The Metzger Marsh Restoration Project Phase I (1995-1996): Habitat and Avian Community Response to Dike Construction and Drawdown.

A Final Report to The Ohio Lake Erie Commission
Project ID LEPF-05-94

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EXECUTIVE SUMMARY

The freshwater coastal marshes of the Great Lakes are among the rarest communities in the Midwest. Attempts to restore such habitats thus far have relied on impoundments and artificial manipulation of water levels. The Metzger Marsh restoration project, along the southwestern shore of Lake Erie, offers an alternative to a totally impounded marsh. A lakefront dike was constructed with openings to allow lake/marsh exchange and natural water level fluctuations with the lake. Beginning in 1995, we studied the effect of restoration on avian use of Metzger Marsh before, during, and after restoration. Remote surveys, point counts and constant effort mistnetting stations, rail traps, and quadrat studies were employed to study avian use. Permanent vegetation plots along four transects documented habitat changes in the marsh and the Great Lakes Forecasting System was employed to document water level fluctuations. An unimpounded coastal marsh was also included to serve as a reference for the study. In 1995, Metzger Marsh consisted of an inner bay dotted with remnant patches of emergent vegetation and a continuously submerged outer bay devoid of emergent plant cover. Before dike closure, patterns of avian use of Metzger's outer bay and the unimpounded reference marsh were similar. After dike closure, drawdown and subsequent flooding, Metzger's outer bay was used by more wading birds, gulls and terns for feeding, especially where low water levels concentrated fish into pools. Shorebirds were abundant and diverse at Metzger in both 1995 and 1996, but moved from the inner to the outer marsh after the drawdown, following the moist mudflats. A peak in migrating passerines also occurred in late summer both years, but was much greater in 1996 as the icterids fed on the annual plant seed crop produced under drawdown conditions. During the 1996 drawdown period, we also found that the dramatic increase in annual vegetation on the newly-exposed mudflats did not result in more breeding pairs of passerines in Metzger Marsh. However, stabilized water levels during drawdown did appear to increase the nesting success of passerines and ground-nesting shorebirds and geese.

ACKNOWLEDGMENTS

This project was made possible by grants from the Lake Erie Protection Fund, the Ohio Department of Natural Resources Division of Wildlife, and the Maumee Valley Audubon Society. The University of Toledo, Department of Biology also provided an assistantship for the senior author as well as clerical and material support. The staff at the Crane Creek Wildlife Experiment Station and Ottawa National Wildlife Refuge provided permits and information for this research. The authors gratefully acknowledge these agencies and groups for their support. Our profound thanks also goes to field assistants Tim Walters and Brian Swartz for cold, wet, muddy days spent in the marshes.

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INTRODUCTION

It has been estimated that the Great Lakes Basin has lost approximately 2/3 of its original wetlands since European settlement (Brown 1995). The State of Ohio has actually exceeded this regional trend with wetland loss estimates ranging from 90 to 98% (Marshall 1990, Dahl and Johnson 1991, Kaptur 1991). Many of these lost wetlands were located along the southern shores of Lake Erie. Bednarik (as cited in Prince et al 1992) noted that these lake marshes encompassed 121,500 ha at the time of settlement. But draining, filling, farming and construction of homes and marinas have taken their toll on the coastal marshes. Herdendorf (1987) estimated that only 15,000 ha. of marshes remain, mostly enclosed by earthen and rock dikes to protect them from the lake. Indeed, he classified Great Lakes coastal wetlands as "endangered" environments.

Before diking, these coastal wetlands were shaped by Lake Erie through short-term and long-term water level changes, the high wave energy of the lake, a lack of senescence due to lake-caused disturbances, and the deposition and creation of diverse protective landforms (Herdendorf 1992).

Unfortunately Lake Erie's post-settlement coastal marshes were subject to prolonged high water levels which led to loss of emergent vegetation and creation of open water conditions (Farney and Bookhout 1982, Sherman et al. 1996). As a result, the extant marshes rely on man-made dikes with artificial draining and flooding to maintain their emergent plant biomass (Kadlec 1962, Keddy and Reznicek 1986).

AVIAN USE AND MANAGEMENT OF LAKE ERIE MARSHES

Lake Erie's coastal marshes provide breeding and/or summer foraging habitat for state and federally endangered and threatened birds including the Bald eagle (*Haliaeetus leucocephalus*), American bittern (*Botaurus lentiginosus*), Least bittern (*Ixobrychus exilis*), Yellow-crowned night heron (*Nyctanassa violacea*), King rail (*Rallus elegans*), Common tern (*Sterna hirundo*), Black tern (*Chlidonias niger*) and Sedge wren (*Cistothorus platensis*) (Tramer and Durbin 1982; personal observation). In addition, these rich wetlands provide migratory feeding sites for thousands of shorebirds including the federally-endangered Piping plover (*Charadrius melodus*) (Black Swamp Bird Observatory 1996) and for Peregrine falcons (*Falco peregrinus*) which follow and feed on the shorebirds. Abundant invertebrate food produced by the marshlands feed thousands of warblers, flycatchers, and swallows on migration, including the occasional Kirtland's warbler (*Dendroica kirtlandii*) each spring (personal observation). Waterfowl by the hundreds of thousands also take advantage of the plant, fish and invertebrate food in the coastal marshes during spring and fall (US Fish and Wildlife Service, 1993).

Thus, the fertile marshlands are the main food production and nesting areas of a dozen threatened avian species. The decline of Ohio's rare birds, like the Bald eagle, can be traced to habitat loss and contamination of the coastal wetlands. Restoring productivity and health to the marshes of Southwestern Lake Erie will greatly benefit these species.

But restoration of coastal marshes has meant diking. This cuts off any lake/marsh exchange except for the yearly filling or draining of the management unit. Managers of diked marshes are faced with the dilemma of how often to let water into and out of a marsh, considering the time, expense and hazards fluctuating water levels pose to ground-nesting species like waterfowl. There is growing concern that diked wetlands create a loss of function in the coastal marsh system including loss of regular nutrient exchange (Harris et al.1977, Wetzel

1992), fish access for spawning and nursery sites (Johnson 1989, Jude and Pappas 1992), and natural water level fluctuation.

Yet the nesting, feeding and foraging tactics of many wetland birds have adapted to these fluctuating water levels (Weller and Spatcher 1965, Harris et al. 1977, Kushlan 1989, Burger 1985). Indeed, shorebirds depend upon periodic drying and inundation to create critical feeding habitat. Impounded marshes also tend to be managed for maximum production for fall waterfowl migration, reducing invertebrate production in the spring, plant species richness, and habitat for certain avian species like shorebirds (Meeks 1969, Swanson and Meyer 1977, Farney and Bookhout 1982, Kushlan 1986, Riley 1989, Frederickson 1991, Prince et al.1992, Sherman et al. 1996).

The relationship between wetland bird communities and vegetation has been studied by many researchers (Weller and Spatcher 1965, Murkin et al. 1982, Burger 1985, Kushlan 1989 for example). Vegetation structure and distribution influence where birds nest, feed, and find protection from predators. Man-made dikes protect southwestern Lake Erie's marshes from storm-driven waves which scour out wetland plants, prompting wetland managers to conclude that impounded marshes, despite their deficiencies, are much preferred to an open embayment when considering avian communities.

PROJECT DESCRIPTION

The Metzger Marsh project offers an alternative to a totally impounded marsh. The lakefront dike provides protection from storm-driven wave action that had scoured most of the emergent vegetation from the unrestored wetland. Yet openings in the dike allow lake/marsh exchange and fluctuating water levels-- theoretically increasing the range of habitats available to birds for nesting and feeding over a totally diked marsh (see Wilcox and Meeker 1991). Careful study of the changes in habitat and avian use of this marsh before, during and after restoration is necessary to evaluate the effects of the project in terms of avian productivity and species composition.

This report is the culmination of two years of research effort in Metzger Marsh on the southwestern shore of Lake Erie. The study was undertaken as part of a multi-agency effort to document the effect of dike construction and marsh restoration efforts. In its pre-restoration state, Metzger Marsh consisted of a shallow embayment with emergent cover estimated at less than 12 hectares in the 369 hectare unit (US Fish and Wildlife Service 1993). The northeast end of the bay was open to the lake, and seiche and wave action caused widely fluctuating water levels. Lacking protective beaches or sandbars and prevented from migrating inland by an interior breakwall, Metzger's remaining vegetation was scoured by the lake during storm surges resulting in extensive loss (US Fish and Wildlife Service 1993).

To protect the marsh from the destructive action of the lake, a 2,300 meter lakefront dike was constructed across the mouth of the embayment. Water and fish control structures were added during 1996-7 to make this restoration unique among Lake Erie's diked marshes. These openings in the dike will allow lake/marsh exchange and water levels to fluctuate with lake levels within limits determined by the managing agencies. Extreme high water level fluctuations will be prevented in order to preserve emergent vegetation.

A drawdown period of several years will follow dike construction to enable emergent vegetation to become established. At the time of this report, the 1996 summer drawdown has been completed and the marsh shallow reflooded to accommodate fall use by migrating waterfowl. Current plans call for another such drawdown period during the 1997 growing season

followed by stabilized, flooded conditions from fall 1997 through 1998. If the high lake levels subside, the marsh will be opened to Lake Erie and subject to fluctuating water levels in 1999.

OBJECTIVES

While wetland restorations are being attempted at an increasing pace, rarely have adequate measures of the wildlife habitat value of these restorations been undertaken (National Research Council 1992). Our research evaluates changes in the structure and composition of the plant community and changes in avian use of Metzger Marsh before, during, and after restoration. Our goal is to determine whether the project is creating and improving habitat for migratory and breeding birds. Specifically, in 1995 and 1996 we 1) evaluated avian species richness and abundance, 2) examined the effect of drawdown on vegetation and avian use, and 3) related changes in avian use to habitat components including vegetation, open water and mudflats.

SITE DESCRIPTIONS

Metzger Marsh

Metzger Marsh is located in Jerusalem Township, Lucas County, 23 km. east of Toledo, Ohio (See Figure 1). At the time of European settlement, the marsh was protected by a continuous barrier beach. Campbell (1995) notes that in the early 1900s, Metzger Marsh was diked and drained, becoming Metzger Farms. It was flooded by high lake levels in 1910 and 1929. The latter flood was severe and the owners abandoned the land. Low lake levels of the 1930's encouraged a duck hunting club to operated the property and the Ohio Division of Natural Resources (ODNR) purchased the property in 1955. The lakeward dike was never repaired and a 1952 USGS map shows the beach breached in 5 places. By 1964 these four outer islands had eroded away, leaving only a spit of land approximately 900 meters long jutting east from Ward's Canal.

The marsh was inundated by the lake during the floods of 1973, and high water eventually destroyed 75% of the marsh vegetation (Campbell 1995). At the start of restoration activities in 1993, it was estimated that 12 ha. of emergent vegetation remained in the 369 ha. Metzger Marsh. The remaining vegetation was concentrated in the southwestern corner of the marsh, behind remnant dikes. Wave action from seiches and storm events were eroding an estimated 1.5 to 3.0 meters of vegetation per year and immediate action was deemed necessary to prevent further losses (USF&WS 1993).

In 1995, Metzger's Marsh could be divided roughly into two parts based on vegetation. The "inner marsh" supported roughly 10 ha. of cattail mats and the "outer marsh" (comprising 2/3 of the entire site) was an open embayment. Widely fluctuating water levels existed in Metzgers from Jan. 1, 1995 to the beginning of September when the dike construction was completed. The marsh was drained through pumping from May to June 1996 and reflooded in September of that same year. During drawdown, Metzger did hold several transitory pools, including a large pond in the outer bay that never went completely dry.

In spite of the paucity of emergent vegetation, the marsh supported bird habitat. A summer 1980 study of Metzger by Tramer and Durbin (1982) lists Red-winged Blackbirds, Marsh Wrens, and American Coots, Great Blue Herons, Black-crowned Night Herons, and Great Egrets as common or fairly common species. (It should be noted that the emergent vegetation has continued to decline in the 15 years since this study). In addition, the mudflats of Metzger

provided migratory feeding sites for thousands of shorebirds in late summer and early fall and feeding and resting areas for migrating waterfowl (personal observation).

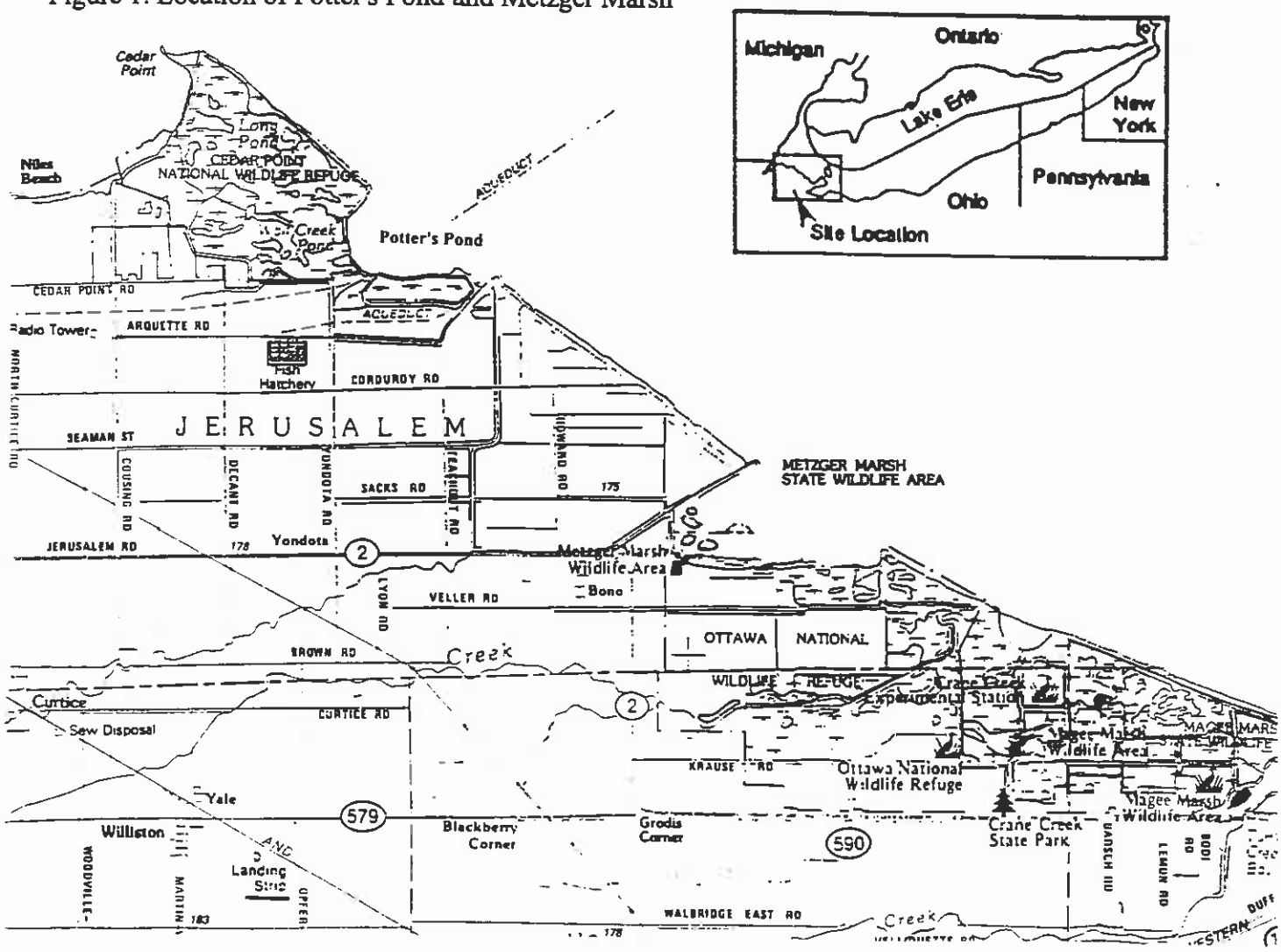
Potter's Pond

Potter's pond served as a reference for observations at Metzger by providing a picture of normal fluctuations in avian use of an unprotected embayment. This open embayment has the same northeast lakeward orientation as Metzger Marsh and is roughly 275 ha. in size. Lacking emergent vegetation, Potter's is similar to the outer marsh area of Metzgers.

Potter's Pond is also located in Jerusalem Township, Lucas County, approximately 20 km. east of Toledo, Ohio and 2.8 km west of Metzger Marsh. It borders the eastern dike of Little Cedar Point National Wildlife Refuge. Herdendorf (1987) noted that during the northeastern storms of 1952, the sand bar on the southeast side of Little Cedar Point was washed away and the lake engulfed this once-productive coastal marsh. Currently, man-made dikes protect the marshes on the interior of Little Cedar Point, but Potter's Pond has never been impounded.

No emergent vegetation is present in Potter's Pond and exposed mudflat occurs infrequently. Rather, a shallow embayment is the normal condition of the site. Thus, avian use is limited mainly to aquatic species who feed or rest on the shallow water with some shorebird use of the beach and breakwall.

Figure 1. Location of Potter's Pond and Metzger Marsh



MATERIALS AND METHODS

Habitat changes during restoration- Because of the potential influence of water levels on habitat, water level fluctuations were monitored throughout the restoration period. The Great Lakes Forecasting System (GLFS) was employed to assess the water levels over time. This system incorporates four water level readings per day (0600, 1200, 1800 and 000 hours) and extant weather conditions with a computer model to interpolate fluctuations throughout the 24 hour period. Fluctuations from the 1985 ICLD low water datum are graphed and stored at The Ohio State University for access by researchers. Records for 1995 were compared with patterns of avian use. 1996 was a period of impoundment and drawdown for Metzger Marsh, rendering the GLFS data non-applicable to conditions in the marsh during this period. Water level stakes were also placed in Metzger and Potter's and levels recorded during point counts and remote surveys.

To evaluate the relationship between Metzger's bird community and its vegetation, permanent vegetation transects were established (See Figure 2). Two 400 m. long transects were placed in the remnant plant community (inner marsh) and two 300 m. long transects were placed in the open water portions of the restoration unit (outer marsh). The four vegetation transects sampled the extent of emergent vegetation, water and mudflat in meter square plots placed every 10 meters along the transects. Species composition, height, density of vegetation (modified after MacArthur and MacArthur 1961), and percent cover of plants, mud flat, open water or litter was recorded for each meter square sample. The density readings were taken using a meter wide board placed behind the meter square vegetation plot. Standing on the opposite side of the plot, the observer recorded the percent of the board covered by vegetation at .5, 1.0, 1.5 and 2.0 meter heights. Vegetation surveys were conducted once per month from May through September. Comparisons in average percent cover of vegetation, water and mudflat documented changes in habitat.

Remote surveys- Beginning in late 1994, remote bird surveys were conducted weekly during breeding and migration seasons and once per month during winter. The surveys provided a baseline comparison of avian richness and relative abundance between Metzger Marsh and Potter's Pond before the dike construction at Metzger.

Birds were grouped into guilds (after Pianka 1983) and graphed to document seasonal use of the wetlands by migrating and nesting birds and to note differences in this use before and after drawdown and between the experimental and control marshes. To compare Metzger Marsh with Potter's Pond, the remote surveys were broken down into inner (vegetated) marsh and outer (embayment) portions at Metzger. The outer marsh then compared in size, orientation and lack of vegetation with Potter's Pond.

Shannon Wiener diversity indices (H = Sum Pi x log 2 Pi, where Pi = ratio of species i over total number of all species) were calculated for spring migration (Mar. 6 - April 30), the passerine breeding season (May 11 - June 30) and the late summer migration (July 24 - Sept. 8) using remote survey data. The data for each period were summed to find the total number of birds and species. The index was used to compare species diversity between Metzger and Potter's, between the inner and outer marsh areas of Metzger, and between restored and unrestored Metzger Marsh. The higher the value of "H", the greater is the probability that the next individual sampled will not belong to the same species as the previous one (Smith 1990). Thus, a higher "H" value indicates a more diverse avian community.

Point counts and trapping- Breeding bird density and nest success were sampled at Metzger Marsh using a modified MAPS (DeSante and Burton 1994) design. Point counts and mist netting stations were established in the marsh (Figure 2) and data were collected every 10-15 days from June through the end of August. Nesting attempts and success were determined by constant-effort mist netting.

Capture of fledglings and the breeding condition of adults, as revealed by brood patches and/or cloacal protuberances, were used to estimate avian productivity. The total number of birds banded, particularly the numbers of juveniles, was compared between years as a measure of nest success during flooded and mudflat conditions in the marsh. To sample the secretive rails, coots and gallinules, a pre-recorded tape was played at each point count site and 8 funnel traps were set every 10-15 days.

Behavior of adults (nest building, food carrying, territorial behavior) and observations of juveniles during point counts and transect surveys (see below) were combined with banding data to estimate overall avian productivity each year. Territorial males were mapped and differences in placement and total numbers of avian territories examined to note changes in avian use between flooded and drawdown conditions. A male had to occur in the same area during three point counts before he was confirmed as a territorial bird.

Transect and quadrat surveys- To accurately assess the densities of birds within the cattail mats, transect surveys were employed to sample the breeding birds in four 2500 sq. m. quadrats (Figure 3). Three 50 m. long transects, beginning from the edge of each cattail mat, were walked in each quadrat and the singing males located and mapped. Females and any young were also noted, and nesting behavior observed and recorded. To reduce the likelihood of nest failure due to investigator disturbance, nests were not disturbed or searched out. The center transect also served as the net lane for mist netting activities detailed above. This experimental design allowed us to gather data on territory size, number of breeding males and nesting success for each quadrat.

Differences in species and numbers during the breeding season were examined to note the effect of fluctuating and stabilized water levels on the avian use of existing cattail mats in the marsh. Total numbers of breeding birds in the entire marsh were calculated by extrapolation of densities obtained in the quadrat census and studied for differences in 1995 and 1996. This survey estimate was also compared to the data gathered under the MAPS protocol.

Figure 2. Point Counts, Quadrats and Vegetation Transects in Metzger Marsh

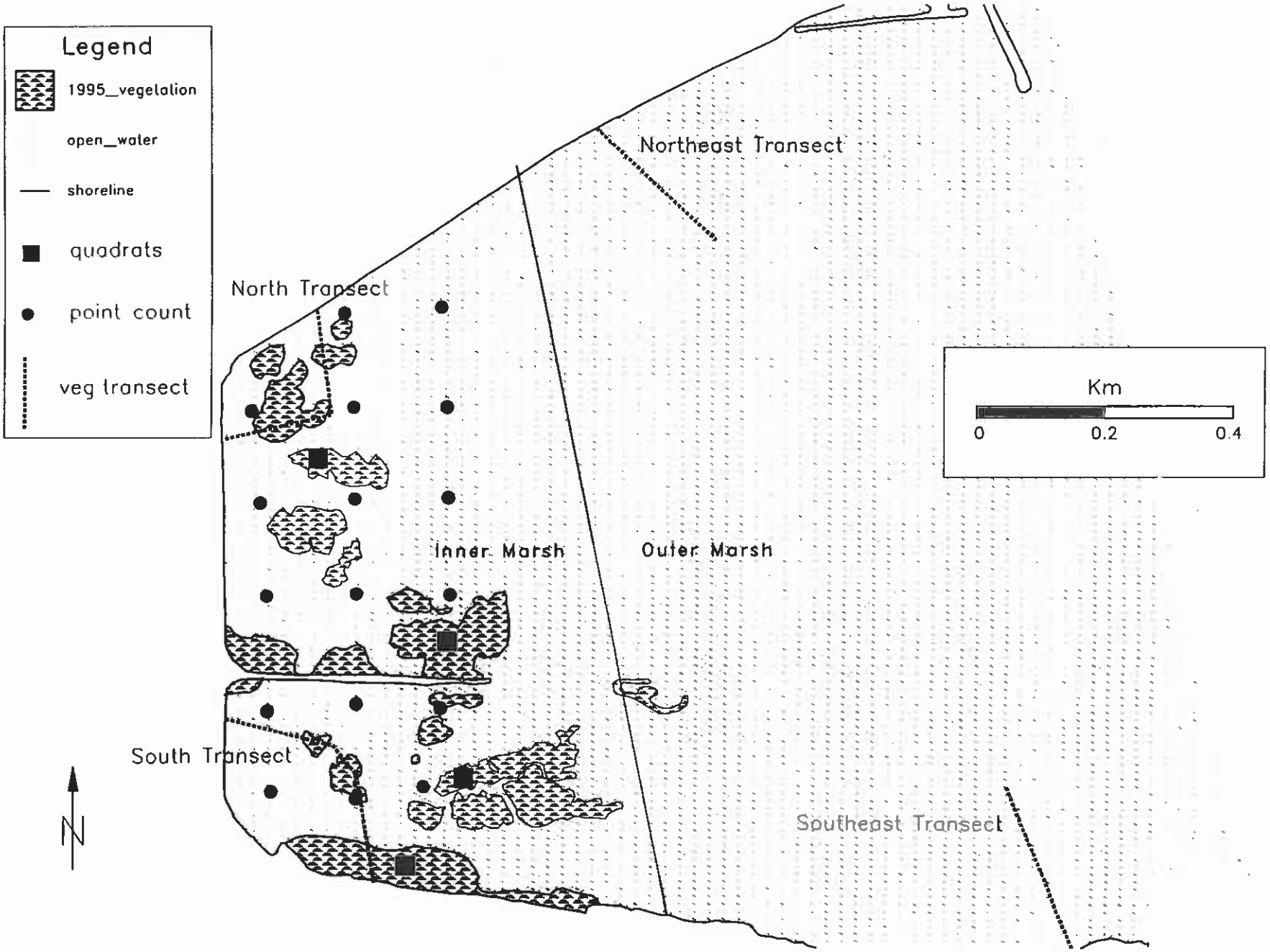
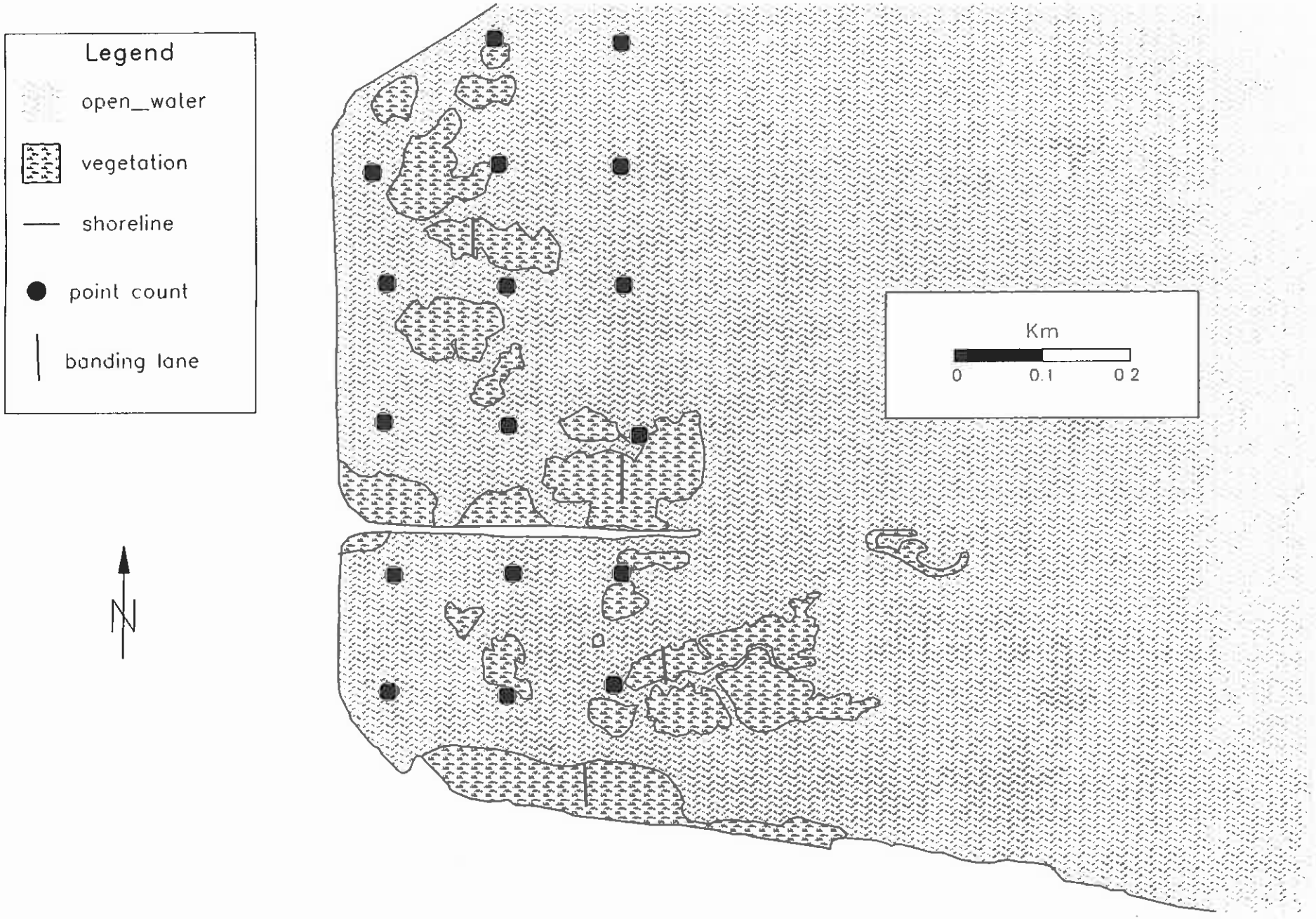


Figure 3. Point Counts and Banding Lanes in Metzger Marsh



RESULTS AND DISCUSSION

Habitat changes during restoration

Mitsch (1992) noted that over the past 130 years, water levels for Lake Erie show a difference of almost 150 cm. between high and low water levels. The GLFS for May through August 1995, shows a variation of 34 cm. between high and low water levels as recorded just north of Metzger Marsh (Figure 4). This chart shows daily average readings for the May - August breeding season. Water level stakes, placed in the marsh and read during remotes and point counts, showed a difference of 40 cm between mudflat and high water levels during the 1995 avian breeding season.

Water levels in western Lake Erie not only fluctuate widely, these changes can also take place quickly, making it difficult for birds to adapt. Herdendorf (1987) noted that sudden fluctuations can amount to over one meter in a few hours. During remote and point count surveys in Metzger Marsh, water levels dropped 20 cm. in 2 1/2 hours (July 2, 1995) and rose 17 cm. in 3 hours (July 30, 1995). In Figure 4 the GLFS readings were averaged for each 24 hour period, which tended to make the graph more legible but also smooth out rapid fluctuations. Hourly data from the GLFS showed that water levels varied as much as 34 cm. in three hours on May 29, 1995.

Birds will shift their nesting sites landward areas as new areas become inundated by high lake levels (Harris et al. 1977). However, rapid changes in water levels pose a more critical threat to avian nest success in Great Lakes marshes. High water levels caused by storm events destroyed most of the established nests of Yellow-headed Blackbirds using the open marshes of Saginaw Bay (Young 1996). Nest abandonment due to Great Lake storm surges have also been documented for Common Moorhen, American Coot, Forster's Tern, and Marsh Wren (Whitt 1996).

Of particular interest to our study at Metzger Marsh is a high water event which took place on June 21, 1995. On June 4, 17 Red-winged Blackbird males on territories were censused by point count. Seven of these were on cattail mats isolated in the marsh, ten had territories which included adjacent upland dikes. During the June 21 survey, the water was 25 cm higher than usual, and 40 cm above mudflat. The point count revealed that 17 males and 14 female Red-winged Blackbirds were perched on the roadside vegetation and trees along the dikes. In addition, flocks of 10-15 blackbirds were seen flying over the cattails. A point count on July 1st revealed only three male Red-wings remained on territories in the isolated cattail mats. Six males were still associated with adjacent dikes, comprising a total of 9 territorial males for the entire survey area.

Metzger Marsh and Potter's Pond are also impacted by northeast storms and seiches which cause dramatic water level fluctuations (Herdendorf 1987, Campbell 1995). Water level fluctuations of over 4.5 meters have been recorded during these storms (Krecker as cited in Farney and Bookhout 1982). A northeastern storm hit Metzger Marsh on July 17 resulting in waves which scoured approximately one foot of cattails off the north side of most of the mats. In addition, much of the remaining vegetation was covered with mud and debris and large areas of the cattails had been laid flat. Quadrat studies after the storm showed that several Marsh Wrens and one Common Yellowthroat were no longer on territory, possibly indicating abandonment.

From these examples, it can be seen that water levels had a profound influence on nesting success and vegetation extent in Metzger Marsh in 1995. During late-1995, the dike construction was complete and water levels were stabilized. Drawdown, begun in May 1996, influenced

vegetation and avian use. Newly exposed mudflats became foraging areas for shorebirds and mammals (including otter) and nursery grounds for germinating plants.

Vegetation transects

The results of monthly changes in habitat structure along the permanent transects in 1995 and 1996 are shown in Figures 5 - 8. Broad categories of litter, vegetation, mudflat and water were charted in 1995 and 1996 along the transects. Litter was defined as dead vegetation of any height. The most striking changes took place in the outer marsh (northeast and southeast transects) where the shallow embayment became mudflat by June 1996 and vegetated by fall of that same year. Along the inner marsh (north and south transects), existing cattail mats expanded and annual vegetation dominated areas which were mudflat and water in 1995. However, because most of this new vegetation was either non-existent or only a few centimeters tall in early summer, it did not provide new nest sites for the breeding birds. Rather, it provided dense cover and a ready source of seeds for late summer young and migrants.

Burger (1985) notes that plant form and structure play key roles in avian habitat selection. To study components of the vegetation which might be important to avian use at Metzger Marsh, several factors were singled out for a detailed comparison: percent cover of vegetation, maximum vegetation height, and density at 1 meter from the ground along each permanent transect.

The percent cover of vegetation along the transects changed dramatically from 1995 to 1996 as annual plants colonized the newly exposed mudflat. Figures 9 - 12 show the percent vegetation cover changes over the growing season and due to flooded or drawdown conditions. Because emergent plants existed in several strata along the transects, it was possible to have over 100% total cover for each plot.

Vegetation height along each transect (Figures 13 - 16) shows how much the topography of the site changed during drawdown conditions. After completion of the dike wall in September, 1995, stabilized water levels allowed the edges of the south marsh cattail mats to support germinating vegetation. These edges expanded rapidly during the early growing season in 1996. By June 1996, the entire mudflat between the cattail mats in the north and south transects was covered with vegetation reaching 200 or more cm. in height.

Density of the vegetation (Figures 17 - 20) plays an important role in providing cover and nesting sites, or even mechanical barriers to access for the birds. To effectively show a change in the habitat component, the density of vegetation at .5 meters off the ground was charted for 1995 and 1996. The existing cattail mats changed little, since they reached 100 percent density by June. The newly germinated vegetation of the mudflats contributed greatly to density differences between months and between flooded and drawdown conditions in Metzger Marsh.

Potter's Pond, the reference marsh, did not have any emergent vegetation in 1995 or 1996. Mud flat exposure occurred only once, for a week in late October, 1995. For the remainder of the two year study, Potter's was covered by water which varied from a few centimeters to over 40 cm in depth.

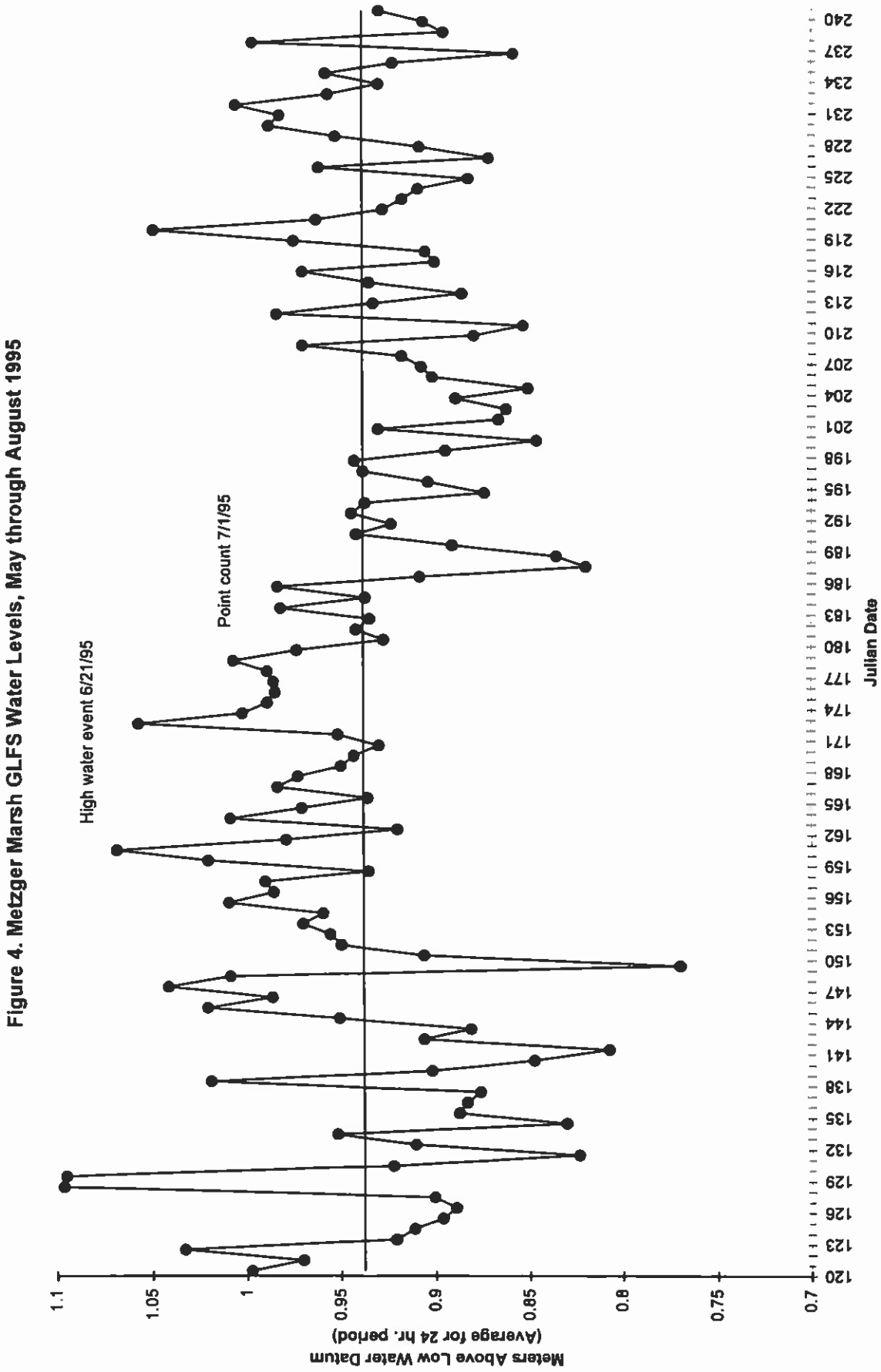


Figure 4. Metzger Marsh GLFS Water Levels, May through August 1995
High water event 6/21/95
Point count 7/1/95
Meters Above Low Water Datum
(Average for 24 hr. period)
Julian Date
1.1
1.05
1
0.95
0.9
0.85
0.8
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Figure 5. Habitat Changes Along the South Transect, Metzger Marsh 1995-1996

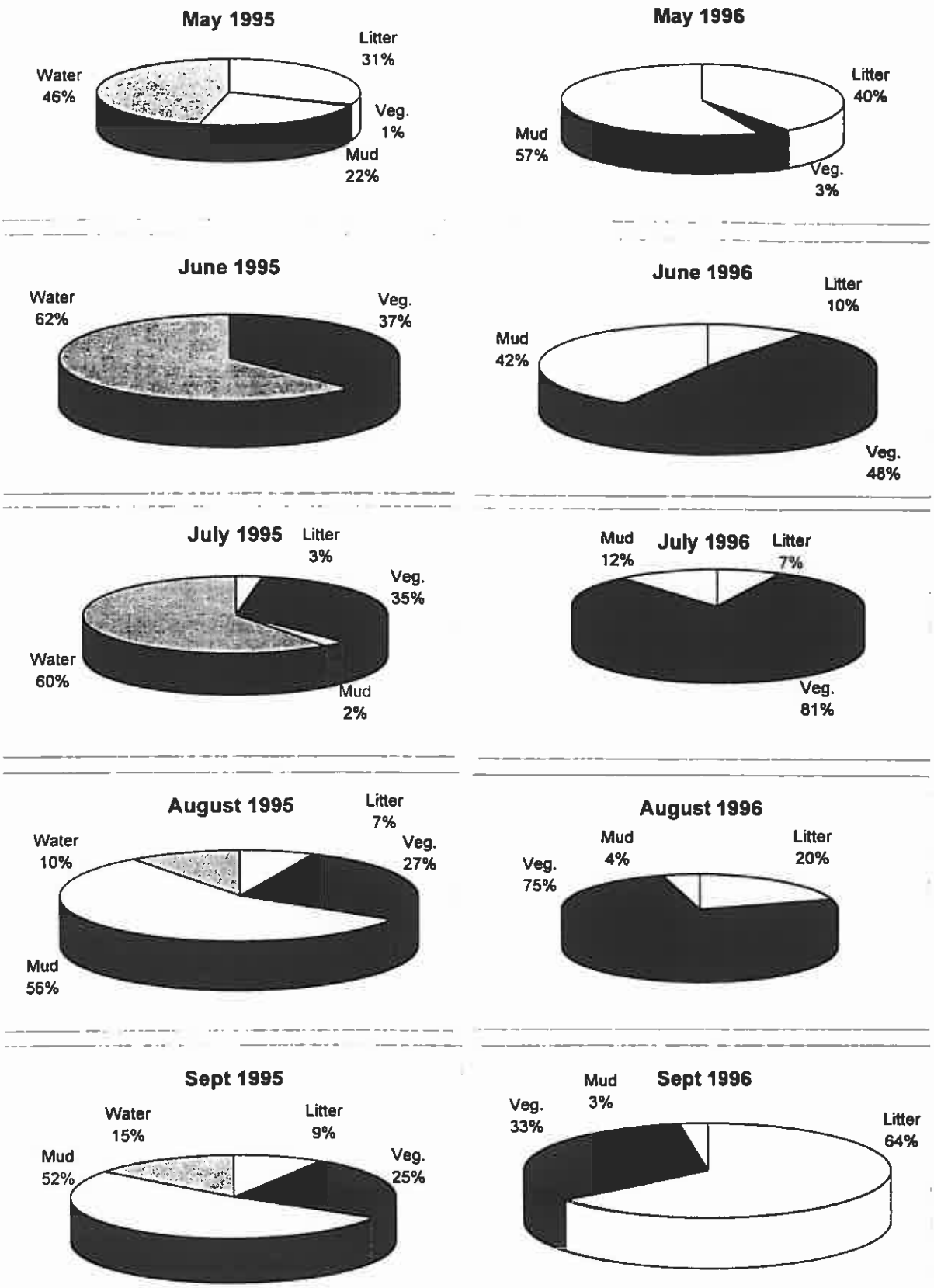


Figure 6. Habitat Changes Along the North Transect, Metzger Marsh 1995-1996

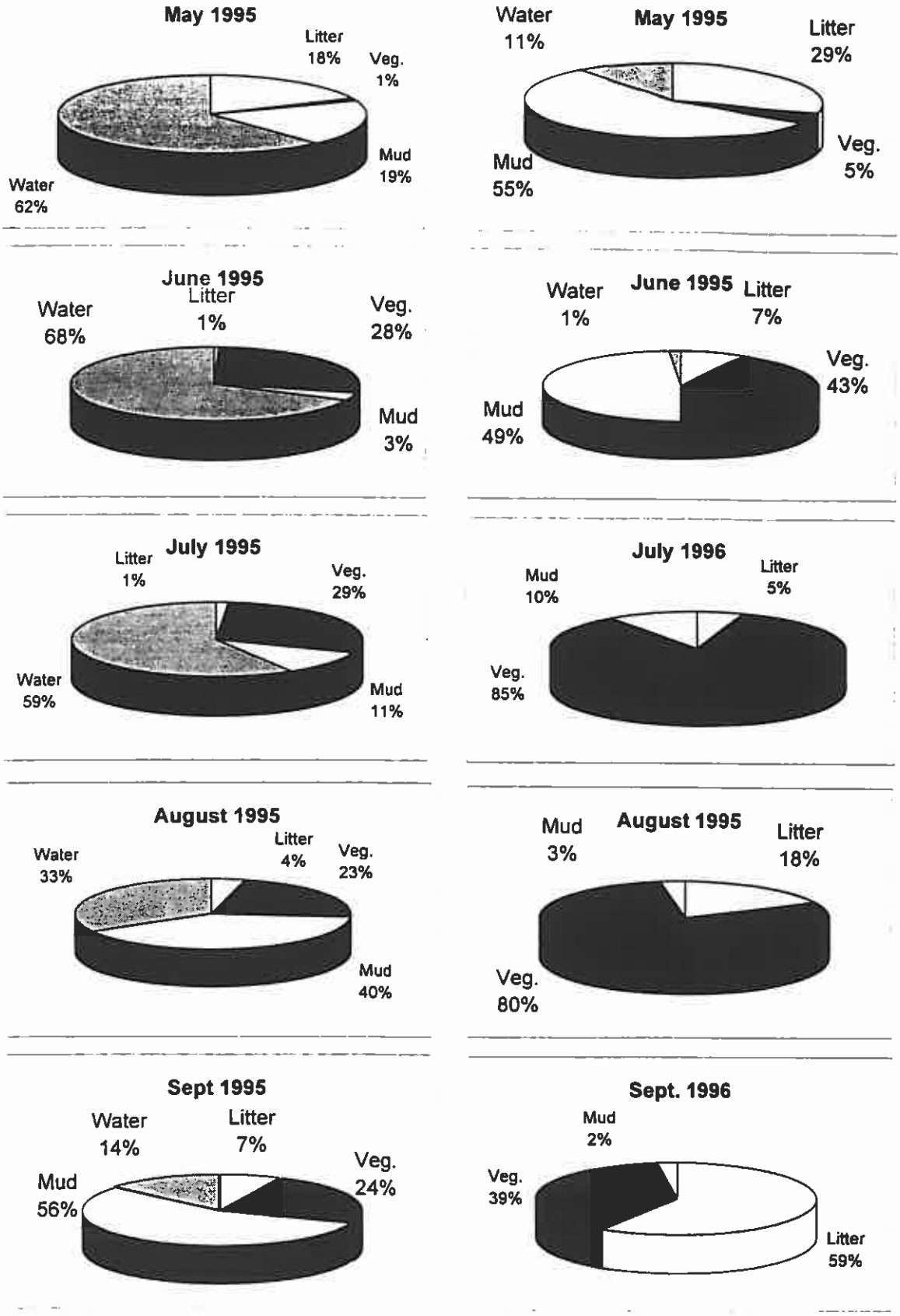


Figure 7. Habitat Changes Along the Northeast Transect, Metzger Marsh 1995-1996

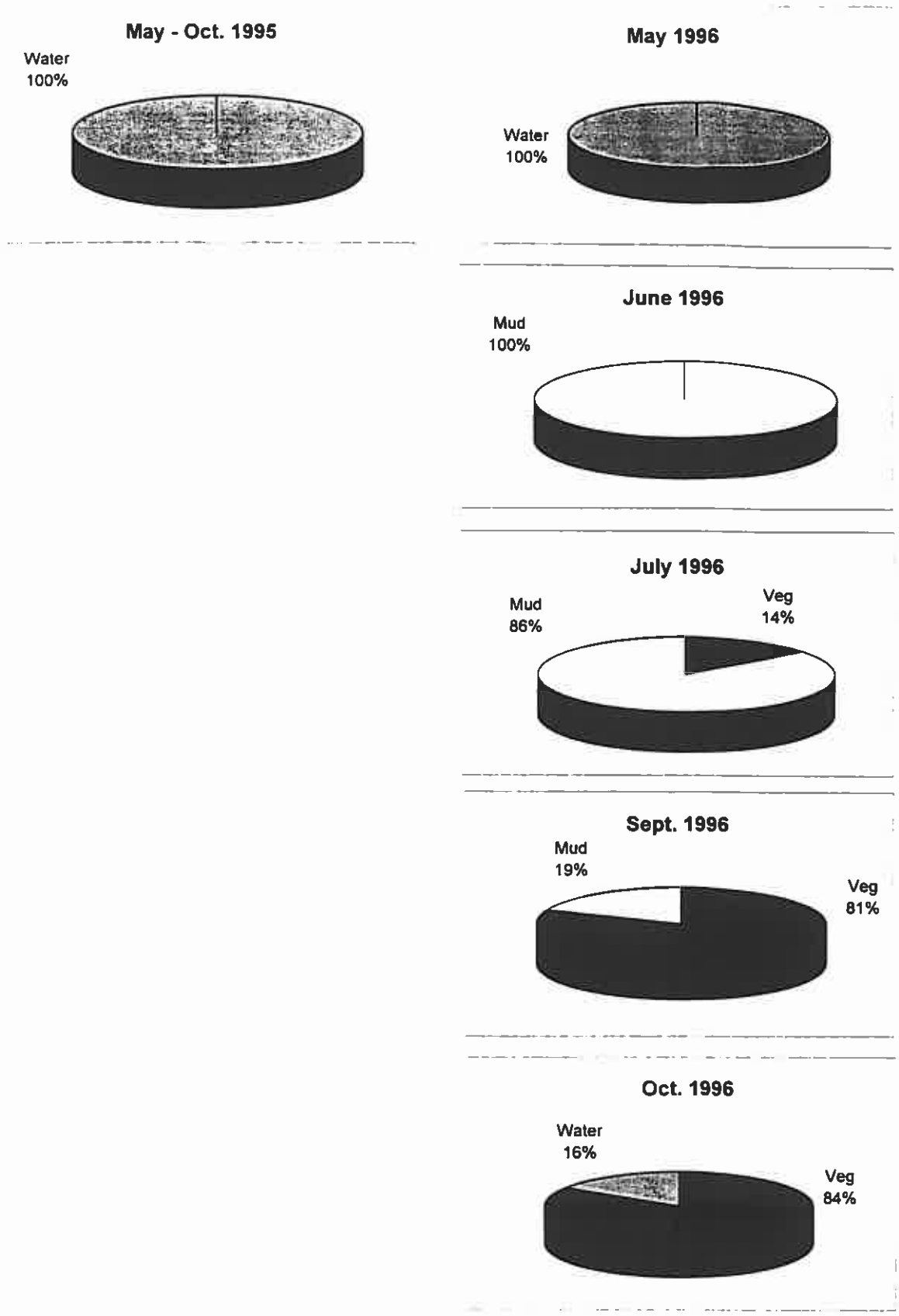
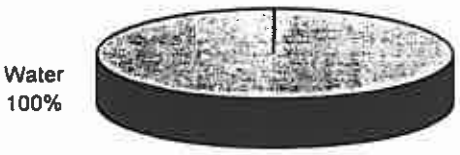
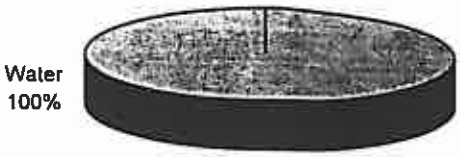


Figure 8. Habitat Changes Along the Southeast Transect, Metzger Marsh 1995-1996

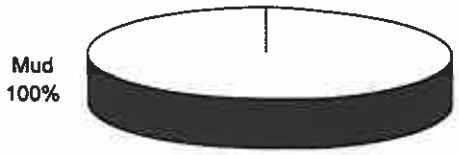
May - Oct. 1995



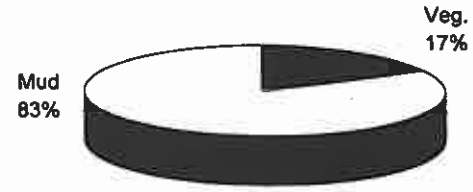
May 1996



June 1996



Aug. 1996



Sept. 1996

Oct. 1996

Figure 9. Percent cover change along the south marsh transect

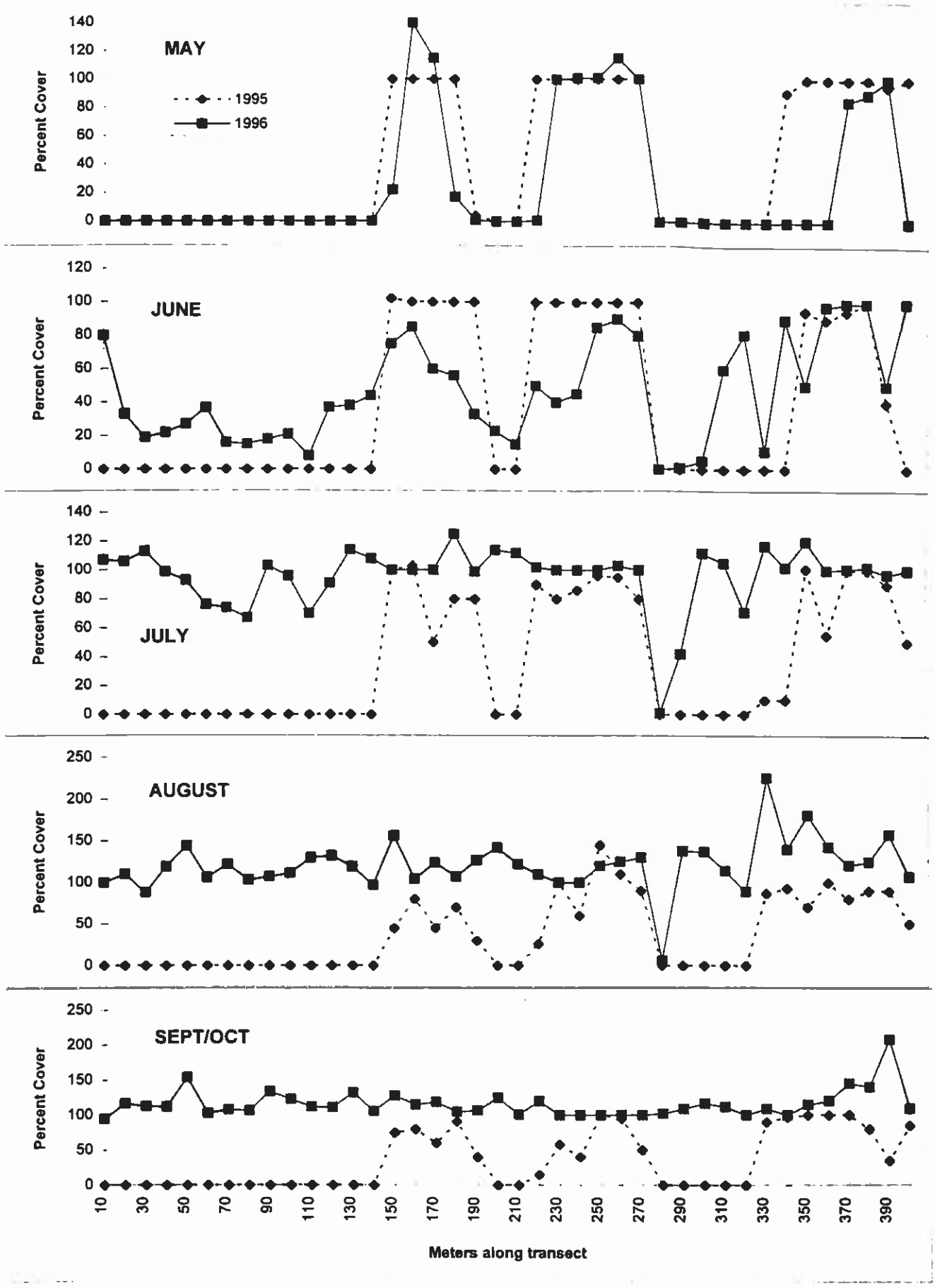


Figure 10. Percent cover change along the north marsh transect

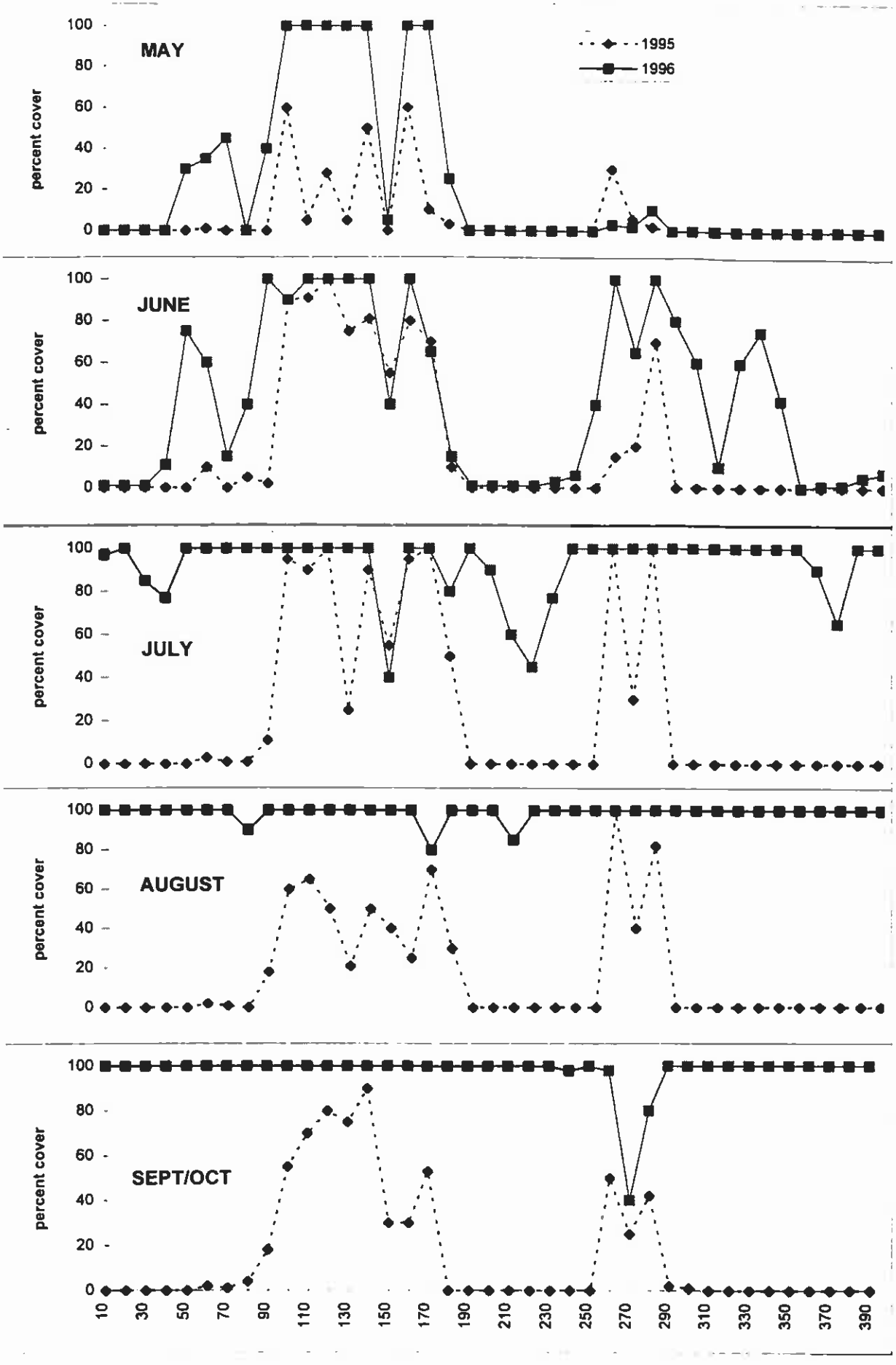


Figure 11. Percent cover change along the northeast marsh transect

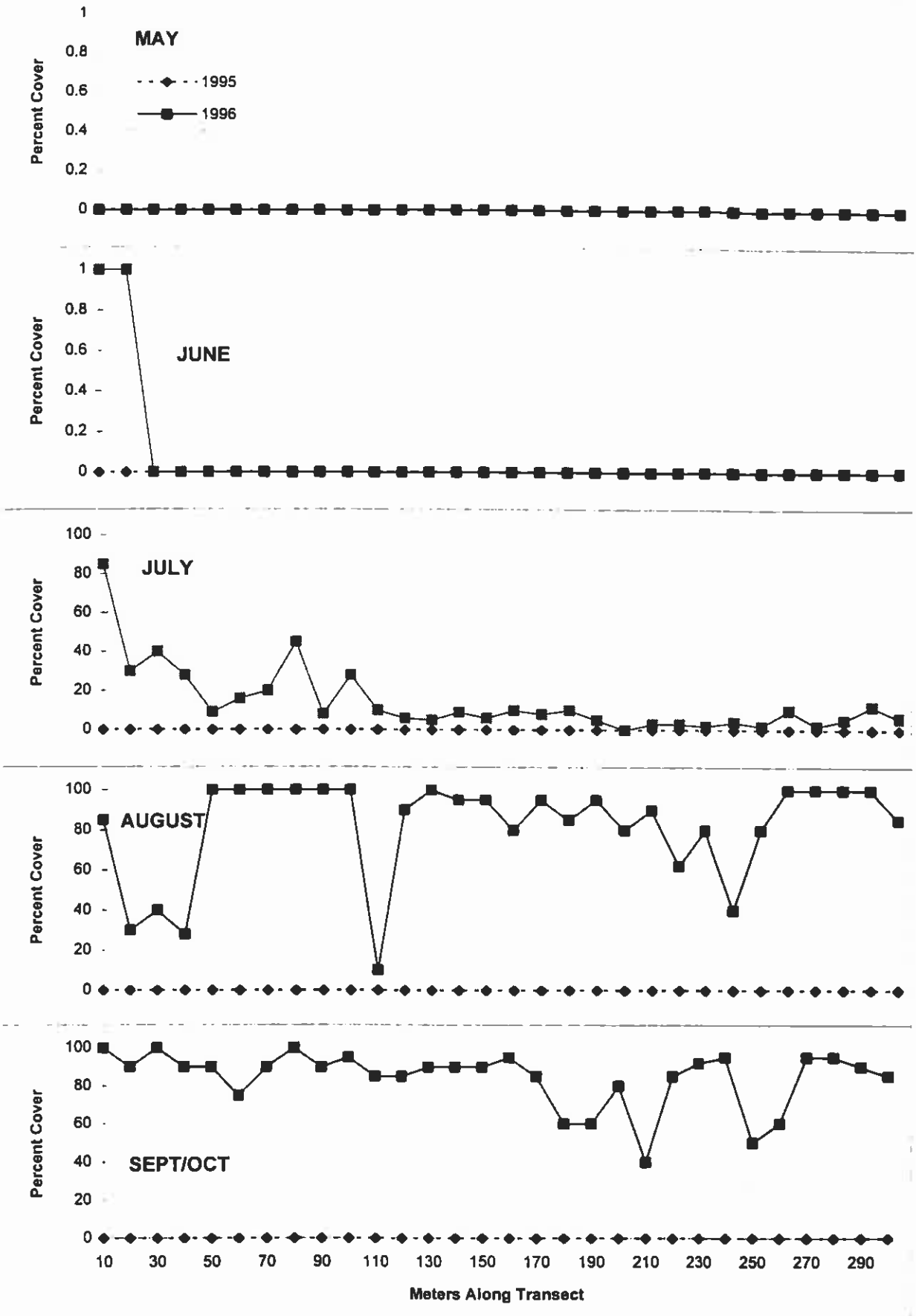


Figure 12. Percent cover change along the southeast marsh transect

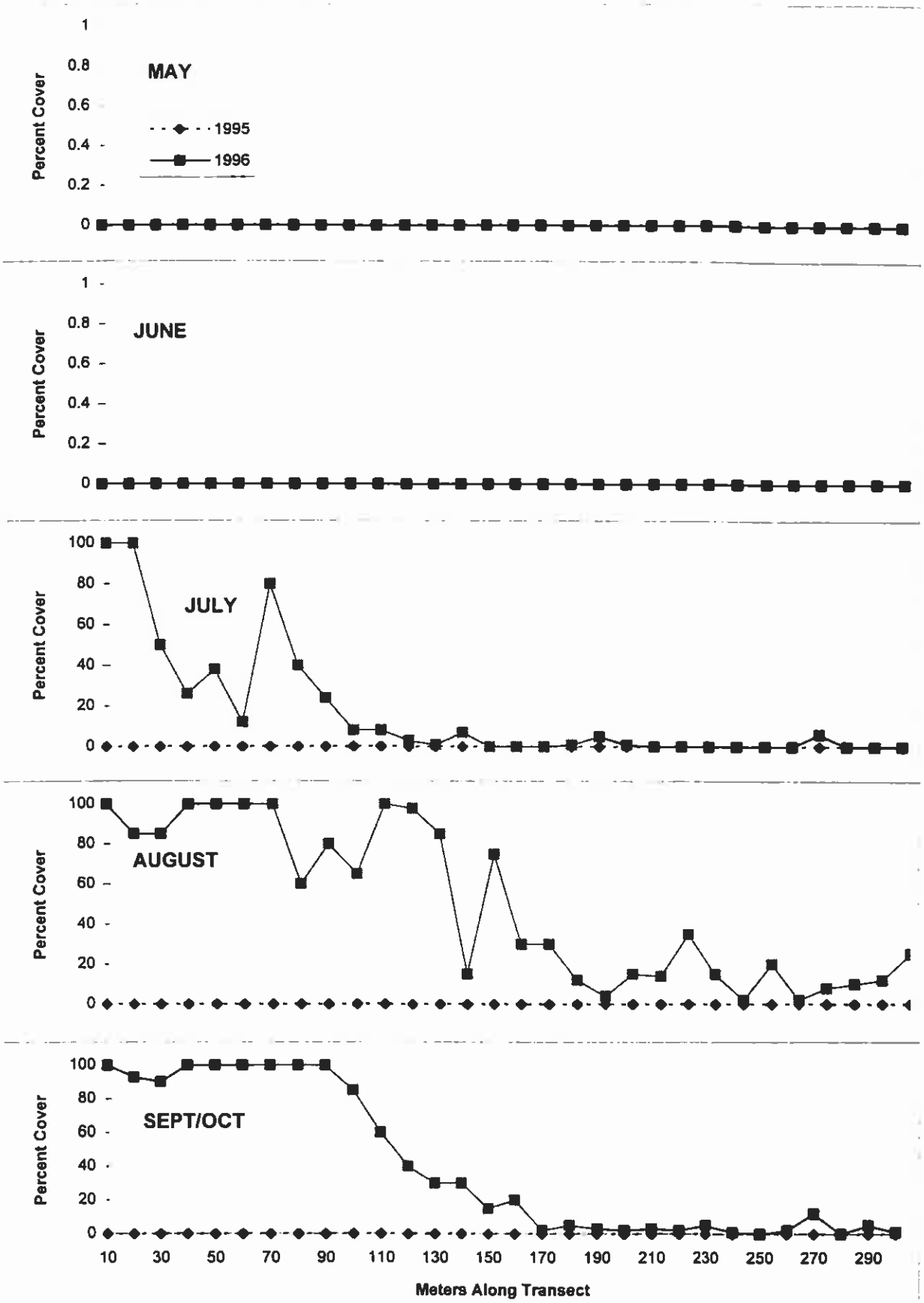


Figure 13. Change in maximum height of vegetation along the south marsh transect

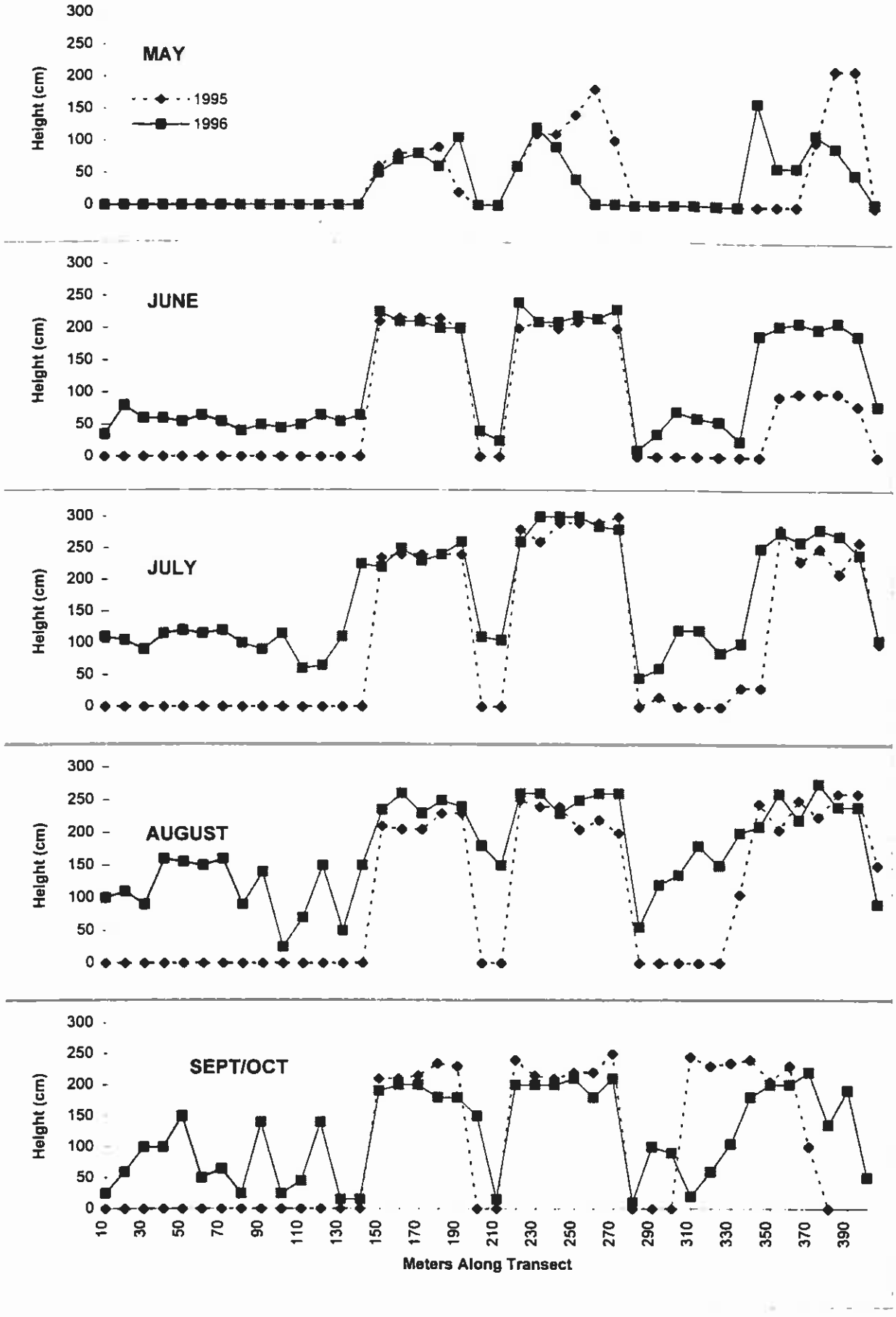


Figure 14. Change in maximum height of vegetation along the north marsh transect

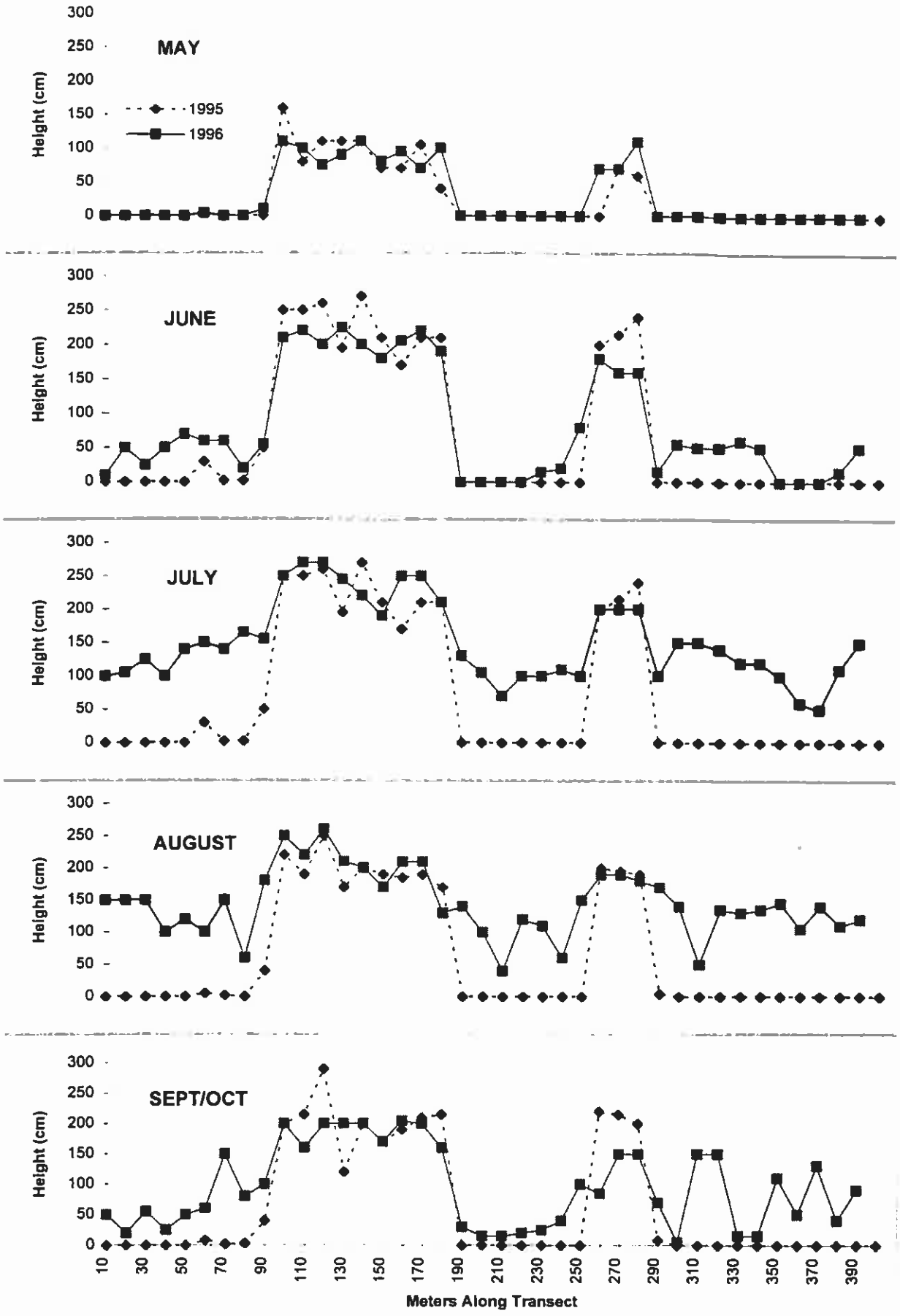


Figure 15. Change in maximum height of vegetation along the northeast marsh transect

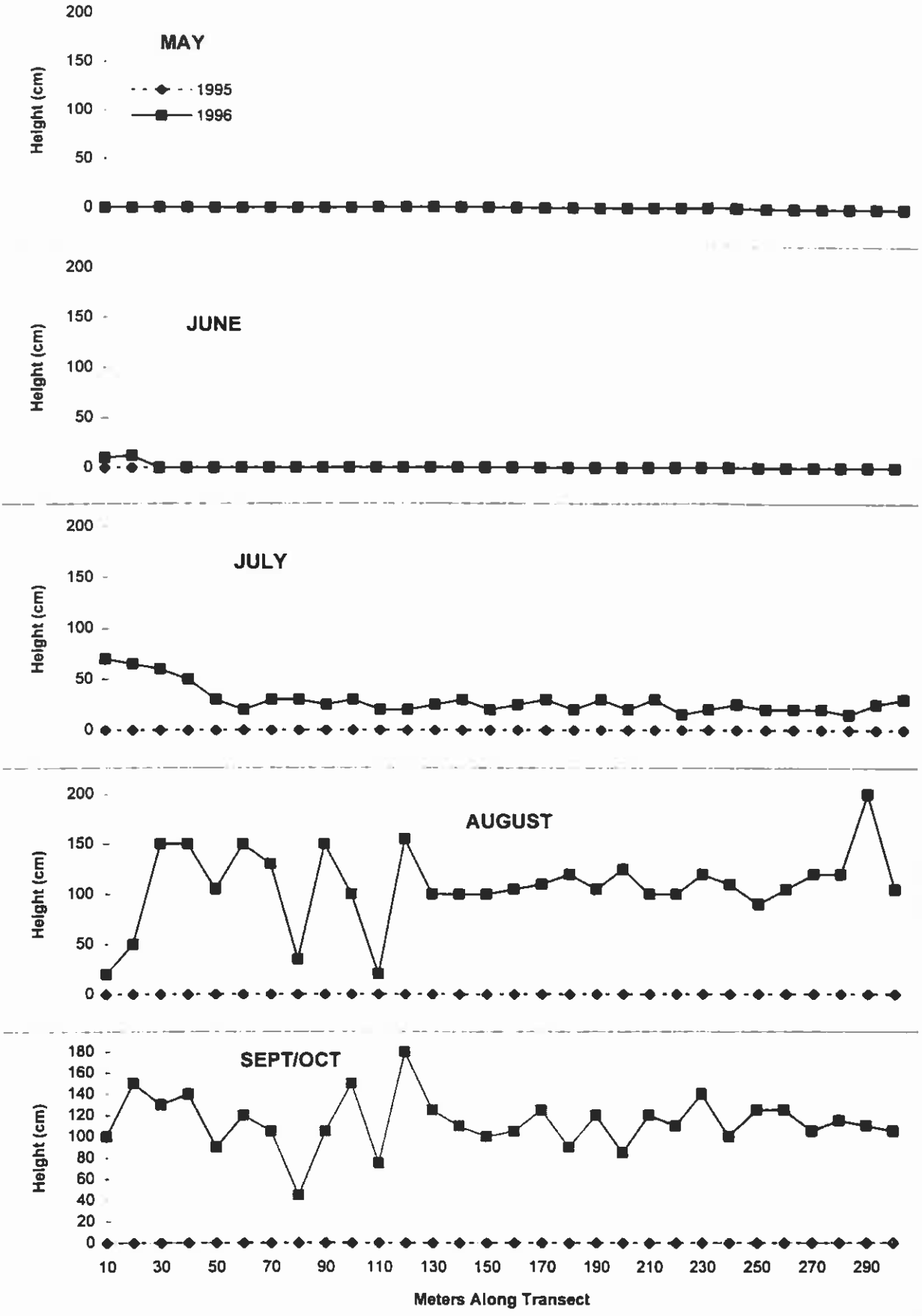


Figure 16. Change in maximum height of vegetation along the southeast marsh transect

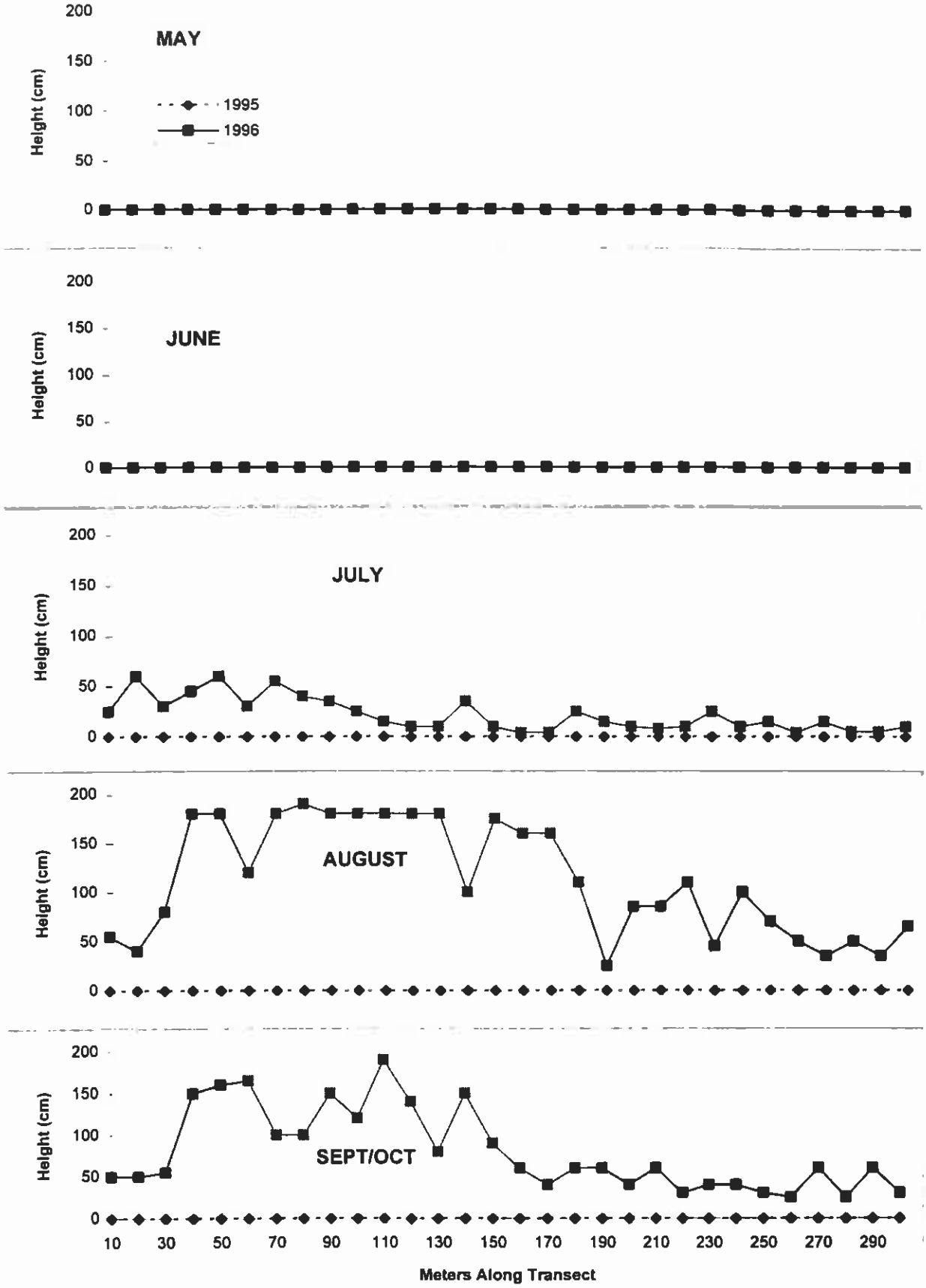


Figure 18. Change in density of plants at 1 meter height along the north marsh transect

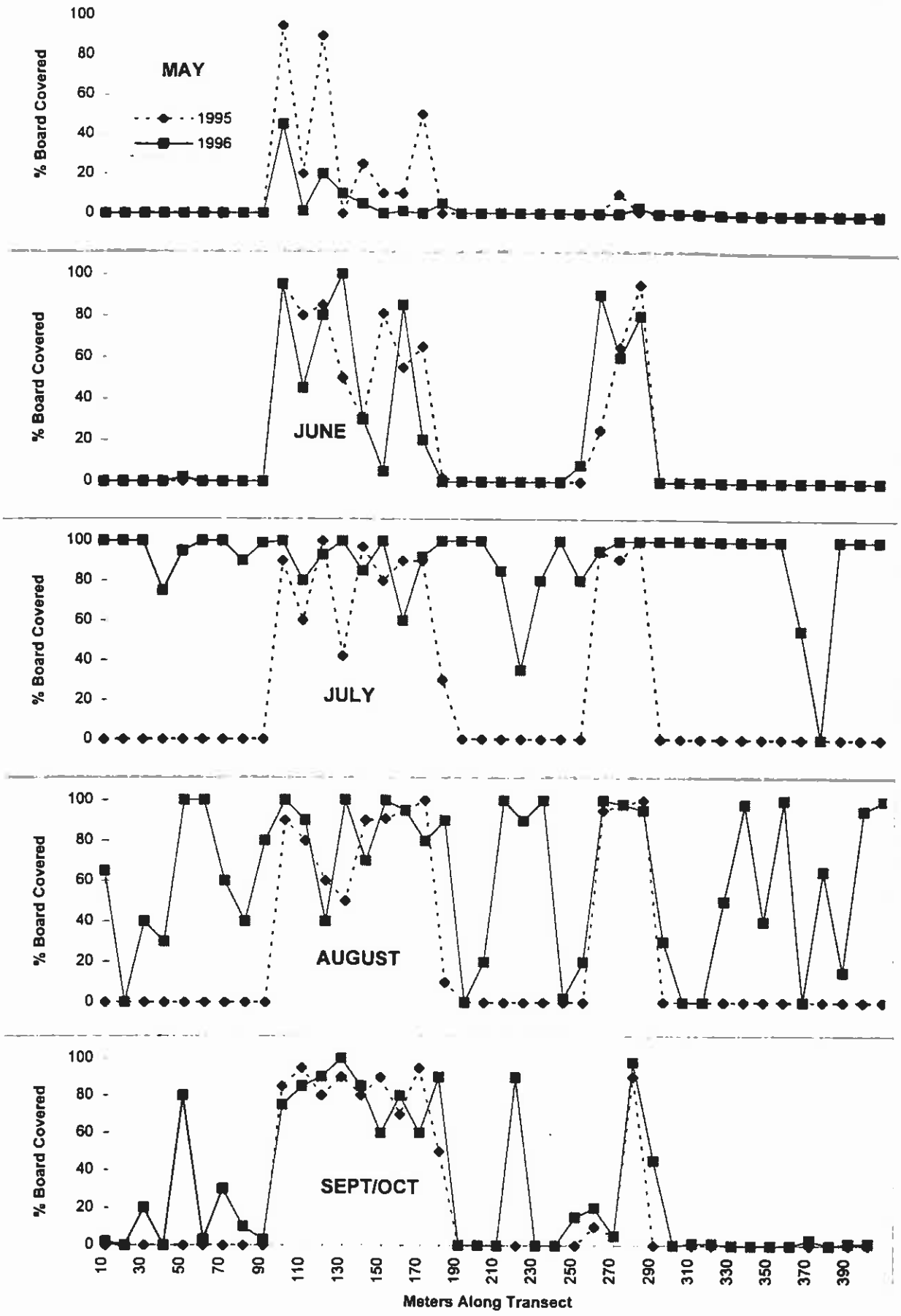


Figure 19. Change in density of plants at 1 meter height along the northeast marsh transect

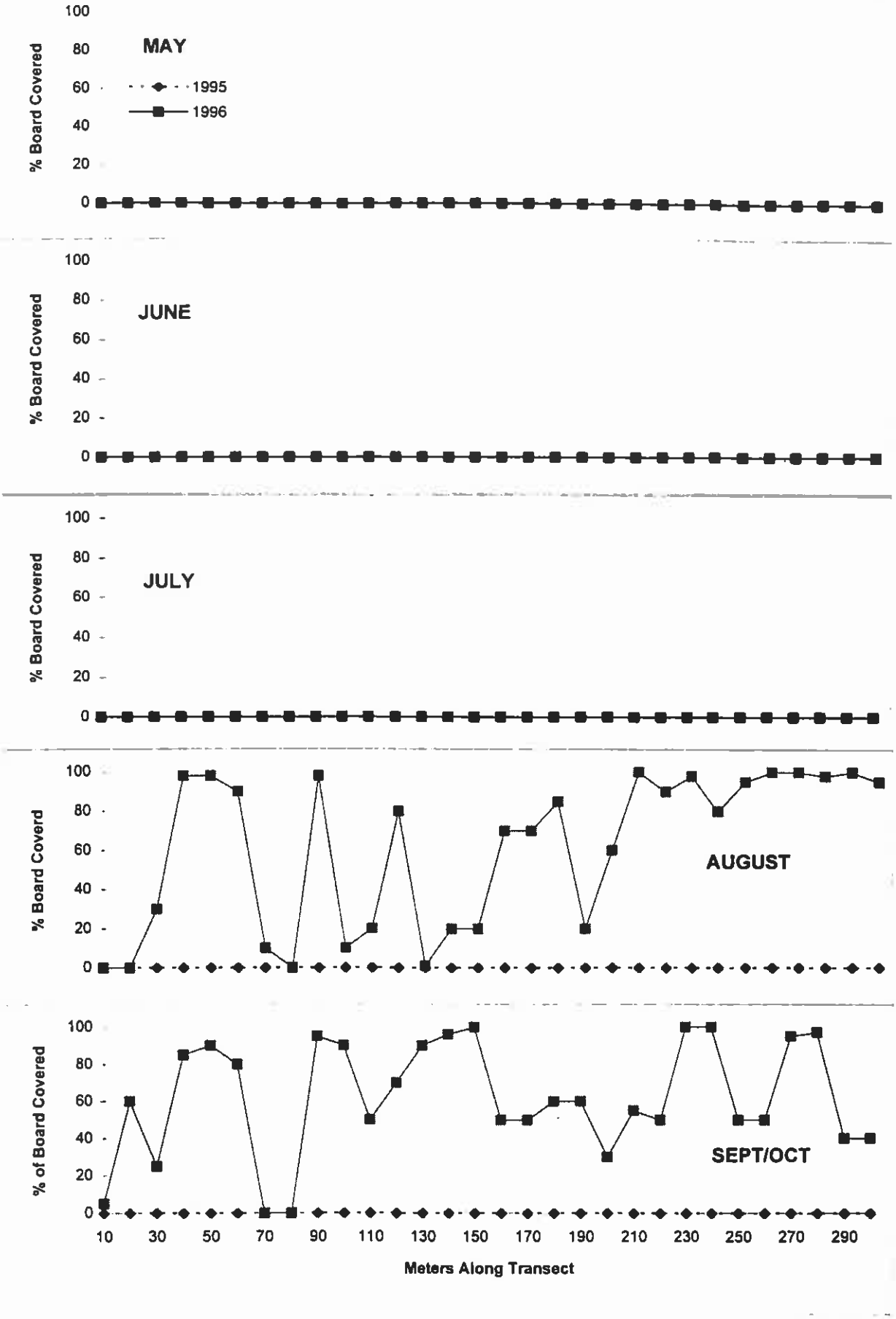
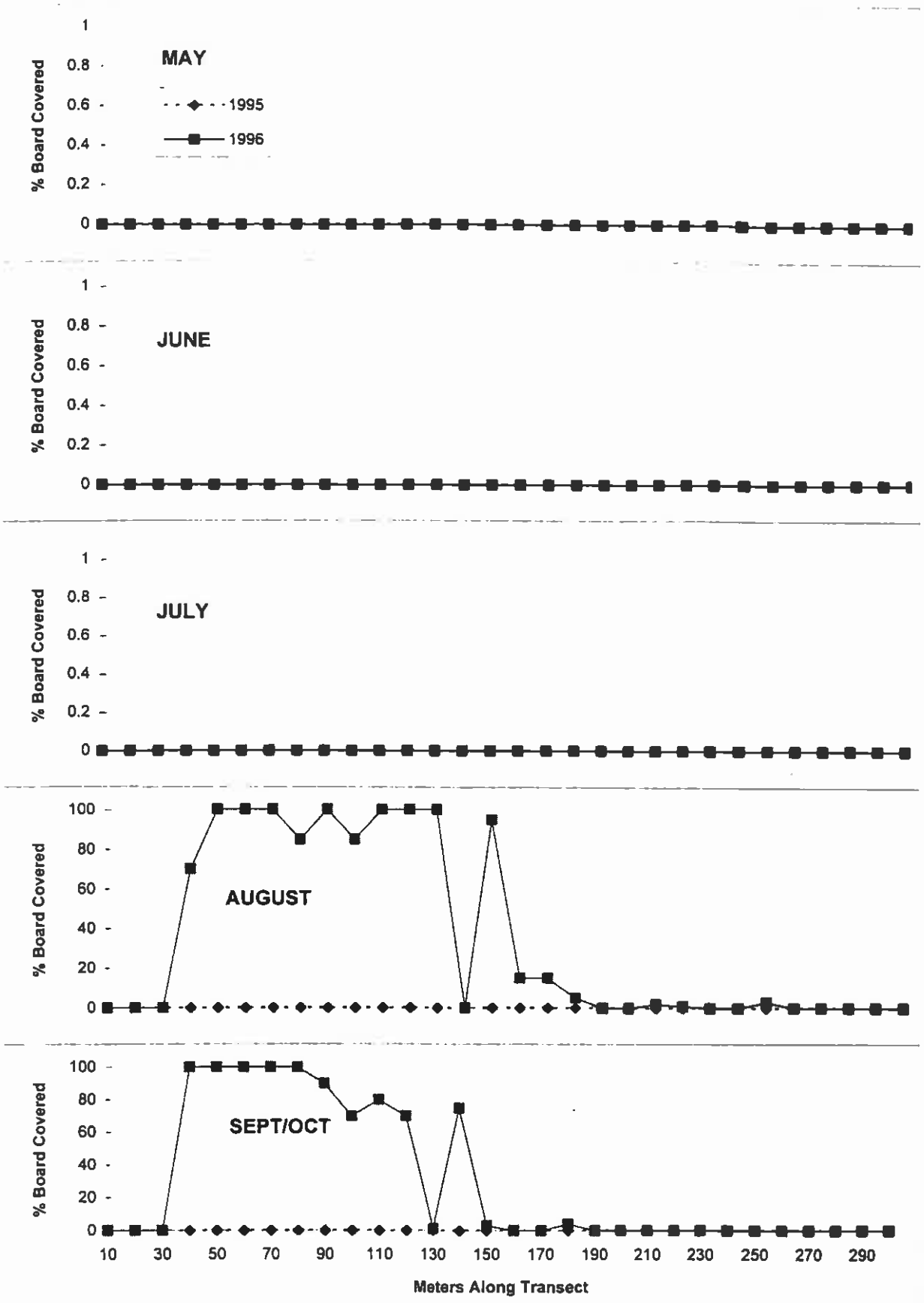


Figure 20. Change in density of plants at 1 meter height along the southeast marsh transect



Remote surveys

Figures 21 - 35 show the seasonal avian use of Metzger Marsh and Potter's Pond in 1995 and 1996 based on remote survey data. Because of a lack of mudflat, Potter's shows little shorebird usage for both years (Figure 21). Seasonal shorebird use of Potter's Pond dropped from a peak of 40 in mid-September 1995 to zero during this same time period in 1996. A flux of Killdeer and Sanderlings foraging on beach exposed by strong southwest winds created this peak (see Tables 1 and 2). The total number of shorebird species also dropped from 8 to 2 in 1995 and 1996 respectively. For the most part, shorebird use was limited to two or three spotted sandpipers combing the thin beach on the west edge of Potter's Pond.

Shorebird use of Metzger Marsh was much greater than Potter's in both years due to the exposed mudflat for foraging and the rich invertebrate food source. Looking at between year differences in Metzger, shorebird use was only slightly higher in 1995, but the timing of peak use was different, possibly due to delayed migration in 1996 (See Tables 3 and 4). 1995 showed low numbers of shorebirds in the flooded marsh during early spring migration. Numbers peaked for a brief period in May and dropped to zero. This spring peak occurred in late-May in 1996, as the marsh was being drawn down. June through mid-July shorebird use was higher in 1996 at Metzger due mainly to the many Killdeer which remained on the site during the breeding season, successfully fledging young. This was in sharp contrast to 1995, when fluctuating water levels drowned out the only known Killdeer nest and discouraged most pairs from even attempting nesting.

A mid-July peak in shorebird use was recorded in 1995 at Metzger due to a flux of Semi-palmated Sandpipers and dowitchers. In 1996, this peak was delayed until early August (see Table 2). Twenty five species of shorebirds were seen during point counts at Metzger in 1995 and 21 species in 1996.

The location of shorebirds at Metzger also varied between years. During 1995, most of the marsh was covered with water. Exposed mudflat, created by strong southwest winds, was limited mainly to the southwest and western edges of the marsh. Shorebirds concentrated in the inner marsh during this time. In 1996, exposed mudflat occurred in both the inner and outer marsh areas. Spring shorebirds concentrated at the edge of the water as drawdown proceeded to drain first the south and western portions of Metzger and then the center and eastern sections of the marsh. A large pond remained in the north-central portion of Metzger Marsh throughout summer 1996 and this area attracted large numbers of shorebirds, wading birds, gulls and terns, and waterfowl. For this reason, shorebird use of Metzger Marsh shifted from the southwestern portion of the restoration to the north portion (See Figures 22 and 23) in 1996. There was also a notable increase in shorebirds that forage in drier sites in 1996, like Sanderlings and Ruddy Turnstones (Tables 3 and 4).

Waterfowl utilized both Potter's and Metzger for feeding and resting areas during spring and fall migration. Teal tended to feed in the recently exposed interface of mudflat/water at Metzger Marsh in greater numbers in 1996 because of the increase in this habitat due to drawdown. A large pond in the otherwise dry marsh remained flooded throughout the summer. This area attracted hundreds of Canada geese in late summer as an evening roost site. Mallards and Black Duck also used this pond in August, 1996. Shallow flooding of Metzger in September 1996, to facilitate hunting, attracted teal, mallards and geese to the newly vegetated areas of the marsh. Hunter disturbance in early September and then Oct.- Nov. reduced the numbers of all species utilizing the open pond and vegetated areas of Metzger Marsh and Potter's Pond in 1995 and 1996.

Remote census data showed waterfowl use to be relatively constant in 1995 and 1996 in Potter's Pond (Figure 24), with a large peak of scaup during spring migration. Mallards and Black Ducks also utilized Potter's by the hundreds on migration. Peak numbers of waterfowl reached 2400 birds at Potter's, which was three times the number of waterfowl seen at Metzger Marsh in either year.

Black Ducks, Mallards, Canada Goose, scaup and teal used Metzger in 1995 and 1996 (see Tables 3 and 4). Diving ducks were limited to the outer marsh, while geese frequented both inner and outer sections. Dabblers tended to concentrate most in the inner marsh areas, although large numbers of Black Ducks and Mallards would occasionally be found rafting in the outer marsh.

Waterfowl use of Metzger Marsh during spring and fall migration was higher overall in 1996 (Figures 25 and 26). The annual plants which grew on the exposed mudflat provided good foraging habitat in the outer marsh during summer 1996 and showed increased avian use when compared to 1995 data. But the biomass of plants produced also made remote surveys of the dabblers all but impossible by August 1996. For this reason, late summer and fall remotes of Metzger did not accurately reflect waterfowl and passerine use of the outer marsh.

While Metzger and Potter's Pond provided migratory stopover and feeding sites, few species of waterfowl were present during the breeding season, and these appeared to be mostly unpaired birds. Hemi-marsh conditions of 50 % plant cover to 50% water have been shown to support higher bird species richness and greater invertebrate resources than dense vegetation or open water (Weller and Spatcher 1965, Weller and Frederickson 1974, Murkin et al. 1982, Nelson and Kadlec 1984, Murkin and Kadlec 1986). Metzger Marsh and Potter's Pond were mainly open water during the 1995 and 1996 waterfowl breeding season.

Herons and egrets (wading bird guild) were found fishing in the shallow waters of Potter's Pond from spring through fall (Figure 27). Wading bird use of Potter's in 1995 was sixfold the use in 1996. This decreased usage could not be correlated with any particular aspect of the reference marsh. Kushlan (1986) noted that wading birds use diverse foraging and nesting strategies to cope with seasonal variations in habitat resources and it is presumed that the birds found Potter's Pond less attractive in 1996 and shifted their activity elsewhere.

Wading bird use of Metzger Marsh in late summer 1996 was 8 fold that of 1995 (See Figures 28 and 29)-- a reverse of the scenario at Potter's Pond. Most of these adult herons nest on an offshore island and fly to the mainland to feed in suitable areas. The increased use of Metzger was most likely due to the concentration of fish in several shallow water ponds of the otherwise dry marsh. These fishing spots were also favorites of herons and gulls, and even attracted 3 White Pelicans in August 1996. The inner and outer marsh areas show a shift in wading bird usage similar to the shorebirds: in 1995, wading birds concentrated in the shallow waters and cattail edges of the inner marsh. During the drawdown of 1996, the birds tended to concentrate heavily in the outer marsh pond where fish were plentiful.

Figures 31 and 32 show gull and tern presence, especially in late summer-fall, increased dramatically in Metzger's outer marsh in 1996. Like the herons and egrets, gulls and terns flocked to the shallow water of the outer marsh in 1996 for easy foraging. Potter's Pond on the other hand, did not exhibit much difference between gull and tern numbers for 1995 and 1996 (see figure 30).

For the most part, passerines did not use the flooded Potter's Pond, although some birds foraged on the shoreline during migration and swallows fed on insects flying over the marsh. The lack of emergent vegetation precluded any nesting by the perching bird guild in Potter's. Figure

33 shows the passerine numbers for Potter's Pond to be higher in 1995 than in 1996. This was due to large flocks of mixed blackbirds which invaded the shoreline or exposed mudflat on several occasions.

Remote surveys at Metzger Marsh recorded maximum numbers of land birds during the Red-wing Blackbird, Grackle and Cowbird migration in late summer in both 1995 and 1996. During the rest of the year, passerines could be heard and seen using the emergent vegetation in the southern portion of Metzger. The outer marsh (Figure 34), covered by water in 1995, was mainly used by foraging swallows. In 1996, the new vegetation in the outer marsh provided ample seed and insect food and the mudflat area was rich in invertebrates (personal observation). Because of this dramatic habitat change, passerines shifted their use of Metzger from the inner to the outer marsh (Figure 35) in late summer 1996 and showed increases in numbers over 1995. This shift in bird use correlates well with the vegetation transects in the outer marsh.

Diversity Indices

Table 5 shows the calculated diversity indices for Metzger Marsh in 1995 and 1996. Values for the inner and outer marsh areas were also calculated. Diversity was higher in the drawn down marsh for the breeding and late summer migration seasons. This was due to increased use of the marsh by swallows, gulls and terns, teal and passerines. Spring diversity was higher in the flooded marsh due to a greater variety of waterfowl and a higher proportion of Lesser scaup in the drawndown marsh which lowered the overall diversity indices. Species numbers were 27 for spring migration in 1995 and 1996, 23 species versus 38 species for 1995 and 1996 respectively, and 46 species during the 1995 late summer shorebird and tern peaks versus 51 species in 1996.

Diversity indices for Potter's Pond (Table 5) showed an almost threefold increase in diversity during the 1996 spring migration due to greater numbers of Mallards, Black ducks, and gulls which offset the large proportion of scaup. There were 23 species present in spring of 1995 versus 18 during spring of 1996 at Potter's, even though the index was lower for 1995. The summer diversity index is also slightly higher in 1995 and can be attributed to swallows and icterids seen on point counts that year. Potter's Pond indices for the late summer migration is the same in 1995 and 1996, but the total number of species were much less: 24 seen in 1995 versus 9 seen during 1996 point counts. Again, this was due to high numbers of icterids and swallows using the embayment in 1995.

Metzger tended to be higher in diversity than Potter's Pond in 1995 and 1996 due to shorebird, waterfowl and passerine use (Table 5). The exception to this trend was the summer breeding season of 1995, when a large influx of Dunlins lowered the index for Metzger Marsh because of their overall proportion to all birds seen on point counts.

Because Metzger's outer marsh diversity indices were calculated separately, this area can be compared with Potter's Pond which it resembled in 1995. Again, the trend is for Metzger to be more diverse in avian species than Potter's. The one exception to this trend occurred during the breeding season of 1995, when a large number of swallow species at Potter's Pond created higher diversity in this embayment. During the summer of 1995, Metzger's outer marsh was shallowly flooded and used by few species.

In looking at the inner and outer portions of Metzger Marsh, a trend towards increased diversity in the drawn down marsh is apparent. An exception is spring migration 1996, when the high proportion of scaup mentioned above greatly lowered the diversity index for the outer marsh. A shift in avian use also occurred in 1996, when inner marsh diversity went down.

Species like shorebirds, wading birds, and gulls and terns shifted their use of Metzger to the outer marsh in summer and fall 1996. For example, total numbers of shorebird species using Metzger remained similar in 1995 and 1996 (24 species vs. 21 species). However, their position in the marsh changed during drawdown, as noted in the remote counts. The inner marsh supported 24 species of shorebirds in 1995, but only 7 species in 1996. The birds moved their foraging activities to the outer marsh in 1996 which held 21 species of shorebirds compared to only 3 species in 1995 when it was a shallow embayment. This shift in use can be attributed to the large pond which remained in the outer marsh and concentrated food such as fish and invertebrates. The inner marsh was dry mudflat at this time.

Figure 21. Seasonal Shorebird Use of Potter's Pond 1995-1996

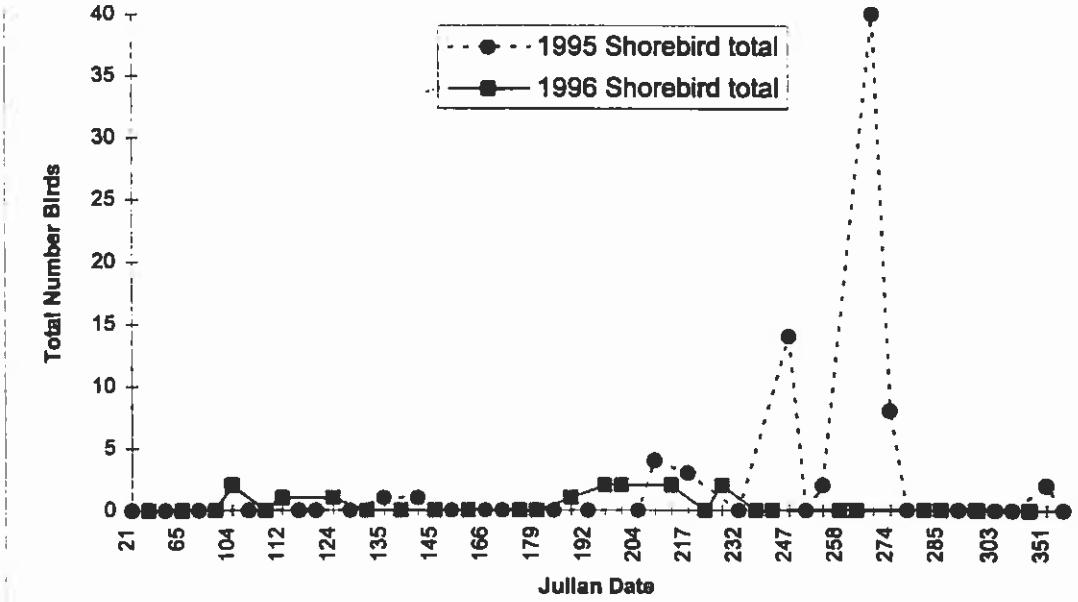
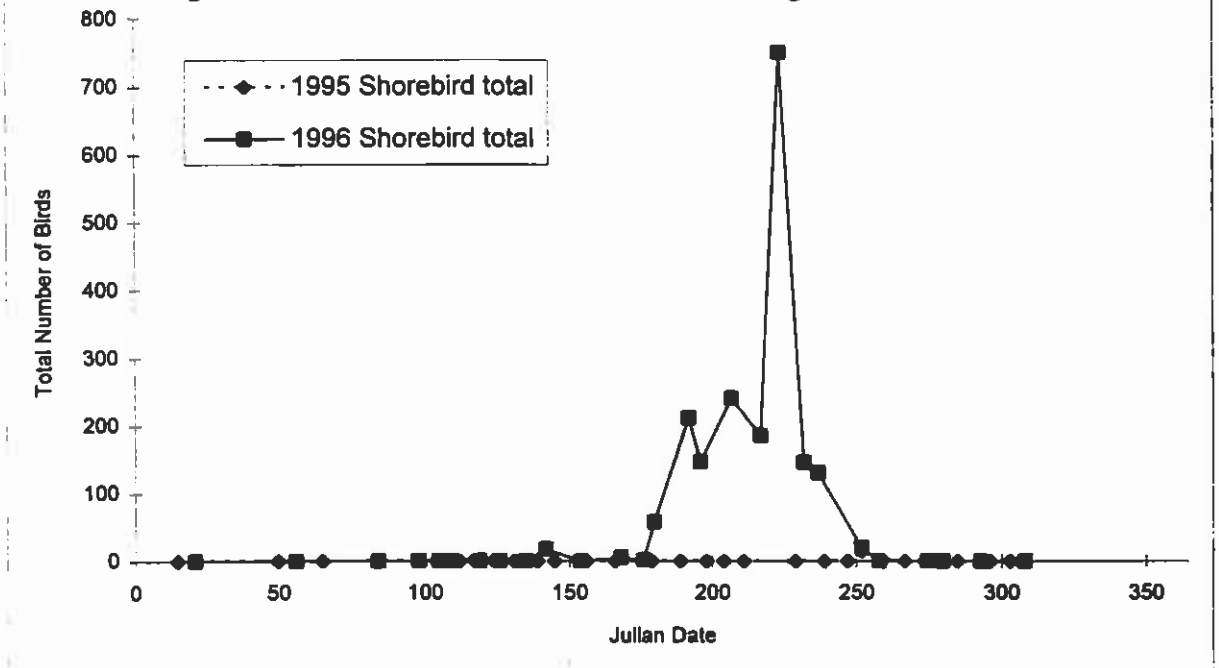


Figure 22. Seasonal Shorebird Use of Outer Metzger Marsh 1995-1996



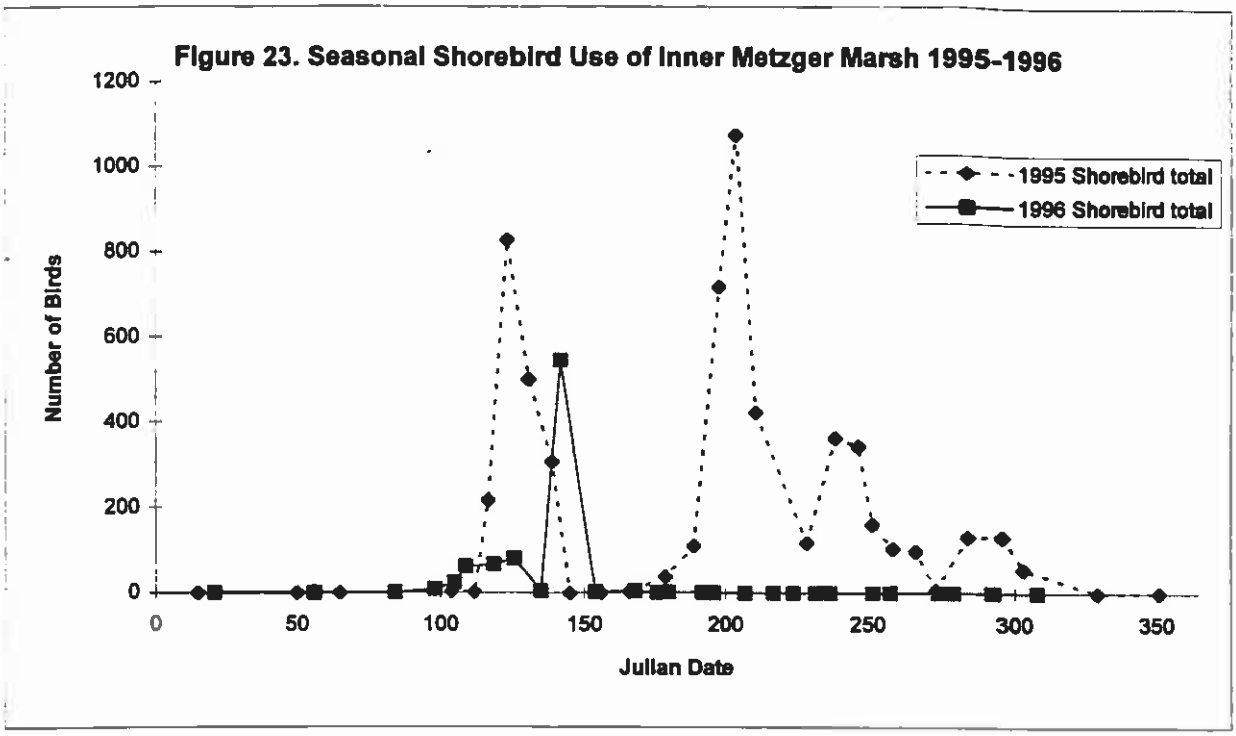


Figure 23. Seasonal Shorebird Use of Inner Metzger Marsh 1995-1996
1200
1000
800
600
400
200
0
Number of Birds
0
50
100
150
200
250
300
350
Julian Date
1995 Shorebird total
1996 Shorebird total

Figure 24. Seasonal Waterfowl Use of Potter's Pond 1995-1996

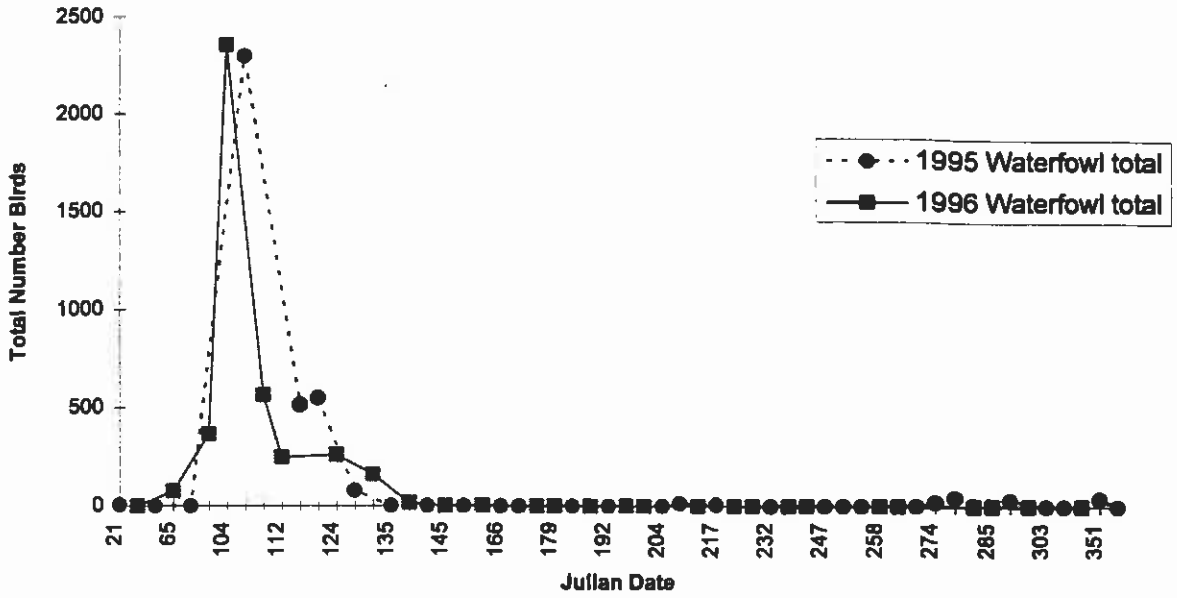
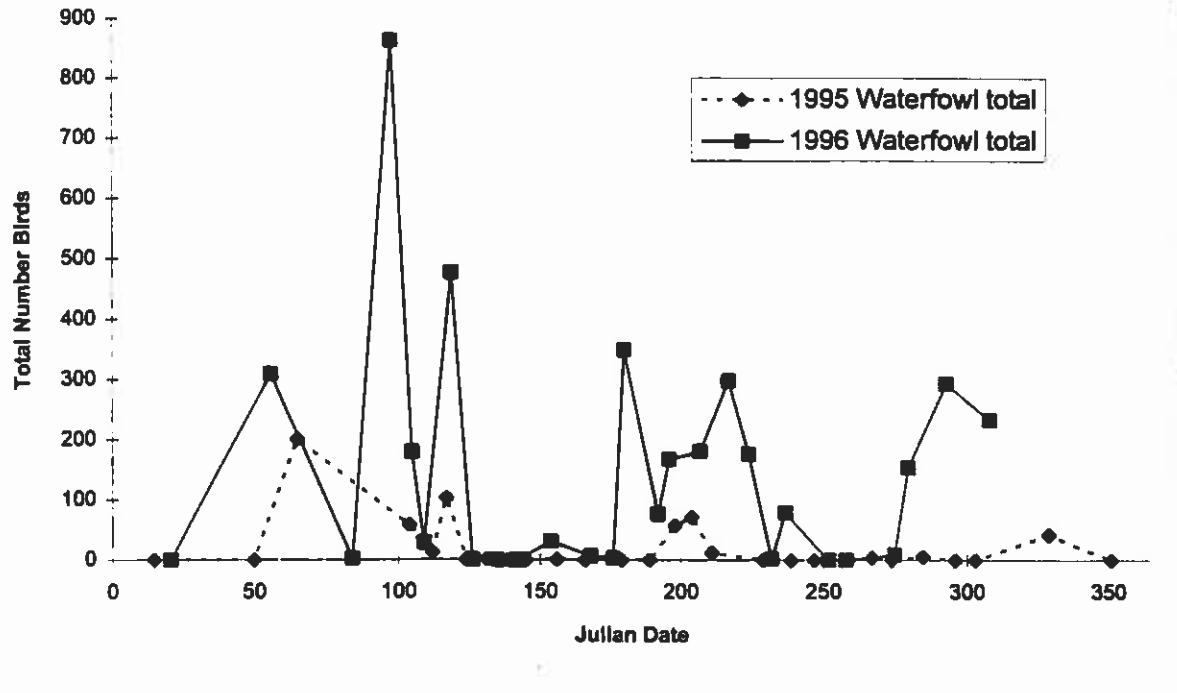


Figure 25. Seasonal Waterfowl Use of Outer Metzger Marsh 1995-1996



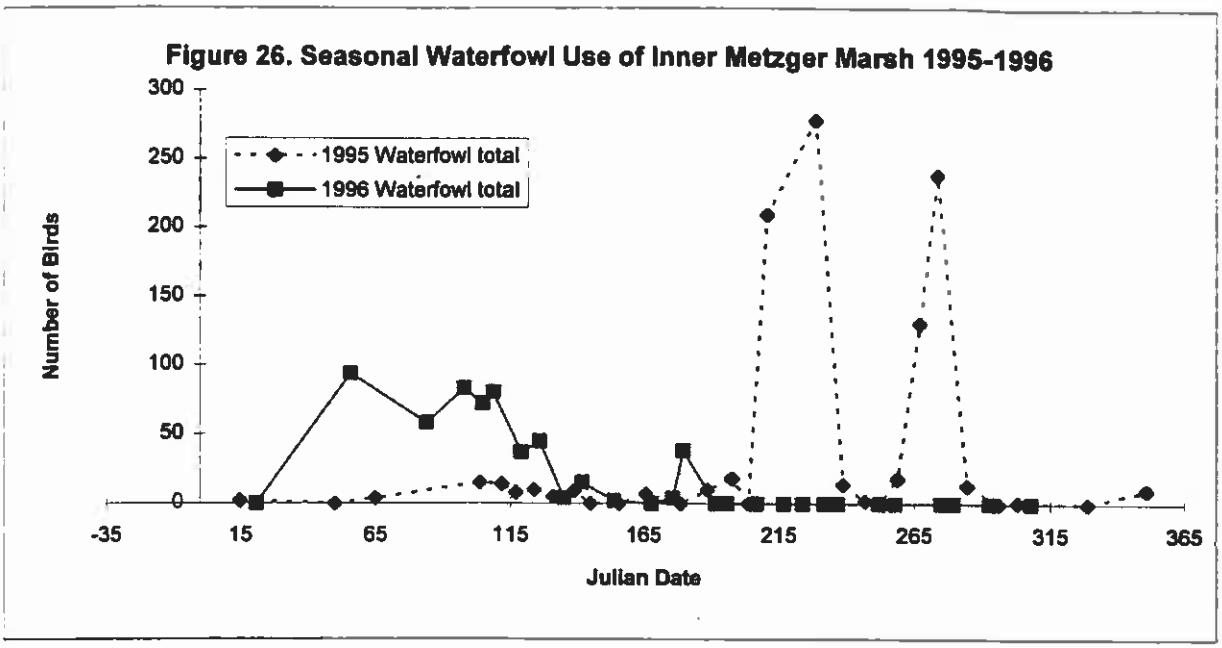


Figure 26. Seasonal Waterfowl Use of Inner Metzger Marsh 1995-1996
300
250
200
150
100
50
0
Number of Birds
1995 Waterfowl total
1996 Waterfowl total
-35
15
65
115
165
215
265
315
365
Julian Date

Figure 27. Seasonal Wading Bird Use of Potter's Pond 1995-1996

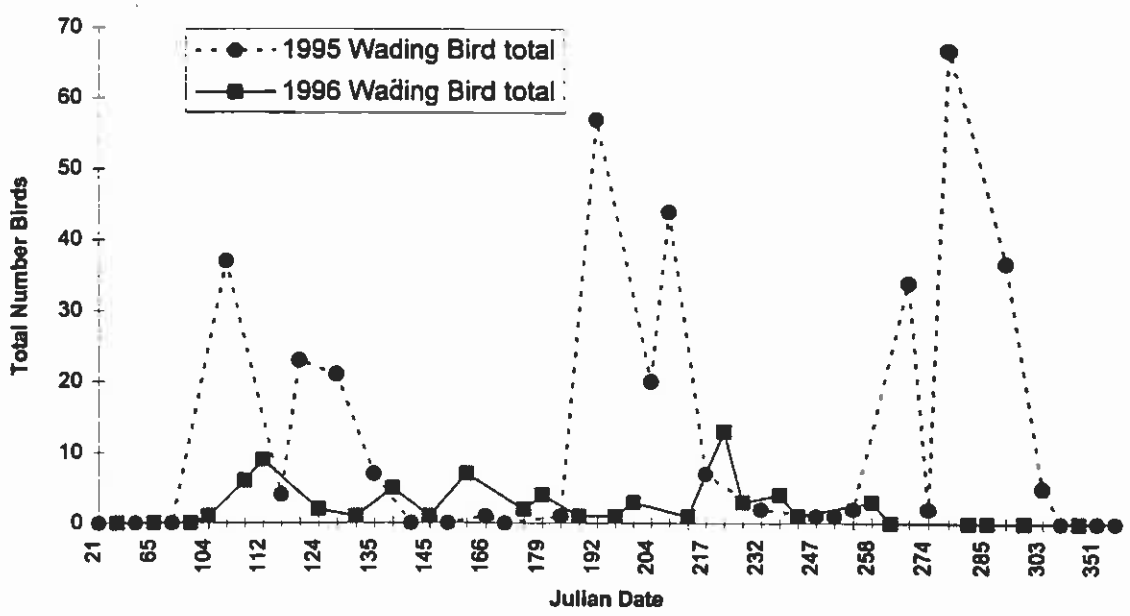


Figure 28. Seasonal Wading Bird Use of Outer Metzger Marsh 1995-1996

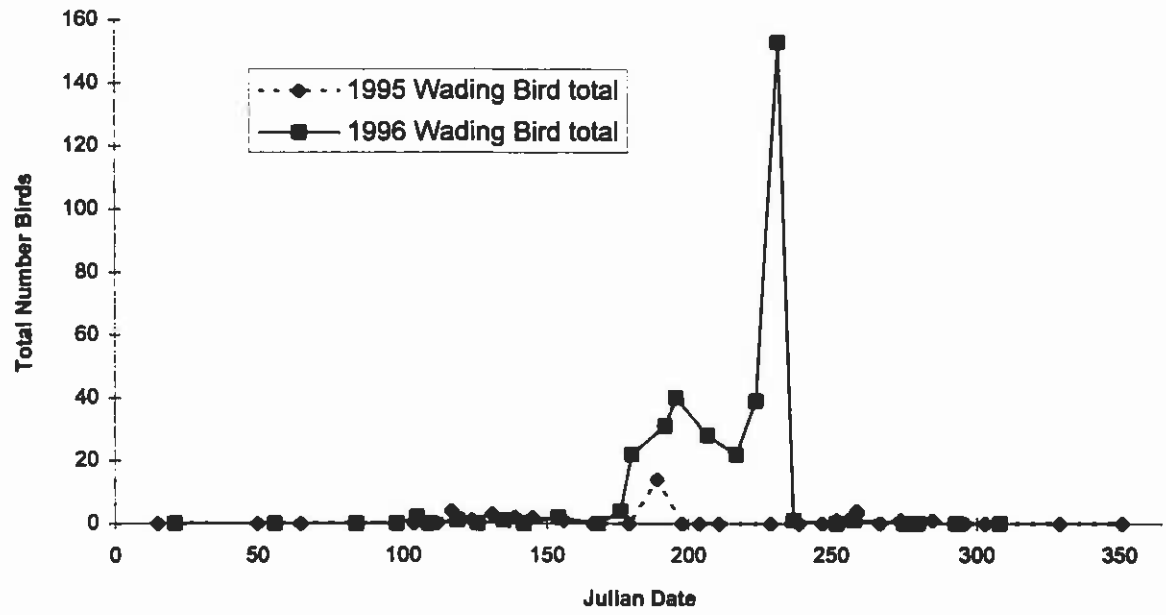


Figure 29. Seasonal Wading Bird Use of Inner Metzger Marsh 1995-1996

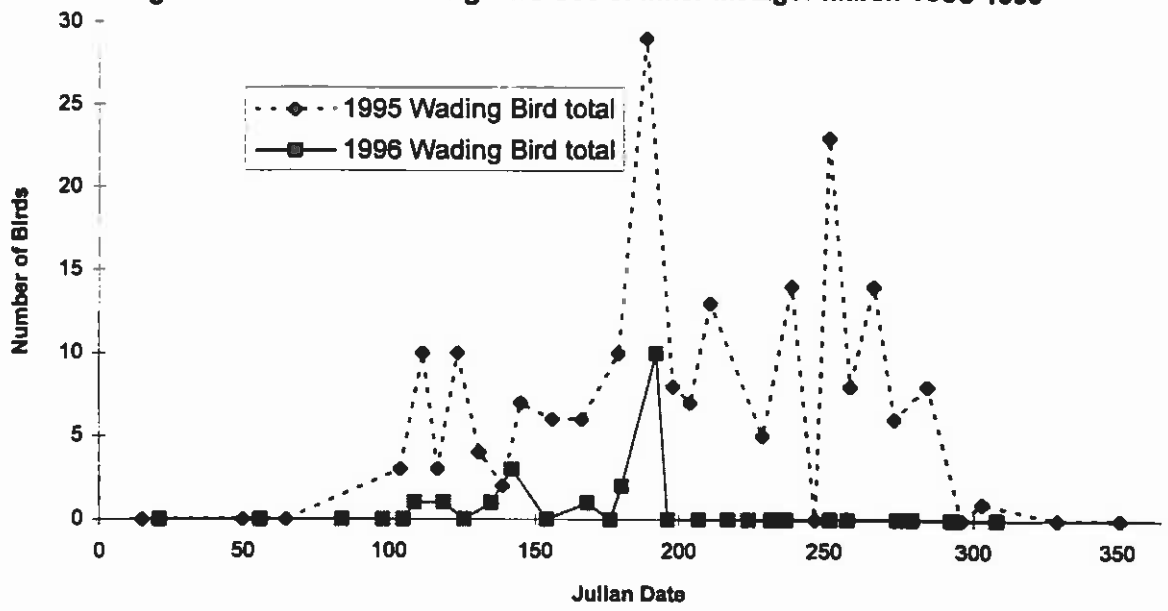


Figure 30. Seasonal Gull and Tern Use of Potter's Pond 1995-1996

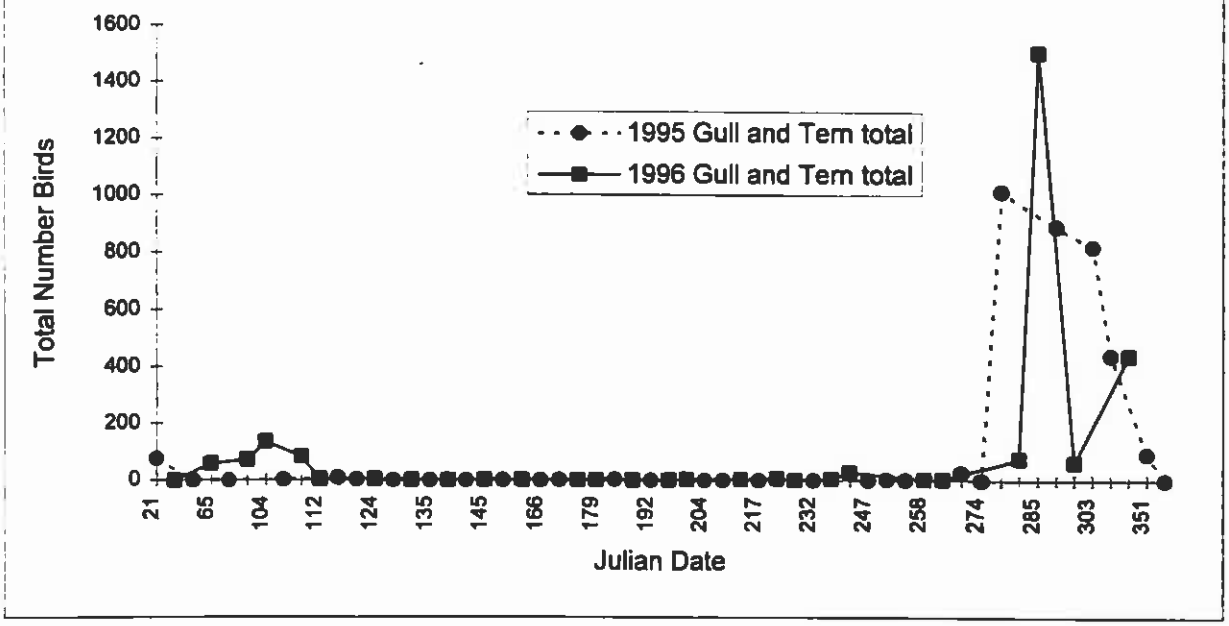
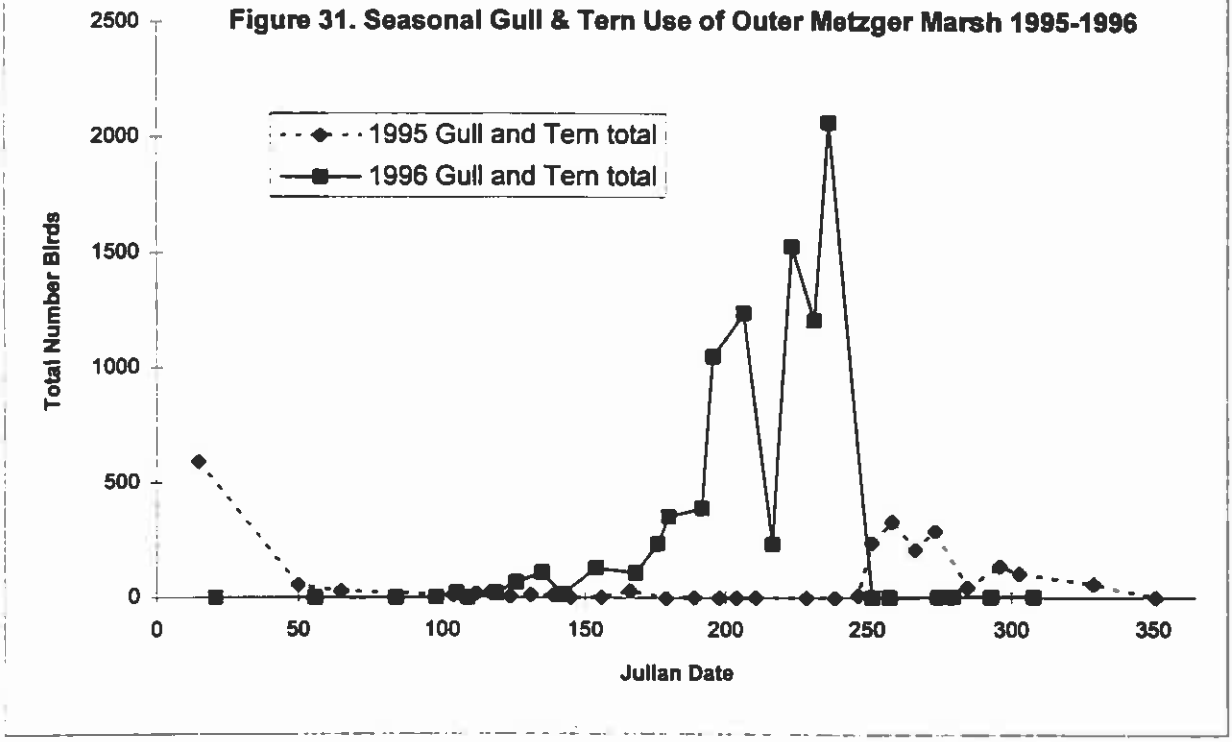


Figure 31. Seasonal Gull & Tern Use of Outer Metzger Marsh 1995-1996



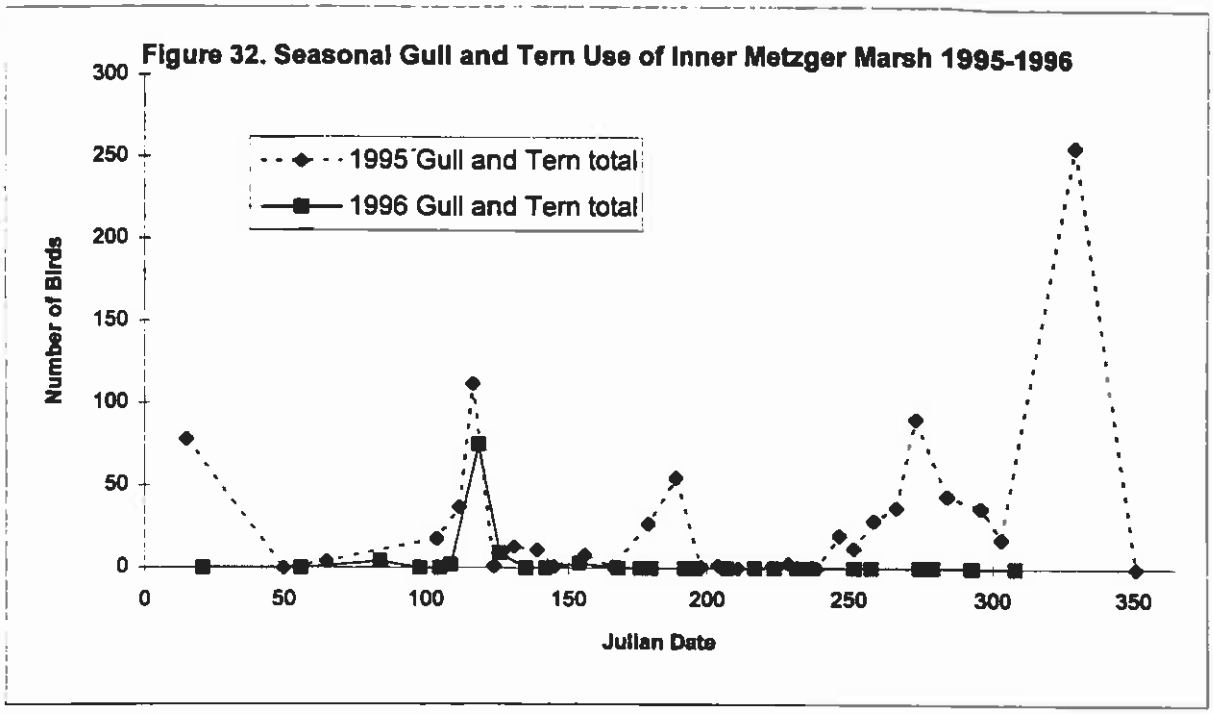


Figure 32. Seasonal Gull and Tern Use of Inner Metzger Marsh 1995-1996
1995 Gull and Tern total
1996 Gull and Tern total
Number of Birds
Julian Date
300
250
200
150
100
50
0
0
50
100
150
200
250
300
350

Figure 33. Seasonal Perching Bird Use of Potter's Pond 1995-1996

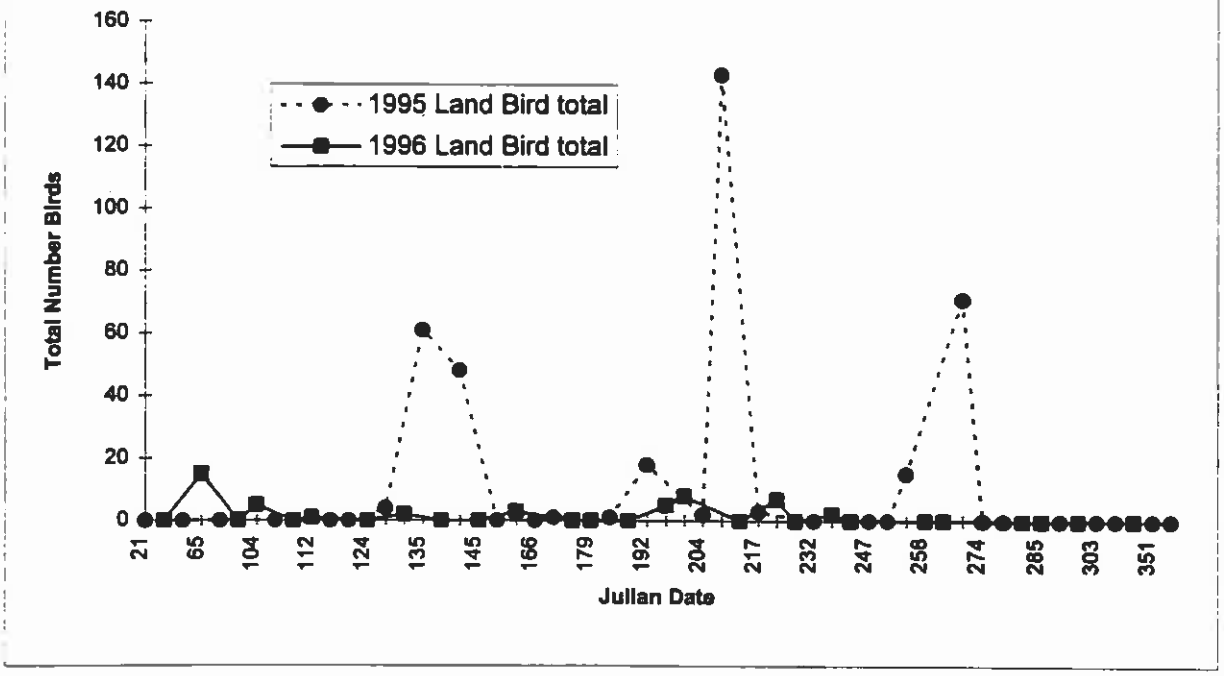
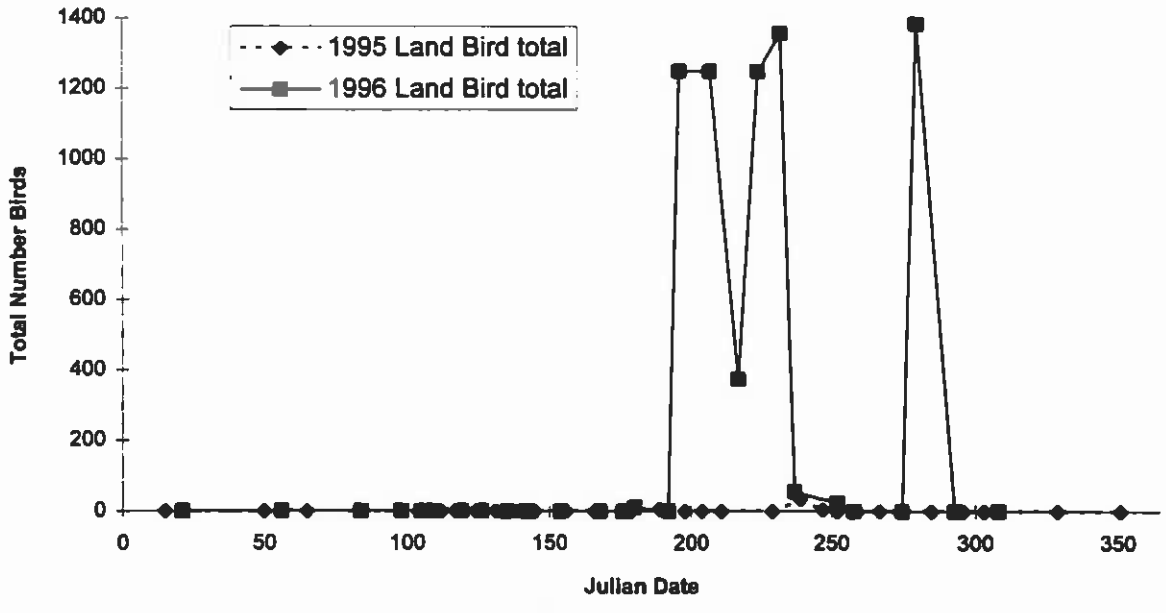


Figure 34. Seasonal Land Bird Use of Outer Metzger Marsh 1995-1996



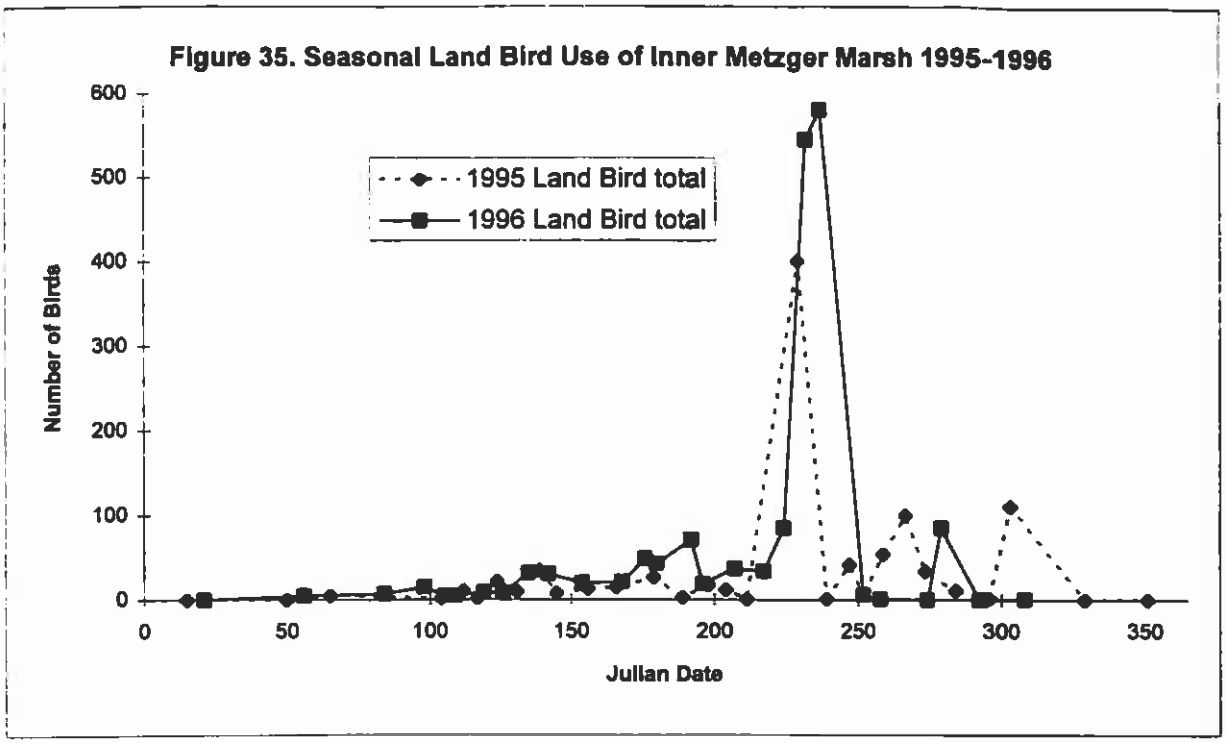


Figure 35. Seasonal Land Bird Use of Inner Metzger Marsh 1995-1996
600
500
400
300
200
100
0
Number of Birds
1995 Land Bird total
1996 Land Bird total
0
50
100
150
200
250
300
350
Julian Date

Table 1. Seasonal Bird Use of Potter's Pond, 1995

Julian date	15	50	65	104	112	117	124	131	139	145	158	166	179	189	198	204	211	229	239	247	252	259	267	274	285	296	303	329	351
	1/15	2/19	3/6	4/14	4/22	4/27	5/4	5/11	5/19	5/25	6/5	6/15	6/28	7/8	7/17	7/23	7/30	8/17	8/27	9/4	9/8	9/18	9/24	10/1	10/12	10/23	10/30	11/25	12/17
Tundra Swan	6																												
Canada Goose				14		2										14	6												
Wood Duck				4																									
Lesser Scaup				2190	470	542	68	2																					
Greater Scaup					1	2																							
Ring-necked Duck				1																									
Ruddy Duck				48	18																								
Black Duck				33	24	2	1																	27	31			32	
Mallard					4	3	7		2														7	17				9	
Wigeon																							7						
Pintail																							6						
Shoveler				6			3																						
Coot				4																									
Pied-billed Grebe																						1							
Western Grebe				1																									
Common Merganser																													
Waterfowl	6	0	0	2301	515	551	79	2	2	0	0	0	0	0	0	14	6	0	0	0	0	1	22	44	31	0	0	41	0
	1/15	2/19	3/6	4/14	4/22	4/27	5/4	5/11	5/19	5/25	6/5	6/15	6/28	7/8	7/17	7/23	7/30	8/17	8/27	9/4	9/8	9/18	9/24	10/1	10/12	10/23	10/30	11/25	12/17
Herring Gull	25			2		1						1	3											85	100	20	6	4	
Great Black-backed Gull	1																										1		
Ring-billed Gull	50				9	1																26		900	800	772	423	87	
Bonaparte's Gull																										36	11	2	
Caspian Tern																				2				7					
Forster's Tern																								31			2		
Gulls/terns	76	0	0	2	9	2	0	0	0	0	0	1	3	0	0	0	0	0	0	2	0	26	0	1023	900	828	443	93	0
	1/15	2/19	3/6	4/14	4/22	4/27	5/4	5/11	5/19	5/25	6/5	6/15	6/28	7/8	7/17	7/23	7/30	8/17	8/27	9/4	9/8	9/18	9/24	10/1	10/12	10/23	10/30	11/25	12/17
Great Blue Heron				37	4	23	21	6			1		1	54	18	28	7	2	1	1	2	18	1	14	31	5			
Great Egret								1						3	2	16						16	1	53	8				
Wading Birds	0	0	0	37	4	23	21	7	0	0	1	0	1	57	20	44	7	2	1	1	2	34	2	67	37	5	0	0	0
	1/15	2/19	3/6	4/14	4/22	4/27	5/4	5/11	5/19	5/25	6/5	6/15	6/28	7/8	7/17	7/23	7/30	8/17	8/27	9/4	9/8	9/18	9/24	10/1	10/12	10/23	10/30	11/25	12/17
Killdeer								1	1							1	1		3			22	1						
Lesser Yellowlegs																						1							
Sanderling																						14	7						
Pectoral Sandpiper																1													
Spotted Sandpiper																2	2		10		2	1							
Semi-palmated Sandpiper																						1							
Black-bellied Plover																						1							
Dunlin																												2	
Semi-palmated Plover																			1										
Shorebirds	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	4	3	0	14	0	2	40	9	0	0	0	0	2	0
	1/15	2/19	3/6	4/14	4/22	4/27	5/4	5/11	5/19	5/25	6/5	6/15	6/28	7/8	7/17	7/23	7/30	8/17	8/27	9/4	9/8	9/18	9/24	10/1	10/12	10/23	10/30	11/25	12/17
Mourning Dove																						1							
Kingfisher															2														
Kingbird								28	6																				
Purple Martin								9																					
Barn Swallow							2	4								3													
Tree Swallow							2	21					1	18							15								
Rough-winged Swallow												1																	
Mixed Swallow																100													
European Starling																	3					70							
Grackle, Red-wing, Cowbird									40							40													
Land birds	0	0	0	0	0	0	4	61	48	0	0	1	1	18	2	143	3	0	0	0	18	71	0	0	0	0	0	0	0

Table 2. Seasonal Bird Use of Potter's Pond 1996

Julian date	21	56	84	98	105	109	119	126	135	142	154	168	176	180	192	196	207	217	224	232	237	252	258	275	280	293	308
	1/21	2/25	3/24	4/7	4/14	4/18	4/28	5/5	5/14	5/21	6/2	6/16	6/24	6/28	7/10	7/14	7/25	8/4	8/11	8/19	8/24	9/8	9/14	10/1	10/6	10/19	11/3
Species																											
Horned Grebe			1																								
Canada Goose		13	55																								
Lesser Scaup		33	10	2260	387	236	228	182	16																		
Common Goldeneye		3																									
Canvasback															1												
Redhead		2																									
Black Duck		5	100	83	178	5																					
Mallard		2	200	16	16	3	8				3																
Gadwall			1																								
Widgeon				11	3	5																					
Green-winged Teal				1																							
Common Merganser		18																									
Ruddy Duck				8			25																				
Waterfowl	0	76	387	2357	564	249	262	182	16	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1/21	2/25	3/24	4/7	4/14	4/18	4/28	5/5	5/14	5/21	6/2	6/16	6/24	6/28	7/10	7/14	7/25	8/4	8/11	8/19	8/24	9/8	9/14	10/1	10/6	10/19	11/3
Great Blue Heron				1	6	9	2	1	5	1	7	2	4	1	1	1	1	4	3	4	1	3					
Great Egret																2		6									
Wading birds	0	0	0	1	6	9	2	1	5	1	7	2	4	1	1	3	1	13	3	4	1	3	0	0	0	0	0
	1/21	2/25	3/24	4/7	4/14	4/18	4/28	5/5	5/14	5/21	6/2	6/16	6/24	6/28	7/10	7/14	7/25	8/4	8/11	8/19	8/24	9/8	9/14	10/1	10/6	10/19	11/3
Killdeer				2		1	1							1		1			1								
Spotted Sandpiper															2	1	2		1								
Shorebirds	0	0	0	2	0	1	1	0	0	0	0	0	0	1	2	2	2	0	2	0	0	0	0	0	0	0	0
	1/21	2/25	3/24	4/7	4/14	4/18	4/28	5/5	5/14	5/21	6/2	6/16	6/24	6/28	7/10	7/14	7/25	8/4	8/11	8/19	8/24	9/8	9/14	10/1	10/6	10/19	11/3
Great Black-backed Gull		2	8	7																							
Herring Gull		6	63	48	48	2	2			1																	
Ring-billed Gull		50	3	34	35	1					1						1			1	20	2	2	76	16	35	71
Bonaparte's Gull				47			1																		1500	28	370
Caspian Tern																		5			1						
Common Tern																3											
Forster's Tern																	2	2		3	7						
Gull/tern	0	58	72	138	83	3	3	0	0	1	1	0	0	0	0	3	3	7	0	4	28	2	2	78	1616	63	441
	1/21	2/25	3/24	4/7	4/14	4/18	4/28	5/5	5/14	5/21	6/2	6/16	6/24	6/28	7/10	7/14	7/25	8/4	8/11	8/19	8/24	9/8	9/14	10/1	10/6	10/19	11/3
Barn Swallow						1		2			3							7									
Tree Swallow																8				2							
mixed Swallow															5												
American Crow		15																									
European Starling				5																							
Land Birds	0	15	0	5	0	1	0	2	0	0	3	0	0	0	5	8	0	7	0	2	0	0	0	0	0	0	0

Table 3. Seasonal Bird Use of Metzger Marsh, 1995

Julian date	15	50	65	104	112	117	124	131	139	145	158	166	178	189	198	204	211	229	239	247	252	259	267	274	285	296	303	329	351
	1/15	2/19	3/6	4/14	4/22	4/27	5/4	5/11	5/19	5/25	6/5	6/15	6/28	7/8	7/17	7/23	7/30	8/17	8/27	9/4	9/9	9/18	9/24	10/1	10/12	10/23	10/30	11/25	12/17
Tundra Swan																												4	
Canada Goose			2	2	4	1	2	2	2					10	72	71	222						114	230	7		1		
Wood Duck					2		2	1	4									1				1							
Redhead			100																										
Canvasback			40																										
Lesser Scaup			40	54	3																				8				
Ring-necked Duck			1																										
Ruddy Duck					4	100																							
Black Duck	2						1								3			223					7					36	
Mallard			2	4		5	3	2	2		1	7						27				7							10
Gadwall																									6				
Shoveler																		7					11						
Pintail																		8											
Blue-winged Teal					10													13		2		8	3	9					
Green-winged Teal				11		4	2												14			3							
Common Merganser			20	2																								2	
Red-breasted Merganser					3																								
Hooded Merganser								1	1																				
Waterfowl	2	0	205	73	28	110	10	8	9	0	1	7	0	10	75	71	222	279	14	2	0	19	135	239	19	0	1	42	10
	1/15	2/19	3/6	4/14	4/22	4/27	5/4	5/11	5/19	5/25	6/5	6/15	6/28	7/8	7/17	7/23	7/30	8/17	8/27	9/4	9/9	9/18	9/24	10/1	10/12	10/23	10/30	11/25	12/17
Great Blue Heron				3	8	4	9	3	3	3	7	6	5	21	2	1	6	2	1		6	4	4	1	4				
Great Egret					2	3	2	4	1	6			5	22	6	6	7	3	13		18	8	10	6	5		1		
Wading birds	0	0	0	3	10	7	11	7	4	9	7	6	10	43	8	7	13	5	14	0	24	12	14	7	9	0	1	0	0
	1/15	2/19	3/6	4/14	4/22	4/27	5/4	5/11	5/19	5/25	6/5	6/15	6/28	7/8	7/17	7/23	7/30	8/17	8/27	9/4	9/9	9/18	9/24	10/1	10/12	10/23	10/30	11/25	12/17
American Avocet																					1								
Semipalmated Plover						1	4										6		4	12	3	4	2		10				
Killdeer				3	2	2	4	1	1		1	3	39	46	10	33	13		16	12	16	5	24	3	82		3		
Golden Plover																									1				
Black-bellied Plover																				1		1	1						
Piping Plover																					1								
Snowy Plover																			1	1									
Lesser Yellowlegs												1		9	10	50	39	20	9	17	9		2		12	1	2		
Greater Yellowlegs							3							4	2	1	2	6	14	6	7	5		2	5		5		
Spotted Sandpiper																		1	1			1							
Semipalmated Sandpiper														4	347	568	230	25	73	67	123	78	7		4				
Solitary Sandpiper															1														
Least Sandpiper							1									10			2	3	2				1	-			
Pectoral Sandpiper																		1	1	3	2	1	3	2			1		
Baird's Sandpiper																					1	1	1						
Western Sandpiper																						1			1				
White-rumped Sandpiper																					1								
Common snipe																										1	5		
Wilson's Phalarope																1		1	1										
Stilt Sandpiper															1	4	1	2	2	1	1	1							
Short-billed Dowitcher														49	347	408	133	63	240	222	8	1	8			130			
Long-billed Dowitcher																						1							
Sanderling																						5			7				
Dunlin						215	815	500	308													4	50		9		40		
Common Snipe																													
Shorebirds	0	0	0	3	2	218	827	501	309	0	1	4	39	112	718	1075	424	119	384	345	177	107	98	7	132	132	68	0	0

Table 3. Seasonal Bird Use of Metzger Marsh, 1995

	1/15	2/19	3/8	4/14	4/22	4/27	5/4	5/11	5/18	5/25	6/5	6/15	6/28	7/8	7/17	7/23	7/30	8/17	8/27	9/4	9/9	9/16	9/24	10/1	10/12	10/23	10/30	11/25	12/17
Great Black-backed Gull	2																								7	2	1		
Herring Gull	26	50	28	18	3	4	7	21	15	2	11	8		13	1	2	1	2		14			7	27	20	14	20	7	
Ring-billed Gull	644	5	4	1	32	131		5	6			23		27						3	151	106	38	83	82	77	69	309	
Bonaparte's Gull	1			11	21								27									17				80	16		
Caspian Tern																					21		2	1					
Common Tern														16													15		
Black Tern														1															
Tern Sp.																					50	125	180						
Forster's Tern																		3		13	28	11	10	269			2		
Gulls/terns	671	55	32	30	68	135	7	26	21	2	11	31	27	57	1	2	1	8	0	30	250	259	245	360	89	173	123	316	0
	1/15	2/19	3/8	4/14	4/22	4/27	5/4	5/11	5/18	5/25	6/5	6/15	6/28	7/8	7/17	7/23	7/30	8/17	8/27	9/4	9/9	9/16	9/24	10/1	10/12	10/23	10/30	11/25	12/17
Mourning Dove									1																				
Horned Lark																								29		2			
Barn Swallow					1	1	8		1		2	4	8	1	1	3	1	1	1	1									
Bank Swallow																				2									
Rough-winged Swallow								1																					
Tree Swallow								2	4			1	5	8						4									
Mixed Swallow																			34	40									
Blue Jay																													
Marsh Wren			1						3		3	2	5		1	1													
European Starling																							100		9				
Yellow Warbler									2	1	2	1																	
Common Yellowthroat									2	1	1	1	1									1							
House Finch																1													
American Goldfinch													1			1													
Song Sparrow							2		6		1		1			1						1					1		
House Sparrow																2													
Red-winged Black Bird			4	2	10	1	13	7	16	6	4	6	6		18	3					6	52		5	2		110		
Cowbird							1																						
Mixed Black Bird/Grackle																		400											
Land birds	0	0	5	2	11	2	22	10	35	8	13	15	27	9	18	12	1	401	35	47	6	64	100	34	11	2	111	0	0

Table 4. Seasonal Bird Use of Metzger Marsh, 1996

Julian date	21	58	84	98	105	109	119	126	135	142	154	168	176	180	192	196	207	217	224	232	237	252	258	275	280	293	308
	1/21	2/25	3/24	4/7	4/14	4/18	4/28	5/5	5/14	5/21	6/2	6/16	6/24	6/28	7/10	7/14	7/25	8/4	8/11	8/19	8/24	8/28/	9/14/	10/1/	10/8	10/19	11/3
Tundra Swan				2																							
Canada Goose		148	31	26	6	3		1	2	10	10			30	17	150	180	229	138	2	70				6		18
Wood Duck				12		2	3			2																	
Lesser Scaup		235	2	850	178	28	476																	4	135		160
Ring-necked Duck																								5			
Black Duck		17	8	7											4			18	8								
Mallard		2	3	11	2	8	2	3	2	3	18	7	4	338	3	17		50	29		2				12		
Gadwall					4	9	5	26																			
Wigeon											3																
Pintail																			3		6						
Blue-winged Teal				4	30	32	15	1					2	18													2
Green-winged Teal				24	22	26	9	14					1		52												
Common Merganser			16	2																							
Hooded Merganser		1																									
Ruddy Duck																										292	52
American Coot				7	5		3																				
Waterfowl	0	403	60	945	250	108	513	48	4	18	31	7	7	386	76	167	180	297	176	2	78	0	0	9	153	292	232
	1/21	2/25	3/24	4/7	4/14	4/18	4/28	5/5	5/14	5/21	6/2	6/16	6/24	6/28	7/10	7/14	7/25	8/4	8/11	8/19	8/24	8/28/	9/14	10/1	10/8	10/19	11/3
Great Blue Heron					2	1	2		1	3	2	1	4	17	26	21	18	22	23	52							
Black-crowned Night Heron															2	1											
Great Egret					1				2		2			9	15	18	12		16	101	1		1				
Wading Birds	0	0	0	0	3	1	2	0	3	3	4	1	4	26	45	40	28	22	39	153	1	0	1	0	0	0	0
	1/21	2/25	3/24	4/7	4/14	4/18	4/28	5/5	5/14	5/21	6/2	6/16	6/24	6/28	7/10	7/14	7/25	8/4	8/11	8/19	8/24	8/28/	9/14	10/1	10/8	10/19	11/3
Golden Plover																						1					
Black-bellied Plover																			11	9	13	1					
Semipalmated Plover										4						1	18	15	25	12	3	3					
Killdeer			1	4	1	4	1	1	5	5	3	8	3	63	30	69	41	41	85	12	12						
Lesser Yellowlegs					1	45	16	4									22	15	52	15	25	3					
Greater Yellowlegs				1	1	1	1									3		3	10	3	3						
Willet																		1	1		1						
Spotted Sandpiper												1	1	1			1	1	5	1	3						
Semipalmated Sandpiper								6								55	90	60	400	62	24	5					
Least Sandpiper																	2	1	20	1	2						
Pectoral Sandpiper							31									13	10	14	15	2							
Baird's Sandpiper																			1		1						
Buff-breasted Sandpiper																			2		4						
Red-necked Phalarope																					2						
Stilt Sandpiper																			1	2							
Short-billed Dowitcher																23	43	17	100	25	10	2					
Long-billed Dowitcher																			1								
Ruddy Turnstone																1	2	1	1		9	1					
Red Knot																			1								
Sanderling																	11	5	7		18	4					
Dunlin				4	22	12	18	70		555																	
Shorebirds	0	0	1	9	28	62	67	81	5	564	3	9	4	64	30	185	240	174	748	144	130	20	0	0	0	0	0

Table 4. Seasonal Bird Use of Metzger Marsh, 1996

	1/21	2/25	3/24	4/7	4/14	4/18	4/28	5/5	5/14	5/21	6/2	6/16	6/24	6/28	7/10	7/14	7/25	8/4	8/11	8/19	8/24	8/8/	9/14	10/1	10/8	10/19	11/3
Great Black-backed Gull																		1		3	1						
Herring Gull			3		18	4	4	23	30	14	88	58	28	37	4	70	150	25	160	95	135		1	4			
Ring-billed Gull			1		3		80	50	65		45	8	180	128	332	800	950	68	1100	680	1325						
Bonaparte's Gull													18	1	8	2			1	50	6						
Caspian Tern														3		9	7	2	35	12	98						
Common Tern														3		80	30	53	80	130	200						
Forster's Tern							10							182		80	100	79	150	230	300						
Black Tern																8			1								
Tern Sp.									15			41	8														
Gulls and Terns	0	0	4	0	21	4	94	73	110	14	133	107	234	354	344	1047	1237	228	1627	1200	2065	0	1	4	0	0	0
	1/21	2/25	3/24	4/7	4/14	4/18	4/28	5/5	5/14	5/21	6/2	6/16	6/24	6/28	7/10	7/14	7/25	8/4	8/11	8/19	8/24	8/8/	9/14	10/1	10/8	10/19	11/3
Mourning Dove																			21								
Purple Martin																	1		4								
Barn Swallow							1		4	7	8	2	5	4	19	2	3	5			80						
Bank Swallow																500	500	500	500		550	25					
Rough-winged Swallow									3																		
Tree Swallow							1	2	3	1			2	4	22						1				4		
Mixed Swallow									8	2					4	1000	1000	360	1000	1700							
Marsh Wren											1	2		3	2	1											
American Robin			1																								
Warbling Vireo										1	2					1											
European Starling									10	1			8	5		3	3	1									
Yellow Warbler										3	1	4				1											
Yellow-rump Warbler										1																	
Common Yellowthroat											1	4		4	2	3	4	3									
American Goldfinch										2			1				1	3	1								
Song Sparrow			3	3						3	2	1	1	4	4	8	3	8	8	5	1	1					
House Sparrow			1																								
Swamp Sparrow														1													
Tree Sparrow		1																									
Bobolink													1				1										
Red-winged Black Bird		4	2	12	5	5	7	6	4	6	5	5	14	16	8	5	19	28	10	200	4	5	1		1463		
Northern Cardinal										1		1															
Indigo Bunting															2	1	4	2	1	1							
Cowbird										2																	
Common Grackle										1		1	17	13	8												
Mixed Black Bird/Grackle															32	608											
Land Birds	0	5	7	15	6	5	9	8	32	31	20	20	49	54	103	2131	1539	908	1545	1906	836	31	1	0	1467	0	0
* Hunters in the marsh																											

Table 5. Shannon Wiener Diversity Indices
for Remote Bird Counts, 1995 - 1996

Metzger Marsh			**Inner Metzger Marsh**		
	1995	1996		1995	1996
Spring Migration	3.49	2.09	Spring Migration	2.51	3.85
Summer Breeding	2.06	3.40	Summer Breeding	1.79	2.41
Late Summer/Fall Migration	3.18	3.36	Late Summer/Fall Migration	2.95	1.97
Potter's Pond			**Outer Metzger Marsh**		
	1995	1996		1995	1996
Spring Migration	0.57	1.47	Spring Migration	3.00	0.28
Summer Breeding	2.90	2.26	Summer Breeding	2.20	2.85
Late Summer/Fall Migration	2.73	2.73	Late Summer/Fall Migration	2.74	3.33

Table 6. POINT COUNT SUMMARY, TERRITORIAL BIRDS AND POSSIBLE NEST LOCATIONS

Number of Territorial Males in Metzgers Marsh Based on 1995 Point Counts					
1995 Point Counts					
Species	On dike	On cattail mat	In nestbox	On mudflat	Totals
Red-winged blackbird	8	13			21
Marsh wren		28			28
Song sparrow	6	1			7
Yellow warbler	5				5
Common yellowthroat	3	1			4
Wood duck			1		1
Tree Swallow			1		1
Killdeer				1	1
1996 Point Counts					
Species	On dike	On cattail mat	In nestbox	On mudflat	Totals
Red-winged blackbird	7	10			17
Marsh wren		16			16
Song sparrow	8	1			9
Yellow warbler	6	1			7
Common yellowthroat	7	5			12
Wood duck			1		1
Tree Swallow			1		1
Indigo Bunting	7				7
Willow Flycatcher	3				3
Spotted Sandpiper				2	2
Killdeer				5	5
Canada Goose				4	4

Point counts and trapping

Breeding birds at Metzger Marsh were comprised mostly of passerines, both in 1995 and in 1996. The birds concentrated their nesting and territorial behavior on the existing cattail mats and adjacent upland dikes. Figures 36 and 37 show the location of territorial males in Metzger Marsh as determined by point counts in 1995 and 1996 and Table 6 summarizes these data. Despite the new vegetation available on mudflat areas of the marsh in 1996, breeding in the sampling area appeared to be limited to the dikes and existing cattail mats-- because new vegetation did not develop early enough in the season. New species successfully nesting at Metzger in 1996 included a pair of Canada Geese, Killdeer and Spotted Sandpipers, which used the mudflat areas. Indigo Buntings and Willow Flycatchers used the dikes for nesting in 1996.

During May 1996, water in Metzger was gradually drawn off the sampling sites so that, by mid-June, the emergent vegetation mats were surrounded by mudflat. Birds which normally nest near water, like the Canada Goose or Marsh Wren, had shallow water conditions at the very start of nesting. In the case of the geese, all four pairs had fledged young by early May and moved them out to the shallow water ponds which remained in the marsh. Two Wood Duck nests were found in boxes in the south marsh sampling unit. One of the two was destroyed by raccoon predation and the other appeared to have successfully hatched and fledged young. Tree swallows subsequently took over the predated duck box.

Marsh Wren numbers were down by eight singing males in 1996 and the birds which did establish territories concentrated their activities in areas that had adjacent water in early June. Based on banding data summarized in Table 7, Marsh Wrens were able to raise young at two sites under the drawdown conditions of 1996, compared with one documented fledging in 1995. Thus, drawdown conditions in 1996 appeared to reduce the suitable territory for Marsh Wrens, but it did not appear to have a great effect on nesting success, which was already low.

In 1996 expansive areas of mudflat dominated the sampling area from late-May through late-June, when the germinating vegetation began to cover these exposed areas. Five pair of Killdeer and at least two female Spotted Sandpipers took advantage of this habitat for nesting in 1996. This was much different from the fluctuating water conditions in 1995 which washed out the only Killdeer nest in the sampling site. Killdeer were also heard and seen during point counts in great numbers in the outer bay-- the area of Metzger which was under water in 1995 and remained sparsely vegetated until late-July of 1996. Juvenile Killdeer were seen with adults in this area.

The secretive rails and gallinules were heard several times in 1995 on point counts. They responded to the playback tape or called as the researcher paddled up to the cattail mats. On one occasion in late summer, a Sora Rail was captured in the funnel traps. No rails were heard or seen in the marsh during the nesting season, either in 1995 nor in 1996. A single Virginia Rail was detected in 1996 during late-May, before the marsh was completely dry. Water was not introduced into the marsh until September, 1996, and no rails or gallinules were detected during the fall migration.

Territorial male Red-winged Blackbirds decreased from 21 in 1995 to 17 in 1996. But fluctuating water levels under pre-dike conditions in 1995 caused most of the male and female Red-wings to abandon the cattail mats, especially an episode of high water on June 21, 1995 (see water level results for details). Thus, nest success was estimated at close to zero in 1995-- with evidence that only one out of the 21 pairs were feeding young (this evidence came from point count observations and alarm calls of adults and not banding or transect studies). Juveniles caught in the mist nets in 1995 immigrated into the marsh during the annual summer staging of

blackbirds, prior to migration. Poor nest success in Yellow-headed Blackbirds using Saginaw Bay marshes was also attributed to storm surges (Young 1996). Indeed, Young attributes low numbers of blackbirds in the bay during her two year study to both short and long term water level fluctuations.

Stabilized water levels after diking and during drawdown increased blackbird nest success. Of the 17 pair of Red-winged Blackbirds estimated to be using Metzger in 1996, feeding behavior, nestlings or fledglings were observed, for nine pairs. Most of the breeding assemblages appeared to be between one territorial male and a single female Red-winged Blackbird. In only one case each year did a male obviously have two females within his territory.

Red-wing Blackbirds, Grackles and Cowbirds immigrated in large numbers into the marsh in July in 1995 and 1996. Flocks numbering in the hundreds would utilize the cattail mats as evening roost sites and leave enmasse soon after sunrise. In 1995, these birds would fly towards the shore and surrounding agricultural fields. In 1996, the emergent vegetation, which now covered most of the marsh mudflats, became a favored foraging site. These flocks, rather than tapering off in numbers by Aug. and Sept., as they did in 1995, grew to numbers over 1000 birds by late summer and early fall 1996. Red-wing Blackbirds comprised the bulk of these flocks and they spent a good deal of time circling over the marsh and foraging in the vegetation and on the mudflats throughout the day.

Song Sparrows utilized the cattail mats in 1995 as foraging and singing areas, but appeared to concentrate most of their activity (including nests) on the adjacent dikes. Only one juvenile was banded in 1995 compared to four in 1996, indicating increased nest success in the drawn down marsh. July point counts revealed that three male song sparrows had moved their territories out into the emergent vegetation under drawdown conditions, expanding their singing perches into the newly germinated vegetation of the mudflat. No nesting occurred here though, as the vegetation was not thick enough during the first nesting period and had collapsed upon itself prior to the second nesting of song sparrows in 1996.

Yellow Warbler numbers detected via point counts did not vary much in 1995, when there were 5, to 1996 when 7 were recorded. The significant difference was in the number of young raised in the cattail mats as evidenced by mist net captures in 1995 and 1996. Table 7 shows no young were detected in 1995, but six young, from at least three different nests, were captured and banded in 1996. Thus, drawdown conditions favored Yellow Warbler colonization of the cattail mats adjacent to the dikes, and increased their nesting success.

The number of Common Yellowthroats also increased under drawdown conditions. Only one male set up territory exclusively in the cattail mats in 1995, with 3 others detected on the adjacent dikes. In 1996, 7 Yellowthroats set up territories on these dikes and 5 males utilized the cattail mats. One juvenile was captured and banded each year, showing that this species was nesting successfully in the marsh.

Indigo Buntings and Willow Flycatchers were two new species breeding in Metzger Marsh in 1996. This may have been due to the lack of water level fluctuation and the rapidly growing vegetation on the mudflats which made the marsh resemble old field habitat. Indeed, this proved so attractive by late-June that a Bobolink was seen singing on two occasions in the marsh.

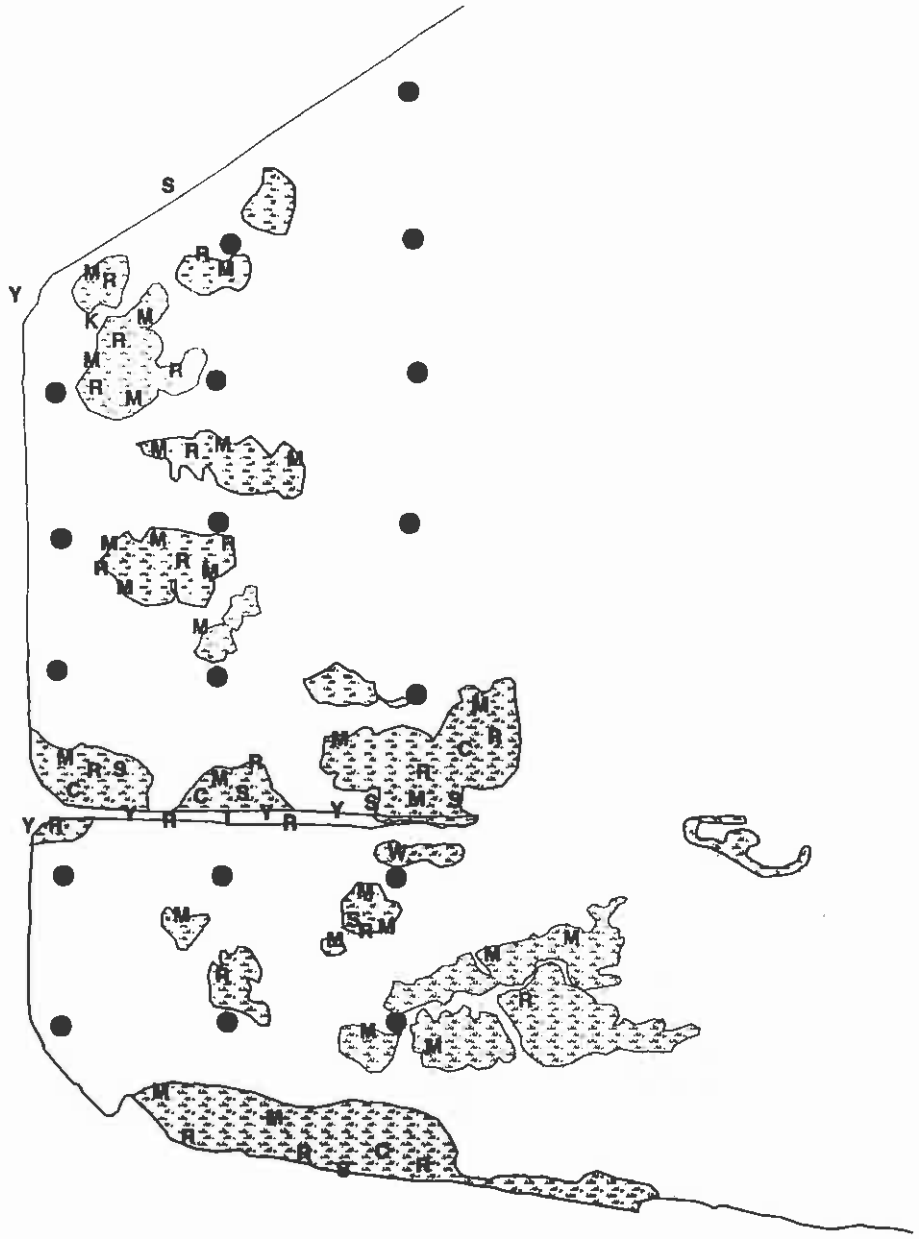
Territorial males showed strong fidelity to their sites in Metzger Marsh. Because the mistnetted birds were banded, individuals could be identified when recaptured. Two males were recaptured in 1996 (one male Marsh Wren and one male Common Yellowthroat), after migrating south for the winter and returning in the spring. Both of these birds were captured on the same

territory they had occupied the year before. Young of these same species were also captured and banded in these territories in 1995 and 1996, strongly suggesting these were successful males.

Table 7. Banding Data Summary for Metzger Marsh

1995 METZGER MARSH BANDING SUMMARY					
BIRDS BANDED PER PLOT					
	Plots				TOTAL
Species	B1	B2	B3	B4	
Song sparrow		3.1.0	1.1.0	0.1.1	4.3.1
Goldfinch		1.1.0	0.1.0		1.2.0
Least flycatcher		0.1.0			0.1.0
Marsh wren	3.1.2		0.2.0		3.3.2
Common yellowthroat		2.0.1			2.0.1
Red-winged blackbird	1.0.0	0.0.1	0.1.4		1.1.5
Yellow warbler		0.1.0		0.1.0	0.2.0
TOTAL	4.1.2	6.4.2	1.5.4	0.2.1	11.12.9
NOTE: 0.1.1 = 0 males, 1 female, 1 juvenile captured					
1996 METZGER MARSH BANDING SUMMARY					
BIRDS BANDED PER PLOT					
	Plots				TOTAL
Species	B1	B2	B3	B4	
Song sparrow	0.0.1	0.1.1	0.1.2		0.2.4
Empidonax			0.0.1		0.0.1
Marsh wren	1.1.1		1.1.0	0.0.1	2.2.2
Common yellowthroat	1.0.0	1.2.0	0.1.0	4.1.1	6.4.1
Red-winged blackbird	1.1.7	0.1.0			1.2.7
Yellow warbler	0.0.2	1.1.3	0.1.1	1.1.0	2.3.6
Indigo bunting		1.1.0			1.1.0
TOTAL	3.2.11	3.6.4	1.4.4	5.2.2	12.14.21
NOTE: 0.1.1 = 0 males, 1 female, 1 juvenile captured					

Figure 36. Avian Breeding Territories in Metzger Marsh Based on 1995 Point Counts



Legend

Point Count Sites

M = Marsh Wren

R = Red-winged Black Bird

S = Song Sparrow

Y = Yellow Warbler

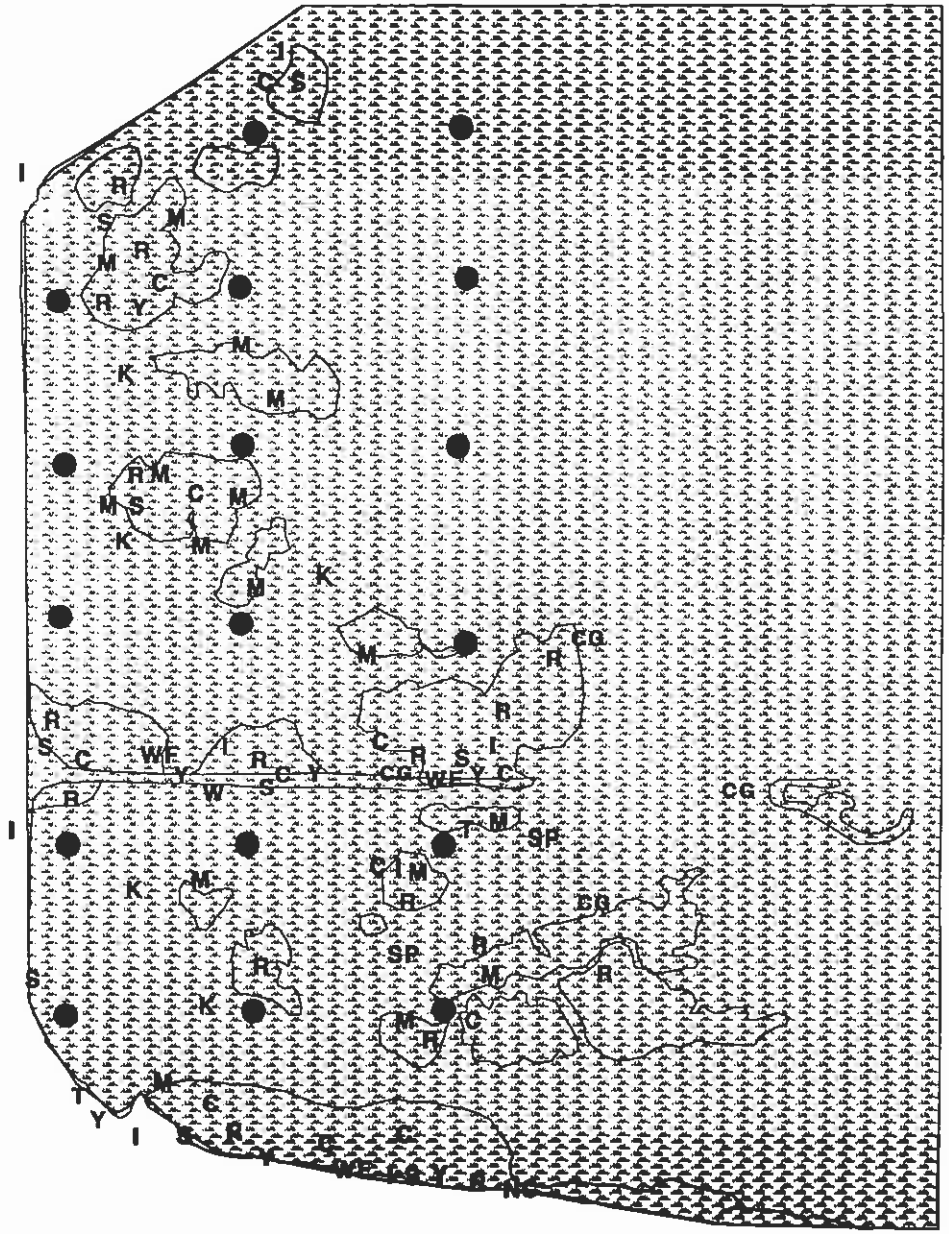
C = Common Yellowthroat

W = Wood Duck

K = Killdeer

T = Tree Swallow

Figure 37. Avian Breeding Territory in Metzger Marsh Based on 1996 Point Counts



Legend

vegetation

Point Count Sites

M = Marsh Wren
R = Red-winged Black Bird
S = Song Sparrow
SP = Spotted Sandpiper
Y = Yellow Warbler
I = Indigo Bunting
C = Common Yellowthroat
W = Wood Duck
WF = Willow Flycatcher
K = Killdeer
T = Tree Swallow
CG = Canada Goose

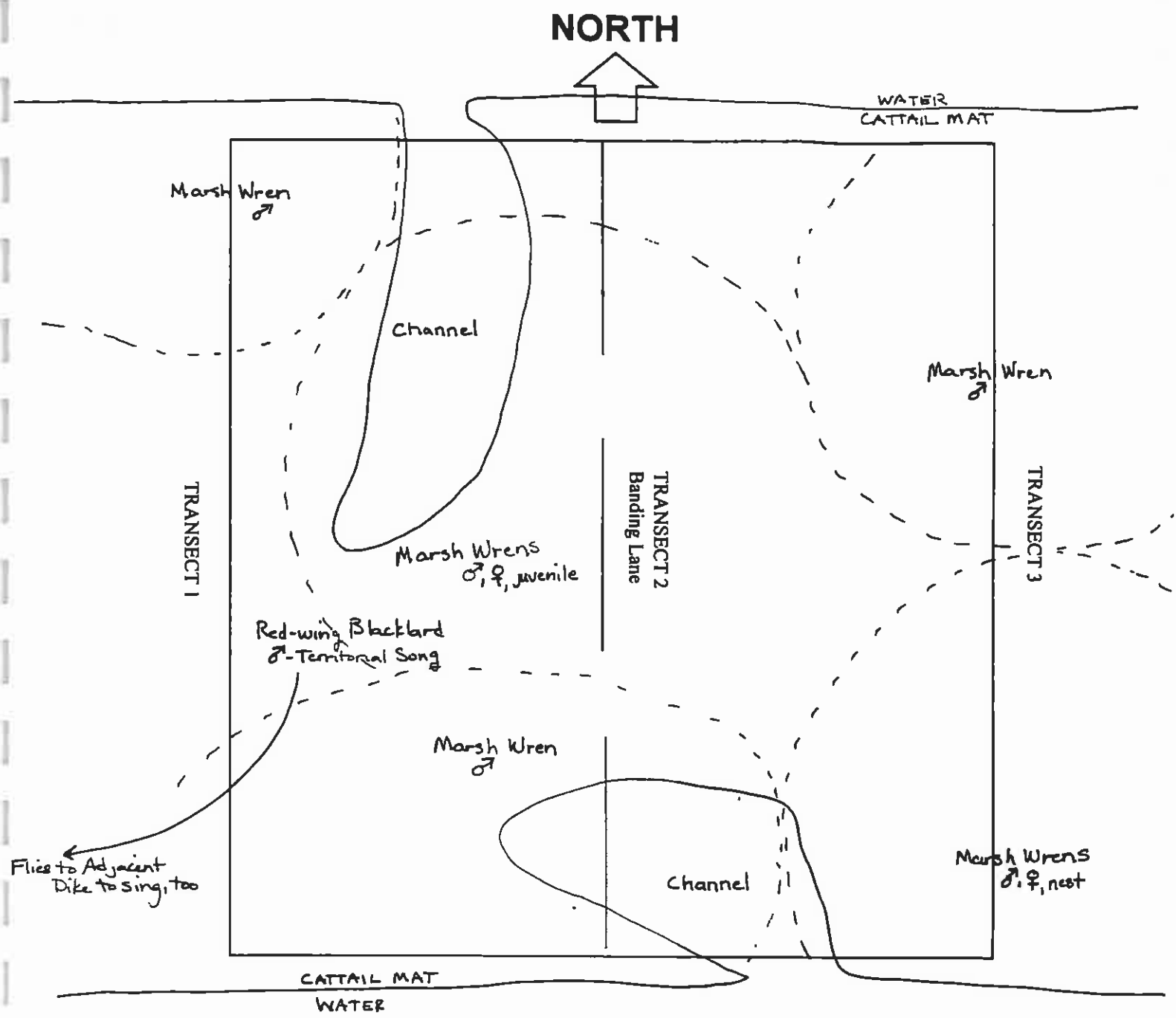
Km

0 0.1 0.2

Transect and quadrat surveys

Figure 38 shows the number and approximate territory size of male birds in one of the four Metzger Marsh quadrats during the 1995 breeding season. This form was used to record breeding birds in the 50 meter square quadrats in 1995 and 1996. Data for all four quadrats each year, showed an estimated average of 1.7 Marsh Wren territories, 0.25 Song Sparrow and Common Yellowthroat territories, and 0.5 Red-wing Blackbird territories per 50 meter square quadrat in 1995. Extrapolating this to the 12 hectares of emergent vegetation in the entire marsh yields a potential of 78 Marsh Wren, 11.5 Song Sparrow and Common Yellowthroat, and 23 Red-wing Blackbird territories. Point count estimates (Table 6) were lower for all these species except the Red-wings due to some vegetated areas outside of the point count and the tendency of this survey method to underestimate numbers of birds.

In 1996, quadrat studies revealed an average of 1.5 Marsh Wren, 0.5 Common Yellowthroat, 0.5 Red-wing Blackbird and 0.25 Song Sparrow territories per 50 meter square plot of emergent vegetation. Vegetation extent for nesting was calculated from extant emergent vegetation in May 1996. Using the 12 ha. estimate yields a potential of 80.5 Marsh Wren, 23 Common Yellowthroat and Red-wing Blackbird, and 11.5 Song Sparrow territories for the entire marsh. Point count estimates for 1996 again yielded lower numbers for all species than did the quadrat surveys extrapolated to the marsh.



BREEDING SEASON: 1995 PLOT NAME: B - 1

METZGER MARSH QUADRAT SAMPLING DATA

50 Meter Square Plot

Figure 38. Sample Quadrat Sampling Data B-1.

SUMMARY

Water level fluctuations and effect on habitat and avian use

High water levels impact vegetation and avian use of the marshes as evidenced by other researchers (Weller and Spatcher 1965, Weller and Frederickson 1974, Farney and Bookhout 1982, Murkin et al. 1982). Fluctuating water levels in Metzger Marsh in 1995 caused high water periods which flooded out nests and resulted in decreased nesting success as evidenced by the numbers of juveniles and nests found during our surveys. This periodic innundation also prevented emergent plants from germinating and even reduced existing vegetation during storm events.

Our transects showed the dramatic vegetative response to stabilized water levels in 1996: previously flooded and mudflat areas became covered with annual vegetation, vegetation height increased, and density in areas not already covered in cattails rose to 100% in most plots.

Because this flush of vegetation occurred in June and July, the nesting birds did not utilize these areas in 1996. Rather, they established territories on existing mats and adjacent dikes. Stabilized water levels in 1995 did result in successful ground nests of Canada Goose, Spotted Sandpiper, and Killdeer. This was in contrast to 1995, when a high water period inundated a Killdeer nest and kept geese and sandpipers from nesting.

Avian use during restoration

Guild use of Metzger Marsh varied with habitat changes. Remote surveys yielded information on seasonal use of the marsh and data for diversity calculations. Point counts, trapping and quadrat surveys provided a more detailed picture of avian use of the inner marsh during nesting season.

Spring waterfowl use of Metzger Marsh varied between years. Greater numbers of scaup and geese utilized the marsh after dike closure, even before emergent vegetation occurred in the outer marsh. Mallards, Black Ducks and Teal concentrated in the inner marsh during spring, and followed the edge of the water as drawdown took place. Mallards and Canada Goose used Metzgers throughout the summer in 1995 and 1996, but in greater numbers during drawdown. They were concentrated with the waders, gulls and terns, shorebirds and swallows in the large pond located in the outer marsh.

Shorebirds were abundant and diverse at Metzger, both in 1995 and 1996, but they moved from the inner marsh to the outer marsh after the drawdown. More wading birds and gulls and terns utilized the marsh for feeding in 1996 when low water levels concentrated fish in small pools. Interestingly, the increase in wading bird use at Metzger's correlates with a decline in wading bird use at Potter's Pond, the reference marsh. Herons and egrets tend to nest in a large off-shore colony north of the two marshes, and it is feasible that the nesting birds shifted their foraging activities to Metzger because of the great fish concentration.

Passerine use peaked in July and August during 1995 and 1996 when large flocks of icterids gathered prior to migration. Metzger was an important roosting and foraging area for these birds, many of which were young of the year as seen during point counts and remote surveys. Nest success for Red-winged Blackbirds was higher in 1996-- in contrast to the fluctuating water levels of 1995 which rendered Metzger a poor nesting area for icterids. The annual vegetation on the mudflats provided rich foraging and perching areas for the icterid flocks whose 1996 numbers were ten-fold those of 1995.

Metzger was also an important foraging area for immature Bald Eagles, especially in 1996 when fish were concentrated in small pools. Adults and immature eagles were seen both years utilizing the dikes and mudflats during point counts and remote surveys, foraging in the shallow waters and learning fishing skills.

Avian breeding species did change slightly in 1996 in response to stabilized water levels in Metzger Marsh when three ground nesting species successfully raised young. Overall nest success was higher in 1996, as evidenced by the number of young censused during banding. Song Sparrows and Yellow Warblers showed increased nesting activity and improved nest success in the drawndown marsh, and Indigo Bunting and Willow Flycatcher were added to the breeding bird assemblage.

Numbers of territorial male Red-winged Blackbirds and Marsh Wrens detected on point counts were lower during drawdown, but higher nest success was evident from increased numbers of nest and juveniles censused by mist net and transect surveys. More Common Yellowthroats used the drawn down marsh, utilizing the isolated cattail mats rather than limiting their territories to vegetation adjacent to and on the dikes. However, based on mist net surveys, nest success was low: one pair, out of a total of one pair, fledged young in 1995 while only one pair, out of a total of four pair, successfully fledged young in 1996.

CONCLUSIONS AND RECOMMENDATIONS

Our two year study of Metzger Marsh before and after dike construction demonstrated the effect of restoration on avian use. Following impoundment and drawdown, stabilized water levels increased the nesting success of passerines, waterfowl and shorebirds in the marsh. Dramatic colonization of former mudflats and water areas by vegetation took place from June through September under drawdown conditions. However, most of the plants were annuals and non-existent or only a few centimeters tall during the onset of the avian breeding season. For this reason, they did not provide new nest sites and the passerines and waterfowl continued to use the existing cattail mats as they had under pre-construction conditions. The newly vegetated areas did provide dense cover and an abundant seed source for late summer young and migrants as well as nesting sites for a few shorebirds.

Increased use of Metzger Marsh by wading birds, gulls and terns, swallows and icterids were documented following drawdown. Isolated ponds in the otherwise dry marsh concentrated food resources and provided foraging areas. Shorebirds, while diverse and abundant in Metzger during both years, altered their use of the marsh from the inner to the outer area-- following the edges of the remaining ponds. By summer 1996, they were all but absent from the inner marsh and concentrated in large numbers around the remaining pond in the outer marsh.

Annual and perennial plant germination on exposed mudflats led to a six-fold increase in vegetation coverage in late summer of the drawdown period when compared to pre-construction conditions. This enormous plant response was due to an abundant seed supply and fertile sediments. Augmentation of Metzger's seed bank was contemplated at the start of restoration. Based on the dense and diverse plant community following the first year of dewatering, we see no need for seed augmentation. Marsh managers should consider management techniques to reduce the prolific cottonwood (*Populus deltoides*) and willow (*Salix* sp.) which have begun to establish themselves in the outer marsh if a shrub/scrub wetland is not desired.

Based on the available literature and historic photos and descriptions of Metzger Marsh, a hemi-marsh community of emergent plants and open water is recommended. Openings in the

dike wall should remain functional to allow fish access for nursery sites, but operated to prevent prolonged high water events that will drown out the emergent vegetation. Marshland birds are adapted to fluctuating water levels, but reduction of extreme and rapid high water levels will increase their nest success in the marsh. Low water levels, caused by southwest winds and seiches will provide ample mudflat areas for foraging shorebirds and increased invertebrate production for waterfowl. It is recommended that all avian guilds be considered when managing Metzger Marsh to provide a more diverse bird community.

Because this study only encompassed the first year following dike construction, it is recommended that research continues to include the period after lake/marsh exchange takes place. Our study has provided a baseline survey of avian use of Metzger Marsh which will be valuable for researchers studying this and other Great Lakes' marsh restorations. This research should be combined with others who are documenting the response to the Metzger Marsh restoration by fish, invertebrates (including bivalves), amphibians, and other components of this marshland system to provide a broader picture of the effect of management activities on a freshwater coastal marsh.

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