire.

Figure 2. Squawk Creek fire June 3, 2001 (photograph provided by ENP).

Methods

Flow velocities and vegetation properties were measured to better understand how flow behavior varied with vegetation changes over time. Flow velocities and water temperatures were measured in 3-cm increments throughout the water column at the burned and unburned sites on 9 dates since November 2001. During four site visits, vegetation characteristics were assessed in three 0.04m^2 quadrats in the vicinity of velocity meters deployed at the SQUB and SQBN sites. Emergent stem densities and vegetation volumes were measured at 10-cm depth intervals from the litter to 60 cm above the litter, and stem diameters in the top 10 cm of the water column were measured to calculate stem spacing near the water surface. Stem spacing was calculated as $s_i = (1/N_i)^{1/2} - d_i$, where s_i = average stem and leaf spacing for the i^{th} stratum, N_i is stem density, and d is stem diameter for the i^{th} stratum[1].

[1]Roig, L.C., 1994, Hydrodynamic modeling of flows in tidal wetlands. PhD dissertation, University of California, Davis.

Summary and Conclusions

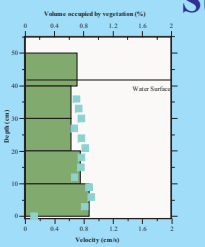

Figure 12. Velocity and vegetation volume at SQUB in June 2002.

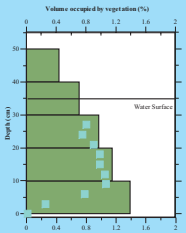

Figure 14. Velocity and vegetation volume at SQUB in October 2002.

In June 2002, flow velocities measured at SQBN were approximately two times faster than at SQUB and vegetation volumes were approximately 25 % less at the SQBN site (figs. 12 and 13). Stem spacing near the water surface was greater at the burned than at the unburned site (Tables 2 and 4) .

Figure 11. Vegetation at the edge of the Squawk Creek fire in July 2001. Inset: burned sawgrass stem.

Similar to June, in October 2002 flow velocities in the upper part of the water column at the SQBN site were two times faster than at SQUB (figs. 14 and 15) and stem spacing near the water surface was greater at the SQBN site. Unlike in June, vegetation volume throughout the water column in October was greater at SQBN due to an abundant growth of periphyton and muskgrass (*Chara sp.*) found there.

Vertical velocity profiles and vegetation volumes indicate that reduced plant heights above the water surface, as well as greater stem spacing just below the water surface, appear to yield reduced shear-resistance effects from vegetation and diminished sheltering effects from wind. These factors contribute to greater flow velocities in the upper part of the water column at the burned site.

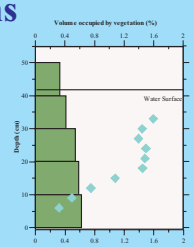

Figure 13. Velocity and vegetation volume at SQBN in June 2002.

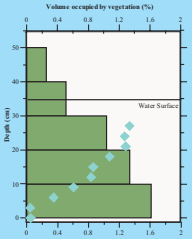

Figure 15. Velocity and vegetation volume at SQBN in October 2002.

Burned Site

Figure 7 . Flow-velocity monitoring site SQBN.

Site SQBN (Squawk Creek burned) is located in an area of sparse sawgrass burned by the Squawk Creek fire (fig. 7).

Table 3. SQBN flow measurements.

Date	Time	Total depth (cm)	Velocity mean (cm/s)	Direction mean (deg)
11/8/2001	1103 - 1220	39	1.6	243
12/5/2001	0952 - 1017	30	1.3	242
1/24/2002	1015 - 1047	22	1.1	243
6/25/2002	1146 - 1218	41	1.2	248
7/24/2002	1049 - 1117	30	0.9	256
8/27/2002	1214 - 1245	27	1.0	245
9/26/2002	1030 - 1105	31	0.8	243
10/29/2002	1108 - 1152	32	1.0	252
12/3/2002	0950 - 1020	22	1.1	261

Data from 9 sets of vertical velocity profiles covering depths of 16 to 41 cm reveal mean velocities ranging from 0.8 to 1.6 cm/s at the SQBN site (Table 3). The vertical velocity structure is non-uniform with velocities near the water surface approximately double the magnitude of those in the lower part of the water column (fig.8). Velocities measured at the SQBN site have decreased in magnitude in the upper part of the water column between the 2001 and 2002 wet seasons (fig. 9).

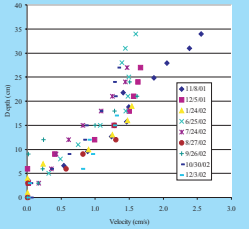

Figure 8. All flow profiles measured at SQBN.

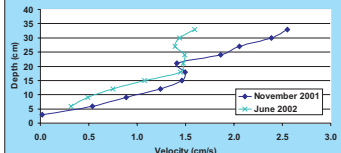

Figure 9. Two flow profiles measured at SQBN.

The dominant emergent vegetation at the SQBN site was sawgrass, though periphyton and muskgrass (*Chara* sp.) also were found in October and January (fig. 10). Plant heights varied between sampling events, ranging from 0.82 (+/- 0.10) to 1.31 (+/- 0.09) m, while percent volume occupied by vegetation increased from 0.52 (+/- 0.05) to 0.96 (+/- 0.09) %. Stem spacing was measured in the top 10 cm of the water column and, as the water level dropped from June 2002 to January 2003, spacings were taken farther down the sawgrass stems. Over this time period, spacings varied from 3.40 (+/- 0.20) to 5.87 (+/- 0.11) cm (Table 4).

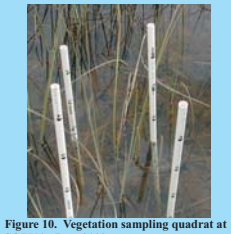

Figure 10. Vegetation sampling quadrat at SQBN in June 2002.

Table 4. Summary of vegetative sampling at SQBN.

Date	Species composition	Mean plant height (m)	Mean volume w/ periphyton (%)	Mean volume w/out periphyton (%)	Mean stem spacing in top 10 cm of water (cm)	Mean # stems in water column	Mean stem diameter (cm)	Site water level (cm)
January 2002	sparse sawgrass	1.31	N/A	N/A	4.10	21.33	0.50	22
June 2002	sparse sawgrass	0.82	0.54	0.52	3.40	26.30	0.50	42
October 2002	sparse sawgrass, periphyton, chara	1.20	1.28	0.65	5.87	10.07	0.45	32
January 2003	sparse sawgrass, periphyton	1.19	1.15	0.96	5.47	11.56	0.43	16