PRELIMINARY REPORT ON THE RESTORATION OF FARMED FRESHWATER MARSHES AT CORKSCREW SWAMP SANCTUARY

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Abstract

Approximately 180 ha of freshwater marshes at Corkscrew Swamp Sanctuary in Collier County, Florida were modified by vegetable farming operations in the mid 1950s. The farmed areas consist of perimeter earthen dikes, with adjacent parallel ditches, and contain a network of smaller interior dikes and ditches, all of which were constructed for water control purposes. Ecological impacts of these farmed areas range from localized, but drastic, changes in ground elevation, hyperperiod, and plant communities, to broad alterations of surface water flows.

In the spring of 1981, earth moving equipment was used to push dike material back into adjacent ditches in an attempt to restore the natural profile of approximately 60 ha of the farmed marsh. An extensive photographic record was made before, during, and after the restoration work. In the fall of 1981, elevation profiles of the restored areas were made and vegetation transects were established, along which species composition, percent cover, height, and biomass of vegetation in restored and control areas were determined. Preliminary analyses indicate that total organic accumulations on the dikes and ditches (a function of time elapsed since field construction) was the major factor affecting success of natural profile restoration, and made precise releveling on our site impossible. Vegetative recovery after one growing season was essentially complete on restored ditches, while restored dikes showed minimal recovery.

Introduction

Corkscrew Swamp Sanctuary is a 4,400 ha natural area preserve located in northwestern Collier County, Florida. The sanctuary lies just within the northern limits of the Big Cypress Swamp region and contains extensive areas of virgin cypress forest and freshwater marsh. This preserve is owned by the National Audubon Society, whose primary management objective is to maintain the area in as natural a condition as possible.

In the mid 1950s, before Audubon acquisition of the area, approximately 180 ha of the sanctuary's freshwater marshes were modified by vegetable farming operations. These modifications consisted of extensive networks of dikes and ditches installed for water control purposes within the farm fields. Ground elevation changes associated with these structures resulted in obvious plant community alterations and the presence of highly visible ridges and swales within an otherwise pristine marsh system.

The elevated dikes provide permanently dry sites for a variety of native trees and shrubs, which would not otherwise be found in marshes. But of greater concern in a natural preserve is the presence of several exotic plant species on the altered sites. Brazilian pepper (*Schinus terebinthifolius*) and melaleuca (*Melaleuca leucodendron*) can be found on dikes and water hyacinth (*Eichornia crassipes*) is very common in the ditches. All these exotic species have shown themselves to be aggressive invaders in other areas of South Florida, capable of completely displacing native plant communities. Old field dikes and ditches provide lanes of access across marshlands, which would otherwise act as barriers to the spread of these exotics.

Although the effect of the farmed areas on surface water flow has not been measured, it is potentially very great. The marshes in which Corkscrew's old fields occur serve as a major flow way into the sanctuary. Since farm dikes are sometimes oriented perpendicular to natural flow patterns and can be continuous from one upland to another, the potential for alteration of natural flow is obvious.

Because of these visual and ecological impacts, attempts were made in the spring of 1981 to restore the original marsh ground profile of the farmed areas with earth moving equipment. This report described the success of this ground leveling technique and the preliminary results of an ongoing vegetation monitoring study.

Study Site

The study site is a 60 ha old field located in an extensive freshwater marsh in northeastern Corkscrew Swamp Sanctuary. Exact construction date of the field is not known. However, they do not appear on January 1953 aerial photography, but are present on a 1958 USGA topographic map.

Farming history was probably typical of the winter vegetable operations throughout South Florida from 1940 to the early 1970s. Farm fields were located in marshes to minimize or eliminate the need to clear woody vegetation. A network of ditches and dikes was quickly excavated in the study substrate, and when coupled with a system of pumps and wells for drainage or irrigation, shallow ground water levels within the fields could be fairly well controlled. The farm ditches were continuous excavations five to six meters wide at the original ground surface, sloping down from both sides to a maximum depth of about one meter. The spoil material deposited next to the ditch resulted in a continuous ridge, or dike, also five to six meters wide at the original surface, but sloping to a maximum height of about one meter.

Fields were then disced to eliminate native vegetation and make the soil workable, and low ridges (beds) were plowed into the surface. Beds were approximately one meter wide and 0.3 meters high, and provided an elevated well-drained row upon which the vegetables were planted. Chemical fertilizers and pesticides were applied liberally to these areas. However, because chemicals did not exist at that time which controlled certain soil-borne plant diseases, the fields were normally farmed only one season and then abandoned. Our study area, therefore, has probably been recovering from farming impacts for 24 years.

It is questionable that the entire area within the perimeter dike of the study site was actually farmed. The larger western section of old field has visible plant bed remnants indicating farming did occur (Fig. 1). However, beds are not visible in the smaller eastern section. This section could have been disced flat after farming or left unfarmed. Other than complicating elevation measurements within the old field, this has little effect on our study, since all restoration efforts involved only major ditches and dikes, and determination of the effects of the smaller beds was not part of the study design.

Methods and Materials

In May 1981, a D6 bulldozer began pushing dike material back into adjacent ditches on the study site. This work was done in the spring during naturally low water conditions, so that the impacts of the heavy equipment would be minimal on the dry marsh substrate. The operator was instructed to restore the profile of the dikes and ditches as closely as

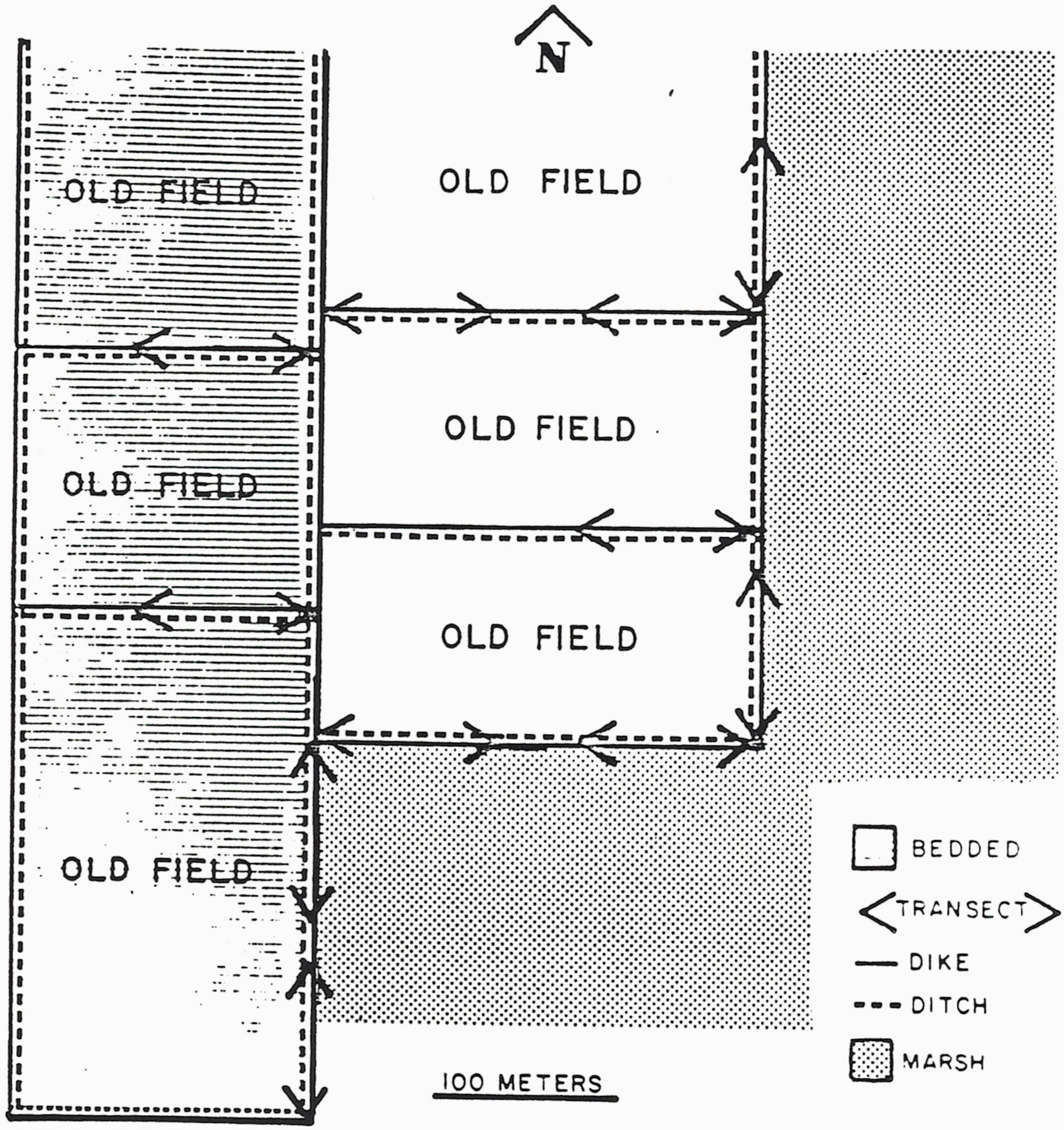

Fig. 1. Old field study site.

possible to the adjacent marsh or old field levels. Dike material, which was almost exclusively sand, was pushed back into ditches, from a direction perpendicular to the dike and then segments of the releveled areas were back bladed. All 2200 m of dike in the study area were leveled in four days.

Photo points were established at all corners and intersections of the restored lanes and photos taken June 3 and July 30, 1981 and April 30, 1982. Eleven 100 m long vegetation and elevation sampling transects were installed in November 1981, as shown in Fig. 1. Three equally spaced elevation profiles were made across each transect. Each profile consisted of one measurement in both the old field and control marsh 10 meters perpendicular to the transect, and two measurements on the restored ditch and dike. Elevation measurements were made with a Keuffel & Esser model 77 builder's level and a Crain metric stadia rod.

Four vegetation samples were made at a randomly-selected position along each transect. Marsh and old field samples were located 20 m from the random location perpendicular to the transect; ditch and dike samples 3 meters off the transect, centered on the restored areas. Within square 1 m^2 frames plant species were identified and the relative abundance of each species was estimated. General height of vegetation was measured and percent cover was estimated. All standing vegetation was clipped, separated into live and dead, and oven dried at 100°C for 24 hours in the lab.

Results

Elevation data show the marsh to be quite flat, the maximum range of our individual measurements was only 17 cm with no indication of a general slope. Values for the old field are complicated by the presence of plant bed remnants, which have an average height difference of 7 cm (Fig. 2). As would be expected, the mean elevation of the undisturbed marsh falls between the means of the bed tops and swale bottoms. The mean elevation of the unbedded region of old field is similar to the marsh as are the strips of restored dikes in both bedded and unbedded areas. However, the filled ditches are considerably higher in both regions. The difference in elevation means between restored dikes and ditches for each of our transects averaged 12 cm (range 4-19 cm) with filled ditches being consistently higher.

The biomass of living vegetation in natural marsh and old field plots was essentially the same (Fig. 3) and agrees well with biomass values for other marshes in the area reported by Duever et al (1976). The mean live biomass on the restored ditches and dikes after one growing season was approximately 60% greater and 80% less, respectively, than the control marsh. Standing dead vegetation was negligible on the restored areas, since all vegetation on them had produced that year and little had died by the sampling date. Height of live vegetation showed the same relationship among the sites as live biomass, except that the values for ditches were more similar to the marsh and old field (Fig. 4). Vegetation height was much less on the sparsely vegetated dikes. Percent cover values were similar for the marsh, old field and ditch sites, except that the old field values, at nearly 100%, were greatest (Fig. 4). Restored dike plots had about one-third to one-half as much cover as control marsh and restored ditch sites respectively.

An average of 7 plant species occurred in m^2 biomass plots in the marsh and old field; ditches averaged 4 species per plot and dikes 3.

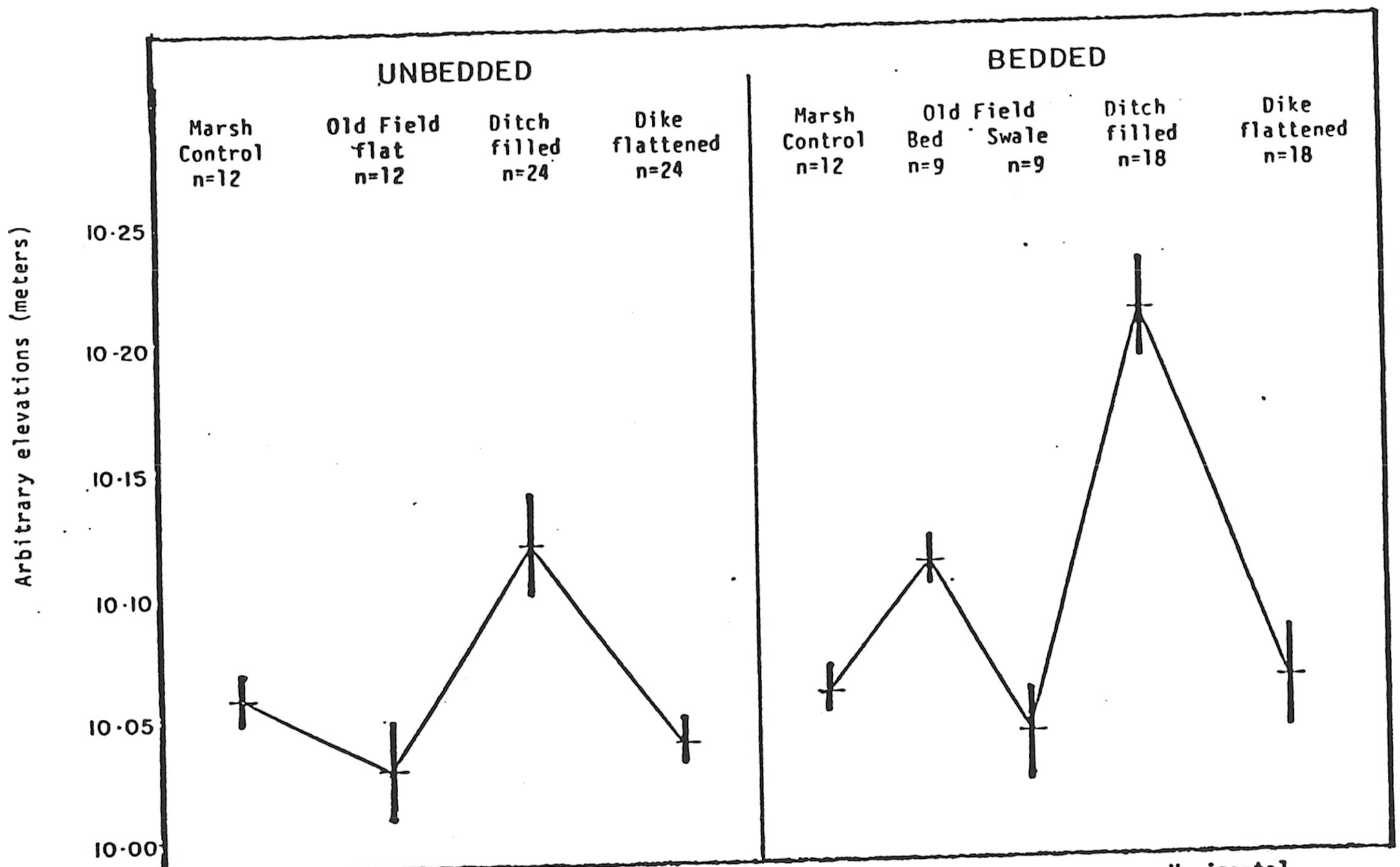

Fig. 2. Relative elevations of Natural Marsh, Old Field, and Restored Dikes and Ditches. Horizontal lines indicate means, vertical lines indicate ± one standard error.

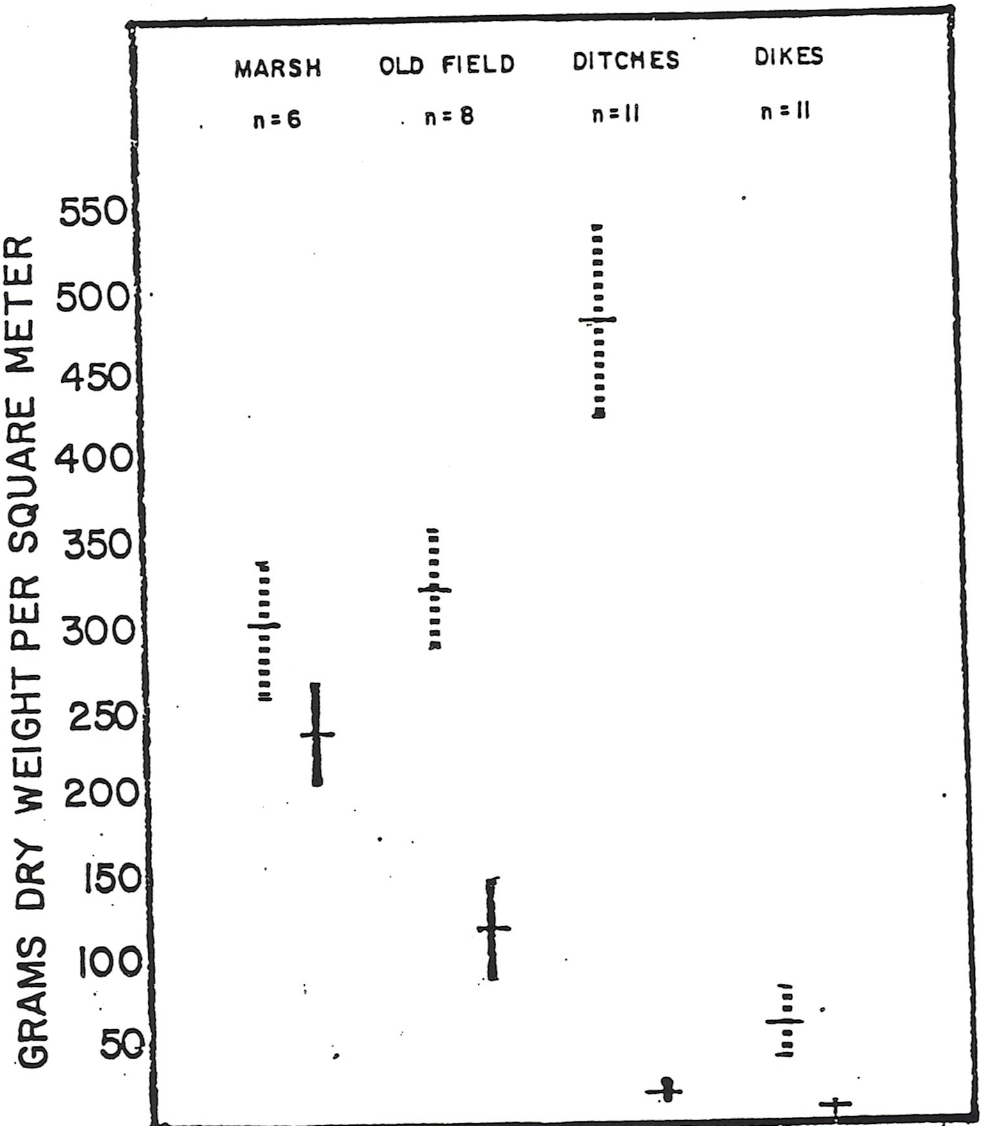

Fig. 3. Biomass of Marsh, Old Field, and restored areas after one growing season. Horizontal lines indicate means, vertical lines indicate ± one standard error. Dashed lines indicate live vegetation, solid lines indicate standing dead vegetation.

Species were listed in order of their abundance for each plot (subjectively and the top three ranked species were considered dominants. The percent frequency that each species was found in a plot and how frequently it dominated the sample is shown in Table 1. Species composition of the marsh and old field samples were fairly similar. However, maidencane (<u>Panicum hemitomon</u>) and other panicums were more common in the marsh. <u>Utricularia</u> and <u>Pluchea</u>, which were fairly common marsh plants, were absent in the old field. <u>Lippia</u> was more common and <u>Centrella</u> more abundant in the old field. <u>Eleocharis</u> was important in the old field and absent in the marsh.

Almost all restored ditch sites were dominated by maidencane; the next most abundant species was an exotic plant, <u>Urea lobata</u>; unidentified panicums and <u>Diodia</u> were also abundant.

As we have seen from the previous data, dike sites were sparsely vegetated. Species occurring on these areas, where up to 1 meter of soil was scraped off, should be considered pioneers. Panicums, <u>Cyperus</u>, and <u>Utricularia</u> were most common; <u>Sagittaria</u>, <u>Diodia</u>, and <u>Ludwigia</u> fairly common; maidencane, <u>Urena</u> and <u>Polygonum</u> were occasionally present.

Discussion and Conclusions

Our results indicate that moderately sized, readily available earth moving equipment, such as a D6 dozer, can restore natural ground elevations of areas impacted by farm ditches and dikes at the rate of about 550 meters of dike-ditch per day with good precision. This rate of restoration enabled us to restore a 60 ha old field in four days (34 hours) at a total cost of $1,360.

Elevation measurements show accuracy of the dike leveling to be

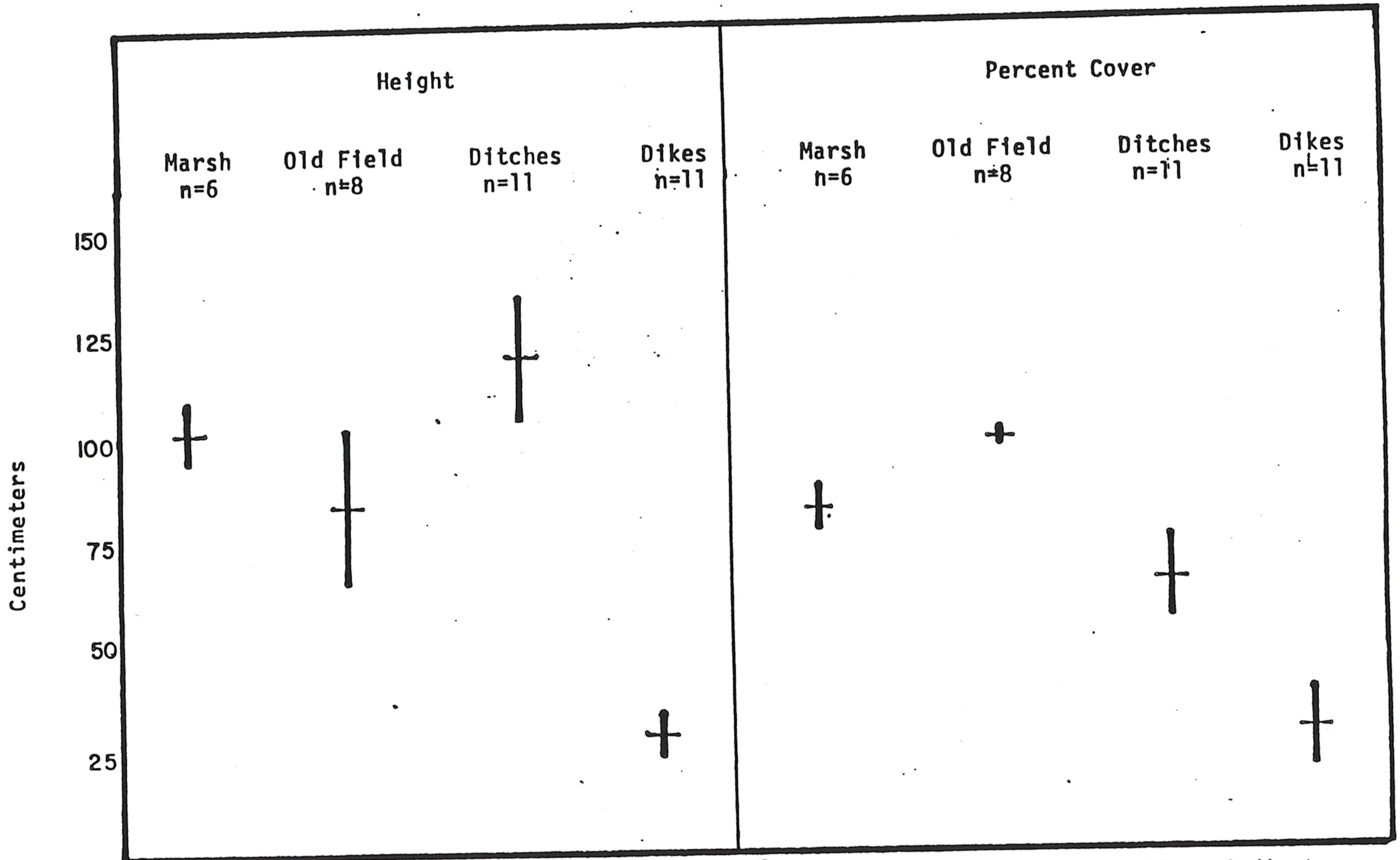

Fig. 4. Height and percent cover of live vegetation in m^2 biomass plots. Horizontal lines indicate means, vertical lines indicate $\pm$ one standard error.

Table 1. Species composition of natural marsh and restored old field biomass samples. First number in a column indicates percent frequency of occurrence, second number indicates percent frequency of dominance.

	Marsh (control) n=6	Old Field n=8	Ditches (filled) n=11	Dikes (flattened) n=11
Panicum hemitomon	67-67	38-38	91-91	18-18
Panicum sp.	67-67	50-25	64-55	45-36
Pontederia lanceolata	67-33	63-63	9- 9	9- 9
Cyperus sp.	50-33	38-25	- - -	64-27
Utricularia inflata	50-16	- - -	9- 9	64-55
Sagittaria lancifolia	16-16	25-25	9- 9	27-18
Spartina bakeri	16-16	- - -	- - -	- - -
Nymphoides aquatica	16-16	13- 0	9- 0	- - -
Centella asiatica	83- 0	88-50	9- 9	- - -
Bacopa caroliniana	67- 0	50- 0	9- 0	9- 0
Diodia virginiana	67- 0	38- 0	64-27	27-18
Pluchea sp.	50- 0	- - -	- - -	- - -
Lippia nodiflora	33- 0	100-13	9- 0	- - -
Polygonum hydropiperoides	16- 0	38-13	9- 9	18-18
Ipomea sp.	16- 0	- - -	- - -	- - -
Ludwigia repens	16- 0	- - -	9- 0	36-36
Eleocharis cellulosa	- - -	50-50	- - -	- - -
Aster carolinianus	- - -	38- 0	- - -	- - -
Andropogon sp.	- - -	13- 0	- - -	- - -
Hydrocotyl umbellata	- - -	25- 0	36- 0	- - -
Proserpinaca palustris	- - -	13- 0	- - -	9- 0
Urena lobata	- - -	- - -	82-64	18-18

almost perfect when compared to control areas. The adjacent filled ditches, however, were substantially higher than the flattened dikes and control areas.

Several factors which could have contributed to this difference include operator skill, unconsolidation of the fill material, and the presence of substantial amounts of vegetation and organic matter on the dikes and ditches at the time of restoration. The first two factors are not considered to be significant, since (1) the operator was consistently able to level the dikes to the control elevations, and (2) elevation measurements were made more than six months after the restoration work, allowing an entire wet season to inundate and settle the filled areas.

The accumulation of organic material on the dikes and ditches since field construction is felt to be the most important factor affecting both the speed and accuracy of the releveling. After more than 20 years of recovery, both dikes and ditches were heavily vegetated. In addition to shrubs and ground covers, sabal palms (*Sabal palmetto*) were so thick on some sections of dike that it was impractical to push them into the ditch. The ditches themselves supported dense growths of aquatic plants and probably had organic accumulations in them. These extra organics made precise leveling impossible. All the originally excavated soil and the accumulated organics simply would not fit back into the original excavation. The elevation differences between the filled ditches and the other sites we see in Fig. 2 are due to these extra organics in the fill material. If we assume that the amount of vegetation and other organic material on old field dikes and ditches is directly related to the time elapsed since field construction, then the age of an old field becomes a significant factor in determining the success of natural profile restorations. The precision with which such areas can be restored will decrease over time unless extra effort is made to remove accumulated organics. We expect the filled ditches of our study site to remain permanently as the highest features in the restored marsh.

Measurements of vegetative recovery after only one growing season show the filled ditches to have values similar to (height and percent cover) or greater than (living biomass) the natural marsh and old field. This is largely due to the great success of maidencane and other panicums and the exotic Urena lobata in the filled areas (Table 1). The panicums not only survived being pushed into the ditches along with the dike soils, but they apparently found being mixed with and burried in sand at various depths to be growth stimulating. Filled ditches also provided an excellent seed bed for Urena. None of the upland species that had occupied the sites and no exotics except Urena were observed on the restored areas. Even the presence of Urena is expected to be temporary, since the entire old field profile is now below the elevated sites it prefers.

Acknowledgments

This report is the result of a joint effort between the staff of Corkscrew Swamp Sanctuary and the Ecosystem Research Unit of the National Audubon Society. Corkscrew's director, Jerry Cutlip, who is primarily responsible for the initiation of the old field restoration effort on the sanctuary, provided information on the mechanical phase of the project and staff help for vegetation sampling. Dr. Michael J. Duever, Director of the Ecosystem Research Unit, advised on the experimental design and data analysis phases of the study.

Literature Cited

DUEVER, M. J., CARLSON, J. E., GUNDERSON, L. H., RIOPELLE, L. A. and DUEVER, L. C. 1976. Ecosystem analyses at Corkscrew Swamp Sanctuary. Pages 707-785 in H. T. Odum, K. C. Ewel, J. W. Ordway, and M. K. Johnston, eds. Cypress wetlands for water management, recycling, and conservation. Center for Wetlands, University of Florida, Gainesville.