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Recent Patterns in the Vegetation of Taylor Slough, Everglades National Park

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Introduction

Taylor Slough is a 158 mi^2 freshwater wetland located in southern Miami-Dade County, Florida, within Everglades National Park (ENP). The slough consists of a relatively narrow, sediment-filled channel that broadens southward, flanked by areas 10-30 cm higher in elevation that are much broader than the slough itself (Fig. 1). The headwaters are poorly defined, originating north of the slough in the Rocky Glades, a slightly elevated area west of the Miami Rockridge, a low outcropping of oolitic limestone which forms the southern extent of the Atlantic Coastal Ridge. When sufficiently hydrated, Taylor Slough flows south to the mangrove forests that border Florida Bay. Although Long Pine Key is preserved as a slash pine forest reserve within ENP, the remainder of the Atlantic Coastal Ridge has undergone intensive urbanization and conversion to agriculture that has left little natural area remaining and has led to significant lowering of the water table throughout the region, including Taylor Slough. In addition, the northernmost portion of Taylor Slough lies outside of ENP. It has been drained and converted to agriculture and is now separated from the rest of the slough by the L-31W levee and canal.

Despite the evident changes in the hydrological regime of Taylor Slough, relatively few data are available pertaining to the effects of these changes on the vegetation. Water levels probably were once distinctly higher than today judging from reports that it was possible to navigate Taylor Slough by skiff all the way to Little Madeira Bay from Long Pine Key around 1900 (Craighead 1971). Under natural conditions, Taylor Slough regularly channeled water drained off adjacent uplands and marl prairies southward to the mangrove forests along the north shore of Florida Bay. During wet years, additional water flowed from the much larger Shark Slough to the northwest across the slightly elevated Rocky Glades into the northern portions of the Slough. The resultant sheet flow persisted in the early dry season, maintaining high marsh ground-water levels and freshwater flows to northern Florida At present, Taylor Slough is clogged with freshwater emergent vegetation in its upper and middle segments and by mangroves in its lower segments, a condition consistent with chronically lowered water levels.

Werner (1975) and Hofstetter and Hilsenbeck (1980) inventoried marsh vegetation from plots in the slough and the East Everglades, respectively, but the plots were not inventoried again. Thus, any changes in vegetation and their possible relationships to climatic and hydrological variations,that may have occurred since then cannot be determined. To remedy this deficiency and provide a quantitative basis for determining the effects of a newly established pump station situated on the L-31W canal, Olmsted et al. (1980) established vegetation baseline data from field inventory plots in 1977-78 along three transects downstream from the pump. In this report, we present results of

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resampling of one or more these transects in 1992 and 1995-99, thus providing the first opportunity to measure temporal change in the plant cover in Taylor Slough.

Alteration of the Natural Hydrologic Regime

The development of south Florida has depended on an elaborate water management system that was initiated in the late 19th century. The hydrological consequences for south Florida wetlands are well documented (**REF**). By 1963, when the L-29 canal extending across Tamiami Trail was completed, inflows to Shark Slough from the Water Conservation Areas to the north were provided entirely by way of water control structures (Fig. 1). Closer to Taylor Slough, the Everglades National Park-South Dade Conveyance System was authorized in 1968 for improving the supply and distribution of water to ENP, while providing for expanded agricultural and urban needs in southern Miami-Dade County (Fig. 1). The L-31 canal was realigned and the L-31W canal was added, thus severing the uppermost reaches of Taylor Slough lying just outside of the park boundaries from the main portion of the slough. Comparison of Taylor Slough discharges from 1960 to 1981 reveal the significant flow reductions that occurred after canal construction in 1968 (Rose et al. 1981)

Pump station S-332 on the L-31W, which began operation in 1980, was built to delivery water to Taylor Slough, thus partially replacing the lost flows that once originated from the upper reaches of the slough. However water deliveries here seldom were driven by natural hydrological conditions. In fact, since 1981, ground water stages in the headwater areas of Taylor Slough have been significantly lowered for flood protection east of the Park. As a result, large losses of water from the Taylor Slough marshes to the canals have frequently occurred (Van Lent et al. 1993) although adjustments of deliveries since 1993 have partly reversed this loss. In addition, the water management system has significantly reduced ground water levels in eastern areas of ENP, eliminating overland flows into Taylor Slough from the adjacent Rocky Glades areas to the north. These hydrologic alterations in southern Miami-Dade County have led to reductions in water table of two feet or more at the Homestead well located ca. 10 km (?) east of Taylor Slough (Craighead 1971; Ley et al. 1994). In the natural system, ground water levels were high enough in northern Taylor Slough and its adjacent drainage basin to inundate the soil surface two to three months per year (Van Lent et al. 1993).

Vegetation Patterns in Taylor Slough

The central channel of Taylor Slough supports aquatic plant communities tolerant of long periods of inundation while the slightly higher flanks are occupied by sedge and grass-dominated communities adapted to varying periods of surface inundation and growing on shallow marl soils (Olmsted et al. 1980). Periphyton is generally present in most of the plant communities and is the source of the calcite marl soils that formed on the limestone substrate. In addition, dispersed limestone outcrops within the Slough support tree-dominated communities of several kinds. Bay (Armentano *et al.* 2001).

Three vascular plant species are characteristic of the Slough and appear to have some value as indicators of hydrological conditions. Sawgrass (*Cladium jamaicense* Crantz) is the freshwater marsh dominant throughout most of the Everglades including large portions of Taylor Slough. It occurs in marshes which range in hydroperiod (annual flooding duration) from two to nine months and typically dominates marshes exposed to five to nine months of annual flooding (although water depths, fire severity and nutrient concentrations can affect distribution) (Wade et al. 1980; Doren et al. 1997; Olmsted and Armentano 1997). Muhly grass (*Muhlenbergia filipes* M. A. Curtis) is a characteristic species of marl prairies that annually are flooded for approximately one to three months a year but sometimes up to six months (Olmsted et al. 1980). Spike-rush (*Eleocharis cellulosa* Torry.) often is found in wet prairies that are annually flooded on average about six to nine months (Gunderson and Loftus 1993; Olmsted and Armentano 1997). All three species show considerable plasticity in adaptation to environmental conditions and thus the hydroperiod ranges suggested herein are best considered as approximations.

Because the headwaters of Taylor Slough are cut off by the L-31 canal and surface water flows from Shark Slough have declined, hydroperiods and water depths in the Slough can be assumed to have been reduced for at least three decades, and probably much longer. Numerous observations have been made that are consistent with a trend of lowered water tables. For example, increased fires, particularly in drought years, are believed to be responsible for the destruction of many bayheads in the East Everglades immediately north of Taylor Slough over the past 60 years or so (Craighead 1971; Hofstetter and Hilsenbeck 1980; Alexander and Crook 1984). In many cases, fires have consumed not only the bayhead vegetation but also the organic soils, leaving bare rock outcrops which are very resistant to recolonization.

In addition, the encroachment of exotic tree species (principally *Melaleuca quinquenervia* (Cav.) S.T. Blake, *Schinus terebinthifolius* Raddi, and *Casuarina equisetifolia* L.), along with apparent expansion of native woody species into Taylor Slough and Rocky Glades marshes, has been reported over the past several decades, but left unquantified (Hofstetter and Hilsenbeck 1980, Wade et al. 1980). Woody plant encroachment, along with expansion of native mesic herbaceous species into marshes (Hofstetter and Hilsenbeck 1980) are believed to be responses to reduced water levels and flooding duration brought about by water management policies.

Methods

Sampling Area

Taylor Slough's basin can be subdivided into five physiographic zones over its 20-mile length (Schomer and Drew 1982, Olmsted *et al.* 1980). The headwater zone collects freshwater that drains the surrounding slightly higher Rocky Glades area of low oolitic outcrops, short-hydroperiod marshes, and tree islands north of the main channel of the Slough. The three middle areas, the Upper, Middle and Lower Slough, consist of the main channel of the Slough and flanking areas of slightly higher areas which support marl prairies having hydroperiods that decrease with increasing distance from the channel. The southernmost area, the Coastal Swamps and Lagoons, is a coastal transitional area typified by tall or short mangrove forests and ponds that are somewhat saline, depending on rainfall regime and proximity to freshwater. The present study reports on the vegetation patterns along two line transects (Transects 4 and 5) established in the headwaters, two in

Upper Taylor Slough (Transects 1 and 2), and a fifth (Transect 3) in Middle Taylor Slough (Fig. 1). The location of the three lower transects and their plots was established by Olmsted and colleagues in 1979 (Olmsted et al. 1980). We were able to find the aluminum plot markers for this study, thus providing the opportunity to resample the same quadrats in either 1992 (Transect 2), 1995 (Transects 1 and 2) or 1996 (Transect 3 and three years To broaden the sampling areas of the northern part of Taylor Slough's basin, we added two additional transects (4 and 5), establishing 20 quadrats systematically along each transect. We following the same vegetation, soils and elevation data collection protocols.

Vegetation sampling

Olmsted and colleagues established 20 permanently marked 1m x 5 m plots, each comprised of five 1 x 1 m quadrats, along Transects 1-3 in 1979. Because of a particular interest in determining the effects of operation of the S-332 station upon the sawgrass and muhly communities of upper Taylor Slough, half the plots along each transect were established in Cladium stands (C plots) and half in Muhlenbergia stands (M plots). In this respect, Transects 4 and 5 differ because the 20 plots in each were not placed according to existing cover types but rather were placed systematically across the transect, adjusting distances as did Olmsted *et al*, to avoid tree islands or outcrops. Thus, although because of biased plot establishment, the results from transects 1-3 are not interpretable as estimates of general cover patterns across the transect areas, the changes that occur within the plots in all the transects across the years aid in understanding the nature of changes within the Slough.

In the spring of 1992, we resampled all 20 of the plots along Transect 2. In the winter and spring of 1995, 1996 and 1997, and again in 1999, we resampled 59 of the 60 plots, with one not found. Transect resampling varied depending upon time and availability of resources. Thus in most years, not all transects could be sampled.

The methods of Olmsted et al. (1980) were continued in order to be able to directly compare results. Cover (per cent of the ground surface covered in a vertical projection) was estimated for all vascular plants, for each of the 1 x 1 m quadrats along the transect. Since vegetation height was primarily under 1 m, observers could sight directly downward to estimate cover. Estimates of cover for each species ranged from 5 to 100% in 5% intervals. Cover of species having less than 5% cover were noted as present. Data were averaged at the level of the plot (5 m^2), providing 100 quadrat estimates and 20 plot estimates per transect. Areas covered by periphyton or devoid of vascular plant material were recorded separately as "open". The three dominant species (*Cladium jamaicense, Eleocharis cellulosa,* and *Muhlenbergia filipes*) were separated into living and dead categories and estimated separately.

All observers were trained and tested in visual estimation by the two senior investigators such there were participants in common through all the sampling in the 1992-1997 period. The spatial unit for which cover was estimated was 0.25 m^2 or 4 units per quadrat. A frame subdivided into quarters with string defined the observational unit. Blind testing of observer differences showed that discrepancy of species cover estimates between individuals was primarily 15% or less where cover was in the 50% range or above and smaller at lower cover. Thus differences of 15% or less between plots or years may not represent true cover differences. With rare exception, all species were identified' including small non-reproductive plants that required marking for future identification.

Soils and Elevation

Soil depths were estimated by probing down with a meter stick to the underlying limestone in the middle of each of the quadrats within the 1 x 5 m plots and the results averaged. There is a high degree of surface irregularity, so if unusually deep holes were encountered, they were excluded from the sample. A single elevation was determined for the middle quadrat of each plot using with a laser Topcon leveler tied to a permanent bench-mark established by professional surveyors.

Results

Results of the macrophyte cover estimates are presented below for each transect. Unfortunately, because the field data collected in 1979 were not archived and the plot-level data were not reported, it was possible only to compare results between 1979 and later sample years at the transect level, using the data presented in the Olmsted *et al* 1980 report. Although in the earlier study cover was determined for plots that were both unburned and recently burned, only the results of the unburned plots are presented to be more consistent with the general absence of fires in the plots in the 1990s (see below).

{Based on information from the three transects collected in 1979 and 1980, Olmsted *et al* (1980) describe a marsh indicative of relatively dry conditions where Muhlenbergia and sparse Cladium were competing in most of the areas outside of the central aquatic slough. Although this broad, simplified description also characterized the marsh in the early 1990's, marked changes in the vegetation were underway in the mid-1990's and perhaps as early as 1993. From data on Transect 2 taken in 1992, Muhlenbergia still prevailed in most areas}.

1979- 1999 Vegetation Patterns

Transect 1, the shortest transect, is located 300-500 m southwest of the junction of the Slough with the L-31W canal where the S-332 pump discharges canal water into the Slough (Fig. 1). The Slough is about 300 m wide at this point and the transect is 520 m wide. According to Olmsted *et al.* (1980), soils across the entire transect were marl with no accumulated peat even in the center of the Slough. Our resampling confirmed this pattern in the 1990s. Soil depths measured in 1999, varied from 35.0 cm to 56.8 cm, with greater depths towards center of the Slough. However, the Slough is relatively ill-defined here, both narrow in extent and shallow relative to the surrounding marshes. Transect 1 is the sampling area closest to the L-31W canal and pump station and thus would be most likely to exhibit the effects of altered water management. Elevations range from 1.2-1.4 m above sea level on the ends of the transect down to 0.9-1.1 m in the center of the Slough (Fig. 2).

1979 Vegetation pattern. In 1979, total cover averaged 49.3 % across the transect, of which 30.3%

was Muhlenbergia and only 6.4 % Cladium (Table 1). No other species exceeded 1% cover (Table 1) In the M plots, Muhlenbergia clearly was dominant (60.6% absolute cover, and over 90% of the relative cover), but Cladium cover was only 1.5%. In the C plots, total cover was only 32.6%. Six species exceeded 1% cover, the most prevalent being Cladium (11.2%), and *Centella asiatica,* (9%). Muhlenbergia was absent from the C plots.
Eleocharis was absent from all M plots and although it occurred on 56% of the C plots, its cover averaged only 0.6%.

1995 Vegetation pattern. The predominant species across the transect in 1995 was *Cladium* which comprised a significant component of all plots (Fig. 3). Although *Eleocharis cellulosa* was absent in 1979, it's absolute cover in 1995 was 30% or greater on four of the 20 plots. It occurred on 65% of the 20 plots, being absent only in the plots at the two ends of the transect where elevations are relatively high. Plots here were mainly comprised of *Cladium* with Muhlenbergia cover generally under 10%. Total absolute cover largely mirrored that of the predominant species, exceeding 50% on only four of the plots and 70% on the two where *Eleocharis* peaked. Cover was generally under 30 % at the high ends of the transect.

For the transect as a whole, total vascular cover averaged 39%. The relative cover of *Cladium* was 31% (i.e. 31% of mean absolute vascular cover) of which 18.5% was live above-ground material and 12.7% was dead standing leaf and stem biomass. *Eleocharis* relative cover averaged 19.8% across the transect, of which 11.1% was dead and 8.6% live. *Muhlenbergia* averaged only 4.9 % cover, of which 3.1% was live.

The total number of vascular species per plot ranged from 7 to 16. The eastern segment of the transect had the most species and the central portion the least, but the trends were not strong. ??*Panicum hemitomum* was an important secondary species. It contributed nearly 13% of the relative cover across the transect. The mean relative cover of all other species fell below 10%.??

1999 Vegetation Pattern- Two years later the cover changes were small, within the margin of estimation error. However the frequency of Cladium increased from _% to _%, as it appeared in __plots in the center and western ends of the transect. Eleocharis remained important and appeared in 2 new plots, but disappeared from one and Muhlenbergia appeared in 2 plots on the western end but with very low cover throughout.

Transect 2 is just over 2 km long and situated 300 m north of the Main Park Road. Nineteen of the 20 original plots were found in 1992 and in succeeding years. The transect spans the Slough proper, which at this level has expanded to about 600 m wide. However none of the plots were situated within the central, peat-filled portion of the Slough. Elevation at the deepest part of the Slough is more than 0.6 m lower than the eastern margin and the bedrock surface is, at its lowest, 30 cm above mean sea level (Olmsted *et al.* 1980). The eastern side of the transect approaches the limestone outcrops occupied by slash pine where topography is more dissected, solution holes are common, and soil depth often is less than 20 cm. Marl mantles most of the area but peat is found beneath the aquatic communities (*Pontederia, Phragmites, Paspalidium geminatum, Panicum hemitomum, Eleocharis cellulosa*) in the center of the Slough and in the willowheads that are dispersed widely in the area.

1979 Vegetation Pattern. Total vascular cover averaged 35.5% across the twenty plots (Table 1). In the M plots, Muhlenbergia averaged 34.8% out of a total cover of 44.7%, with Cladium (2.6%) the only other species exceeding 1%. Total cover in the C plots averaged only 26.3%, with Cladium (12.6%) and Centella asiatica (6.5%) the most important of the 5 species exceeding 1% cover. Muhlenbergia was absent.

1992 Vegetation pattern. Transect 2 was marked by a strong asymmetry in plant cover in 1992 (Fig. 2).. *Muhlenbergia* dominated the western plots, where its cover ranged from 48 to 65%, but was elsewhere either absent or its cover was under 20%. Frequency of *Cladium* was 100% but its cover never exceeded 30 %. *Eleocharis,* absent in 1979, occurred on 10% of the plots with mean absolute cover below 10%. Total vascular plant cover averaged 45.8%, declining nearly continuously from the western end of the transect but increased in the two eastern plots. The sharp increases there were due mostly to the presence of *Spartina bakeri*, a coarse perennial bunch grass sometimes common in short hydroperiod prairies. Overall this species was scarce along the sample transects, but not rare. Its frequency was 15% along Transect 2.

Across the entire transect, *Cladium* comprised 28.6% of the total cover, 19.1% live and 9.5% dead. *Muhlenbergia* relative cover averaged 27.6% across the transect, 18.7% live and 8.9% dead. The only other species to exceed 10% cover for the entire transect was *Centella asiatica,* a small stoloniferous forb with an average relative cover of 11.4%. The total number of species per plot ranged widely from 7 to 21. However there was a general trend of decreasing numbers from west to east beginning in the center of the Slough, a pattern that resembled the total cover changes.

1995 Vegetation pattern. Based on resampling of 19 plots, dramatic changes occurred in the prevailing vegetation along Transect 2 from May 1992 to May 1995. There was a surge in *Eleocharis* which dominated 7 plots in 1995 where it was missing or insignificant in 1992. The frequency of *Eleocharis* increased from 10% in 1992 to 52% in 1995. In contrast, although *Muhlenbergia* frequency remained similar (it disappeared from only one plot), live cover dropped precipitously. Its cover declined from around 50% in 1992 on the western side of the Slough to below 10%. Muhlenbergia cover also declined on the eastern side but to a much less degree. The change in *Cladium* was small- frequency remained at 100% and although *Cladium* cover declined in the middle of the transect, it increased somewhat on the two sides.

The surge in *Eleocharis* in the center of the transect close to the Slough channel was a cause of a near doubling of total cover in places while total cover actually declined by half or more on the western side where *Muhlenbergia* formally dominated. In other words, the lost Muhlenbergia was not replaced by other vascular species. In these areas, instead, there was a conspicuous increase in periphyton cover. On the eastern side where elevations are highest, and soils thinnest, total cover changed relatively little. Thus this side of the Slough was most nearly stable in both dominant species and total vascular cover.

The trend in total species numbers across the transect differed somewhat between the years but without a clear trend. However note that *Spartina bakeri* Merrill. disappeared from the eastern plots by 1995 while the endemic *Schizachrium rhizomatum* (Swallen) Gould, a much smaller perennial grass characteristic of very short-hydroperiod marshes, and thin soils often found in pineland glades which was absent in 1992, became important in those same plots in 1995.

1999 Pattern- In the 4 years since the last sampling, cover the trend of declining Muhlenbergia and expansion of Eleocharis and to a lesser degree Cladium continued. Muhlenbergia continued to decline in both cover and frequency on the west and east ends of the transect. The increase in Eleocharis was dramatic, clearly increasing total cover. Cladium changes in cover were small but it expanded into new areas, as seen in a increse in frequency from _ to _%.

Transect 3 located about 3 km south of the Main Park Road was established at a length of 3.9 km but only the segment east of the Slough was sampled in 1979, a distance of 0.4 km, so our study also was confined to the smaller area. As a consequence sampling did not cross the Slough, producing a more homogeneous sampling area. Soils are entirely calcareous marl and deeper (43.0 cm to 91.4 cm) than areas further north. Elevation of the soil surface across the sampled segment ranges from 35 to 72 cm ASL but is primarily between 40 and 60 cm ASL.

1979 Vegetation Pattern. Total vascular cover was low, just 14.4 to 15.5% across, respectively, in the M and C plots (Table 1). Olmsted et al (1980) speculated that this might have been an area of recent Muhlenbergia colonization but offered no evidence.. In the M plots, Muhlenbergia averaged 8.6% and Cladium 3.2%, the only species reaching 1%. In the C plots, Cladium averaged 13.3% and Muhlenbergia 1.0%, the only species reaching 1.0% cover.

1996 Vegetation Pattern. The transect crossed a marsh dominated by mid-sized *Cladium* that dominated the plant cover in every plot (Fig. 5). *Muhlenbergia* occurred in 55% of the plots, primarily on the eastern side, but was unimportant with cover never exceeding 15%. *Eleocharis* frequency was 45%, with a maximum of 33% cover in one plot. The distribution of the latter two species were largely non-overlapping across the transect. Total mean vascular cover followed closely *Cladium's* cover trend, reaching a maximum of 80% on the eastern side. Total vascular cover exceeded 50% on 55% of the plots; the most of any transect. Species diversity on Transect 3 was low, mostly 3 to 10 species per plot.

1999 Vegetation Pattern – The clearest trend was seen in the increased Eleocharis cover in the middle of the transect. Cladium maintained its strong dominance while Muhlenbergia, unimportant in all the plots declined, as seen in decreased frequency.

Transect 4 was established in 1997 in the Rocky Glades portion of the southern East Everglades near Context Road, 11 km northwest of the intersection of the Slough and L-31W canal (Fig. 1). The road, which roughly parallels the transect a few hundred meters to the north, now exists only as a roadbed that penetrated 6 km into the rough karst topography of this western transition to the Atlantic Coastal Rocklands. Although rough limestone outcrops typify the area, broad swaths of marl prairie occupy increasingly large areas westward towards Shark Slough. A 2 km transect was established on the south side of the road and the marsh vegetation was sampled in Jan. 1997. The terrain here is relatively level with the 20 plots varying from 1.28 to 1.81 m ASL, and most plots falling within 1.4 to 1.8 m ASL. Soil depths are shallow ranging from 8.8 to 37.8 cm, averaging only 18.7 cm

1997 Vegetation Pattern. The marsh was dominated by *Cladium* and *Muhlenbergia which* dominate 45% and 40% of the quadrats, respectively (Fig. 6). In the three remaining plots both species were present in small, approximately equal amounts. Frequencies of the two species were 100% and 90%, respectively. In contrast, *Eleocharis* occurred in only 15% of the plots at cover values well under 10%. Overall cover along the Transect was 45.4%, 18.7 % as *Cladium* and 15.9 % as *Muhlenbergia*, most of the remaining vascular cover was contributed by short hydroperiod species such as *Schizachrium rhizomatum.* Species diversity was high ranging from 12 to 23 species per quadrat and averaging 18 per quadrat. Most of the species were forbs and graminoid species ordinarily restricted to drier, short hydroperiod habitats.

1999 Vegetation Pattern In only two years, changes are relatively small except that Muhlenbergia declined cover markedly in cover while maintaining high frequency. Cladium may be expanding slowly into Muhlenbergia areas but future monitoring would be needed for verification.

Transect 5 extends due west of the L-31W canal almost 2 km north of the juncture of the Slough and the S-332 pump station, but well within the drainage basin of the Slough (Fig. 1). Elevations are intermediate between Transects 3 and 4, ranging from 0.98 to 1.58 m ASL, averaging 1.31 m ASL. Soil depths vary from 15.4 to 41.6 cm, averaging 26.9 cm.

1997 Vegetation Pattern. As in Transect 4, *Muhlenbergia* and *Cladium* were dominant throughout, both species occurring in all quadrats (Fig. 7). Total absolute cover averaged 43.5% across the transect, 11.5% as *Cladium* and 16% as *Muhlenbergia.* Compared to other transects, other species were relatively important, especially ________ and __________ comprising another 16% of the transect cover. Species diversity was intermediate among the transects, averaging 18.6 species per quadrat, but ranging from 12 to 22 species.

1999 Vegetation Pattern- Cover changes were too small to detect a trend in this Muhlenbergia-dominated prairie, but the appearance of Cladium in _ new plots is perhaps noteworthy.

Discussion

Despite the previously described data limitations, the results of this field monitoring study provide evidence that the vascular plant cover of substantial areas of Taylor Slough has been changing in the decade of the 1990's, with a overall shift towards dominance by species adapted to longer periods of surface flooding than in previous decades.

The trends in vascular trends are most obvious from Transect 2 , which show that in the past decade the vegetation has undergone distinct shifts in dominant cover types in parallel with changes in hydrological conditions. Most likely, the shift from the dry period of 1988-91, followed by the protracted hydroperiods of 1993-97 has played a major role in the changes. The change was already evident in 1995, when, compared to 1992, a dramatic increase in Eleocharis cover accompanied a large decline in Muhlenbergia cover. In contrast, the 1992 cover pattern appeared to resemble more closely that observed in 1979 by Olmsted et al (1980), as well as that observed in 1974 by Werner (1975). The data show that over the same interval, Cladium expanded into areas formally occupied by Muhlenbergia, a response predicted by Olmsted et al. (1980). However the expansion of Eleocharis was not foreseen by those authors . Based on the 1999 results, this trend has continued in the Transect 2, suggesting a shift that extended over more than five years. Because there are fewer data from the other transects, the trends are less conspicuous, but similar but smaller shifts involving declining Muhlenbergia- and increasing Eleocharis cover (from 1996 to 1999 along Transect 3), or increasing Cladium cover (from 1997 to 1999 along Transect 4). Along transects 1 and 4, the cover changes observed in the 1990's were smaller and more sampling may be needed to determine if there is a trend. However, a shift away from Muhlenbergia and towards the other two species appears to have occurred between 1979 and 1995 just like in Transect 2.

The trends in total vascular cover were more variable than that of individual species, but largely mirrored the behavior of the dominants. Clearly Eleocharis was more successful in moving into formerly Cladium-dominated plots than into Muhlenbergia-dominated plots, probably because of the longer hydroperids in the Cladium plots, and, in some cases, their shorter distance to the central slough area where Eleocharis was already established. The patterns suggest that Elocharis is capable of faster colonization and clonal expansion than Cladium and that declines in total cover represented the time lags between Muhlenbergia loss and Cladium expansion.

Besides hydrological conditions, nutrient availability and fire are considered to be important in affecting marsh communities in the Everglades ( ). Neither can be dismissed as important, but their dynamics do not appear consistent with the observed vegetation patterns. Given the proximity of Transect 1 to the L-31W canal, some nutrient enrichment might be expected, especially relative to marsh areas far from the canal. However, although only limited data are available on the flow of nutrients into Taylor Slough, total phosphorus concentrations of water entering Taylor Slough at S-332 averaged about 11 ppb in the mid-1990's, a value only slightly above natural background levels for the Everglades of 5-10 ppb or less (Rudnick et al. in press).

We reviewed the fire records for the transect areas for the 1981 to 1998 period because of the known importance of fire in modifying vegetation in the fire- adapted marl prairie community. The records provide polygons whch delimit the perimeter of each fire rather than the area actually burned. Given the patchiness of Everglades wetland fires ( ), this means that even if plots fell withn a polygon, they may not have burned. The last year in which fire could conceivably have affected any of the transects was in 1995 when a fire burned the far western edge of Transect 5, but fell short of the majority of plots. In 1991, fire burned the eastern 60% of the same transect. The effects of this latter fire on the marsh vegetation in 1995 when the transect was first sampled are not known but are believed to be unimportant given the capacity of *Muhlenbergia* and *Cladium* to recover from fire within several years ( ). In 1990, a fire approached but did not actually encroach on transect 3. In 1986, portions of the eastern portion of Transect 4 were burned, but this was a decade before sampling.. Widespread fires in 1985 burned over the entire area of Transect 5, and portions of Transects 3 and 4. Transect 5 also burned in 1983 and Transect 4 in 1981. Thus over the period of fire records the marsh was burned quite irregularly both in space and time. Whether fire has differentially affected Taylor Slough and influenced our plant cover estimates is dependent on how long after the fire data were taken. Because the soils in the study sites were calcareous marls rather than peat, substrates impacts of fire would be minor. Given that sawgrass regains it's pre-burn stature in one to two years even when most of the vegetative cover is removed (Wade et. al. 1980), the effects of fire on our transects would seem negligible in the case of Transects 1-4. Fire effects on Transect 5 are less clear given that frequent, repeated burning can have deleterious effects on marsh vegetation (Wade et al. 1980) but this must be left unresolved for now.

The long hydrological record at the Taylor Slough Bridge reveals some decadal patterns related to canal construction and operation that could have influenced vegetation patterns Rose et al. 1981, Fig --). Clearly the 1989-98 period had much higher stages at the Taylor Slough bridge station than the pervious four decades. Within the period of our sampling, it is possible to estimate the length of inundation at each plot from elevation survey data and elevation and water level data from the nearest hydrological monitoring station (Fig.__). The results are presented as averages over three years, a period in which, based on the data from this study, marsh vegetation would have been capable of adjusting to changes in hydrological conditions. The period immediately prior to the Olmsted et al (1980) sampling can be see to have been much drier than the mid and late 1990's. During the latter periods, inundation durations more than doubled in many plots compared to the period of the Olmsted et al (1980) study. A strong drought occurred in the 1989-92 period producing inundation durations similar to those in 1976-1979, probably explaining why vascular cover along Transect 2 was similar in 1992 and 1979. Figure __ also shows how much wetter the southernmost of the transects was and points out a pattern noted by Olmsted et al (1980), namely that Muhlenbergia occurred under wetter conditions in the more southern areas of Taylor Slough, at hydroperiods which do not support Muhlenbergia further north.

Construction of the L-31W canal/levee system began in September 1968, marking the transition to a new hydrology regime as measured at the Bridge station. Comparison of mean monthly peak water levels averaged over 1960 to 1968 with those for the 1969 to 1978 period shows that water levels were, in addition to being lowered, shifted from October to September. Early wet season levels also were lowered and shifted, in this case from July to June. Water levels were held lower through most of the year, except in the late dry season. The altered hydrological conditions suggest that the extensive *Muhlenbergia* cover found by Werner (1975) and Olmsted et al., (1980) reflected the reduced water levels of the times rather than any kind of pre-disturbance state. Unfortunately, vegetation data from earlier periods are lacking and this assumption cannot be evaluated. However such a conclusion is consistent with the absence of mention in scientific publications of *Muhlenbergia*- dominated prairie in the southern Everglades region prior to the 1950s.

More recently, an evident shift in water levels in the mid-1990s coincided with the declines in *Muhlenbergia* cover and increases in species associated with longer hydroperiods that appears in our data (Fig. 8). The higher water levels are related both to increased precipitation (especially in 1993-

1995) following drought years in 1988-90, and to shifts in water deliveries between the C-111 and L-31W canals that began in 1993 (Armentano 1997, Van Lent). Thus the vegetation changes seen in the 1990s appear at least in part due to lengthened hydroperiod. Thus it is reasonable but unverifiable that the mid-1990s pattern, with scarce *Muhlenbergia* and greater cover by species tolerant of longer hydroperiods, more closely resembles pre-disturbance patterns than in the 1970s.

*Results : measurable change in ~ 3 yr; in 1999, continuing shift to long hydroperiod-tolerant communities that began in mid-90's; connection to hydro record. predictable shift in dominant species; also in sp richness; cover (standing crop) robust across soil depth and elevation;

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Table 1. Year of Sampling for Taylor Slough Transects

Transect No.	Year Sampled						
	1979	1992	1995	1996	1997	1998	1999
1	X		X				X
2	X	X	X				X
3	X			X			X
4					X		X
5					X		X