Comparison of Salt Marsh Restoration and Creation Techniques in Promoting Native Vegetation and Functional Values

DAVID BURDICK
Department of Natural Resources
Jackson Estuarine Laboratory
University of New Hampshire
Durham , NH 03824

and

MICHELE DIONNE
Wells National Estuarine Research Reserve
Wells, ME 04090, and
Zoology Department
University of New Hampshire
Durham , NH 03824

Submitted July 29, 1994
Office of State Planning
New Hampshire Coastal Program
2 1/2 Beacon Street
Concord, NH

This research was funded by a grant from the New Hampshire Coastal Program through the National Oceanic and Atmospheric Administration pursuant to NOAA award # NA370Z0277-01.

ACKNOWLEDGEMENTS

Many thanks to Fred Short for helpful discussions throughout the project. Dan McHugh of Great Meadow Farms was the contractor for the Awcomin Marsh restoration and the Inner North Mill Pond mitigation projects, and we appreciate his help and discussions regarding this report as well as his efforts in salt marsh creation and restoration. We thank Ian Warden and Ty Corneau for their dedicated work on this project. Sincerest thanks to Peter Helm and Jim Lee for heartfelt encouragement.

INTRODUCTION

Many salt marshes in New England and along much of the coastal United States have been destroyed by filling or draining (Mitsch and Gosselink 1986). Though currently protected from direct impacts by the Clean Water Act of 1972 (Section 404) and other environmental legislation, salt marshes continue to be negatively impacted by indirect effects of human alteration of the environment. Many of these indirect effects do not cause loss of marsh area, but they all degrade the marshes, reducing the functions and values of salt marshes in coastal ecosystems. Functional losses at impacted sites are often due to long-term effects of coastal structures that result in tidal restrictions (e.g., roads, impoundments; Roman et al. 1981, Burdick 1992, Rogers et al. 1992, Dionne 1994, Boumans and Day, in press). In New England, the reduction of tidal exchange has been linked to the replacement of typical salt marsh plants by invasive species like *Phragmites australis, Lythrum, salicaria* and *Typha* spp. (Roman et al. 1981, Shisler 1990, Burdick 1992).

Additionally, salt marsh destruction is permitted under current U. S. regulations if there are no alternatives for development projects, especially in cases where the development is marine-related. If destruction is allowed, replacement of the same type of marsh of similar or greater area is usually required (specifics are granted by the U. S. Army Corps of Engineers on a case by case basis), and this process is termed mitigation. Replacement of salt marsh often includes creation of a new salt marsh in the vicinity of the one being destroyed. However created marshes may not survive, and even if they persist some marsh functions require from several years to decades to develop; with some never attaining the same level of performance as the original area (Kusler and Kentula 1990, Moy and Levin 1991).

The state of New Hampshire has lost approximately half of its coastal marshes since colonial times, and many remaining marshes are degraded due to indirect human impacts such as tidal restriction (Cook et al. 1993). Recently, it has been estimated that tidal restrictions are impacting 20% of New Hampshire's remaining salt and brackish marshes (Soil Conservation Service 1994). Degradation due to tidal restriction includes loss of marsh functions and often replacement of typical salt marsh plants by invasive and freshwater species (Shisler 1990). Restoration projects at two salt marshes in New Hampshire are based on increasing tidal exchange, and one includes active methods to deter *Phragmites australis,* an invasive plant. Destruction of a salt marsh on the Piscataqua River, scheduled as part of the New Hampshire Port Expansion Project, has been mitigated by creation of a salt marsh at a nearby site. Here we evaluate the processes of degradation and restoration through an examination of changes in hydrology, soils, vegetation and fish use of salt marsh restoration/creation sites.

In this report, we examine early results from three different types of projects that were designed to improve or replace marsh functions in New Hampshire. One project excavated tidal creeks through berms and marsh filled by dredge spoil (Awcomin Marsh), another added a large culvert through a road causeway that had eliminated tidal exchange about 30 years ago (Mill Creek), and a third created a new salt marsh as mitigation in an urban estuary (Inner North Mill Pond). Our results document pre-restoration conditions and early changes in several functions of the three different systems, which are then used to compare and evaluate the specific design of each project with respect to its goals.

METHODS

Study sites: Awcomin Marsh, which is directly inland of Rye Harbor, was the disposal site of dredge spoil from dredging activities in 1941 and 1962 (Figure 1). Large stands of *Phragmites* occur within and over the 1962 berm, spreading into the salt marsh that is behind the larger, encompassing 1941 berm. A major restoration effort was begun in 1992 to increase tidal exchange with the goal of reversing the spread of *Phragmites*. Two major tidal creeks were cut through the 1941 berm and a large portion of the 1962 berm was removed in 1992 (FIG. 1). In addition, several farmers' ditches were dug to encourage success of *Spartina patens* (salt marsh hay). Further work to increase tidal exchange and control *Phragmites* has included excavations of old dredge spoil from two areas and another tidal creek (Fig. 2).

Mill Creek at Stewart Farm in Stratham (Figure 3) was once bordered by salt marsh. Salt marsh on both sides of the access road to the farm was supported by tidal exchange with Great Bay via the Squamscott River. Tidal flow into the upper creek above the drive was eliminated by installation of a culvert with a tide gate during road improvements in the early 1960s. The culvert allowed drainage from the creek downstream, but a flap gate did not allow reverse flow that would carry saline waters from Great Bay into the area. Hence, the wetlands bordering the creek upstream of the road had become fresh meadows. Recently, these areas have been overrun by purple loosestrife, *Lythrum salicaria*, an invasive weed (Stuckey 1980). Small *Phragmites* stands occur on the upstream and downstream sides of the access road, with no plans to remove or control this species.

North Mill Pond is in Portsmouth, and is currently the primary site where salt marsh was initiated as mitigation for the expansion of the Port of New Hampshire (Figure 4). Clean sediment has been placed on intertidal mudflats in eight lobes (approximately 0.4 ha) and has been planted with *Spartina alterniflora*. Design of the salt marsh includes tidal creeks between lobes and a pool that remains filled with water through low tides.

Hydrology: The extent of tidal flooding was mapped on two spring and neap high tides at each site following restoration/creation. Wells that communicate with interstitial sediment water from 5 to 20 cm below the surface were designed to measure shallow water table depths and allow water samples for salinity determinations to be taken rapidly. Salinity measurements were made with a temperature corrected optical refractometer to the nearest part per thousand (ppt). Wells were installed: 50 at Awcomin Marsh, 33 for Mill Creek at Stewart Farm, and 24 at North Mill Pond. Water table depth (reported as cm below marsh surface), and salinity measurements were performed at Awcomin Marsh on eight dates in 1992, eight dates in 1993, and four dates in 1994, before, during, and after restoration activities. At Stewart Farm, eight data collections were done prior to the restoration, and four collections afterward. One set of measurements were taken at Inner North Mill Pond. Sample dates were distributed to include spring and neap tide periods.

Soils: Soil sampling stations were established in coordination with well and vegetation sampling locations at the three sites. Twenty stations at Awcomin marsh, 18 at Mill Creek Marsh, and 24 stations in Inner North Mill Pond, all with two subsamples per station, were sampled. Soils were sampled for soil moisture (gravimetric determination), percent organic matter (loss on combustion at 450^{o} C for four hours), *in situ* redox potential (Eh at 1 and 10 cm depths), and salinity and pH on interstitial water expressed from cores (0-5 cm deep). Soil temperature at 1 and 10 cm depths was measured to correct Eh readings. During the study period, soils were sampled following restoration on two dates at Awcomin Marsh and one date at Mill Creek and Inner North Mill Pond. Pre-restoration baseline sampling, performed on two dates and ten stations at Awcomin Marsh (Burdick 1992), was included in the data analyses. Pre-restoration sampling was performed at Mill Creek in the summer of 1993, before the culvert was installed.

Vegetation: Plant species (according to Tiner 1977), percentage of cover, canopy structure (stem height and density), and biomass were determined during the period of peak biomass (July to September) at each of the sites in 1993. In 1994, percentage cover was performed in June at Awcomin Marsh and Mill Creek. Habitat development will be assessed using plant occurrence and species composition. Percentage of plant cover was measured using a one meter square hoop at both restoration sites in July 1993 and June 1994, and at the created marsh in September 1993. Aboveground biomass will be used to assess primary production. The potential for water filtration by the marsh was assessed using plant canopy structure, which is an integrative measure of the stem density and height of the dominant species (Table 1). Aboveground plant tissues were collected in 1993 for biomass and canopy structure from a 0.0625 m^2 quadrat placed the same pre-determined distance and bearing from each sampling well as the soil collections for that period. Some pre-restoration sampling of vegetation was performed at Awcomin Marsh in 1992 and will be included in the data analyses (Dionne, unpublished data). Additionally, rough vegetation maps based on vegetative cover before and following restoration were produced.

In Inner North Mill Pond, plants were not harvested, but biomass was estimated from cover estimates and estimates of the area of the ten tallest plants within each quadrat: $\text{BIOMASS } (g/0.0625m^2) = 0.658*(\%\text{COVER}) + .0557*(\text{SHOOT AREA})$
Plants were collected from the natural reference marsh to develop the equation, which accounted for 89% of the variation in these data. Shoot area was obtained from stem heights and leaf numbers of the ten tallest stems within two 0.0625 m^2 quadrats for each station.

Table 1. Canopy structure is composed of serveral variables. First, shoot density and canopy height are integrated using the table below to provide a description of the three dimensional complexity of the dominant species. Then if other species are present, 1 is added to the value obtained for the dominant species to obtain the canopy structure.

STEM DENSITY	MEAN STEM HEIGHT (cm)				
(#/0.0625 m^2)	0-8	>8-16	>16-32	>32-64	>64
0	0	0	0	0	0
1-2	1	2	3	4	5
3-4	2	3	4	5	6
5-8	3	4	5	6	7
9-16	4	5	6	7	8
17-32	5	6	7	8	9
33-64	6	7	8	9	10
65-128	7	8	9	10	11
129-512	9	10	11	12	13
>512	10	11	12	13	14

SHOOT AREA = Σ [0.776*(SHOOT HEIGHT)
- 0.2.26 if two leaves
+0.003 if three leaves
+ 0.366 if four leaves
+ 0.626 if five leaves
+ 2.523 if six to eight leaves]
of the largest 10 shoots in the quadrat.

Secondary producers: Marsh utilization by secondary producers was compared among the different sites with fish surveys to asses whether higher trophic levels are being supported by the restored and created marshes (Rogers et al. 1992). The use of the salt marshes by fish was determined following restoration/creation activities at each site. Two stations were selected in low marsh along creek banks at each site, and Fyke nets with 16 meter wings were set on falling evening tides on two occasions (one spring and one neap tide) for each station. Net specifications and detailed methods for collection procedures can be found in Jackson Estuarine Laboratory Standard Operating Procedure 1.27 (JEL SOP 1.27). Fish were caught in the nets as they migrated out of the low marsh habitat with the falling tide. Fish were indentified to species and enumerated on site. Fish densities were calculated by determining the area of marsh fished at each site. Due to the low numbers of fish caught in some samples, data from both samples from each sampling site were combined. Data for individual samples are presented in Appendix 1.

RESULTS

AWCOMIN MARSH, RYE

Hydrology

Tides: The two major creeks dug in 1992 allowed salt water to enter the area impounded by the 1941 berm throughout the lunar (spring/neap) tidal cycle. However, only spring tides were able to flood the marsh surface (Figure 5). A channel dug subsequently in 1993 through the area impounded by the 1962 berm and excavations within both impounded areas that removed about 30 cm of the dredge spoil overburden on the marsh may increase the saltwater flow into these areas on normal as well as spring tides. The disappearance of standing water on both sides of the 1962 berm indicates the excavated creeks are draining the standing water effectively. The extent of pre-restoration flooding at Awcomin Marsh was the 1941 berm for neap tides and the 1962 berm for spring tides. Ditching in the area impounded by the 1941 berm also appears to have increased drainage in the vicinity, but neap flood tides do not appear to overflow these ditches and flood the marsh surface.

Water Table Depth: Prior to restoration, the water table was substantially lower (by 9.3 cm) in reference zone A than in restoration zone B, and similar to the water table in restoration zone C (Fig. 6a). After restoration in 1992, the water table was slightly lower in B than A (by 1.4 cm), and slightly lower in A than C (by 2.4 cm). After restoration in 1993 and 1994, the water table was lower in restoration zones B, C, and D than in reference zone A (Fig. 6b).

Water Table Salinity: Prior to restoration, water table salinities were higher in reference zone A than in restoration zones B and C, by about 8 ppt (Fig. 7a). After restoration in 1992, these differences in salinity were reduced to about 5 ppt. By 1993 and 1994, salinities in A remained similar to 1992 values, while salinities in B, C, and D, were substantially greater than their 1992 values (Fig. 7a). Salinities among the four zones were fairly high and quite similar in 1993 and 1994, as compared to the lower and more variable data collected in 1992 (Fig. 7b). Salinities in A, B and C were essentially the same in 1993, while D was slightly lower. Salinities in A and B were essentially the same in 1994, while C and D were slightly lower.

Sediments

Soil salinity: In general, soil salinity was greatest at the reference marsh, Zone A, and decreased with each successive Zone (Fig. 8a). Salinity was greater in 1993 than in 1992, following the excavation of the creeks and ditches (Fig. 8b). Fresh water impounded within and pooled around the outside of the 1962 berm was drained by the creeks, resulting in dramatic increases in the salinity from 1992 to 1993. The reference marsh in Zone A showed the smallest relative increase in salinity from pre to post-restoration activities, while soils in Zones B, C, and D showed the largest increases. The increase seen in Zone A is likely due to month to month (synoptic) variation.

Soil moisture: Soil moisture is reported as a percentage of the wet weight of the soil. A comparison of the four sampling times indicated that May was the wettest sampling period. Apparently, restoration had little effect on soil moisture, except perhaps reducing the extremes of soil moisture within the 1962 berm (Zone F). Across vegetation zones, soil moisture averaged 82% in the reference marsh, was slightly greater in Zones B and C (85%), fell back to 82% in Zones D and E, and was appreciably [significantly] lower within the 1962 berm 77%, Zone F), especially following restoration.

Season had little effect on soil moisture in the natural marsh, but variation between months increased with impact to the marsh. Figure 9a shows that soil moisture was least variable in the reference marsh, but slightly greater in Zones B and C that were impacted by the dredge fill activities. Monthly variation in soil moisture was progressively greater in D and E and greatest in Zone F where impacts were greatest.

Soil redox potential: The chemical potential of the soil to accept electrons is measured as Eh. By impeding oxygen entry to the soil, flooding is often responsible for lowering the Eh, which indicates whether oxygen or other electron accepters such as iron or sulfate are being used by respiring organisms. Soil redox potentials were generally positive, except at all the impacted sites in May, the wettest sampling period (Fig. 10). Eh at 1 cm depth was greater for the next three sampling periods and highest in October after restoration. Soil Eh at 1 cm was fairly consistent at the reference sites (Zone A) over the study period, but variability increased with the extent of impact, being greatest at Zone F (Fig. 10a). The trend of greater variability in Eh with greater impact was also observed for the soil moisture data.

Generally, Eh was lower at 10 cm than at 1 cm depth, except in May prior to the restoration at the heavily impacted Zones D, E, and F (Figures 10 and 11). At 10 cm, Eh increased distinctly following restoration (Figure 11). The increase was also seen at the reference sites in Zone A, which is curious. Since Eh and soil moisture are normally negatively correlated (wetter soils have lower Eh), it is curious to note that the two wettest months, May and October, exhibited the extremes in soil Eh at both depths (Figs. 10 and 11). After restoration, the Eh at 10 cm increased the most at plant Zone F, behind the 1962 berm (that is, lowest Eh in May and highest Eh in October; Fig. 11a).

Soil pH: In general, soil pH was never very low (above pH 4), and followed soil moisture. The wet conditions of May were accompanied by relatively high pH, close to neutral, except at Zone F, where fresh water was impounded (Figure 12b). Following restoration, the relatively drier conditions of June and October showed mild pH values of between 6 and 7, except again for Zone F. Instead of fresh, acidic water accumulating as occurred in May, the relatively high elevations within the 1962 berm were drying out, and as the soil oxidized it became more acidic, with mean pH values between 5 and 6 (Fig. 12).

Soil organic matter: The amount of organic matter in the soil, measured as loss on ignition, was determined only for soil samples taken after the restoration (1993). As would be expected, no significant differences in organic content were found between months after restoration (Fig. 13). The amount of soil organic matter is a measure of the ability of a soil to hold water as well as the ability of the organisms within to break down or respire the organic material. Soils having high organic matter content generally hold more water and have greater soil moisture than those under the same drainage conditions with low organic matter content. The pattern across the vegetation zones was similar to that of soil moisture, described earlier (Fig. 9) and these two variable were well correlated (r=).

Vegetation

Maps: Before restoration work was started in 1992, the salt marsh vegetation in the impounded areas at Awcomin Marsh appeared quite different from the vegetation of the surrounding marshlands. Within, and to the West of the 1962 berm, *Phragmites* and *Typha* were growing in stagnant pools and advancing on the *S. patens* marsh that remained (Fig. 24). Beyond the *Phragmites*, but still within the 1942 impoundment, brackish pools of *Scirpus* were surrounded by a mixture of *S. patens* and short form *S. alterniflora*. Surrounding marshes had tall *S. alterniflora* along the creek and panne edges, but almost pure stands of *S. patens* over much of the area. From 1992 to 1993, following the first phase of restoration (Fig. 2), two major changes in the vegetation were noted. The first was the draining of pooled water within both the 1962 and the 1941 berms. Specifically, drainage was improved inside and outside the northern portion of the 1962 berm, continuing northeast from the 1962 berm along the flanks of the new creek (Fig. 2), and inside the northeastern corner of the 1941 berm. All these sites have now been colonized by *Salicornia* and *Spartina alterniflora*, and now are beginning to be replaced by *S. patens*. This vegetation type is called the low mixed community (Figure 25) because it occurs in relatively low elevations.

The other notable change from 1992 to 1993 was the continued advance of *Phragmites* eastward within the 1941 impoundment in vegetative Zone D and along the Northeast corner of the 1962 berm (Fig. 24 and 25). In 1992 these areas were classified as mixed *S. patens* and *Phragmites*. Over the last two years, *Phragmites* had spread and consolidated its position, resulting in clearer boundaries between the two species. Therefore, this category was replaced by monospecific classes in the 1994 map (Fig. 25). In contrast, three tiny stands of *Phragmites* in Zone B (Fig. 24) did not appear to expand in 1993. By 1994, these *Phragmites* 'satellite populations' were absent.

Several other changes in the vegetation maps from 1992 to 1994 are apparent. Two large areas (Zone F and west of Zone E) have been excavated and no vegetation exists, save some scattered *Salicornia* seedlings. The large stands of *Typha* found here were killed by the restoration of tidal flooding. The area of mixed high marsh plants (High Mixed) to the west of the island (Trees), has largely been replaced by *S. patens*, while a large area to the east of the island is now classified as a mixed community of high marsh species (*Juncus gerardi, Distichlis spicata, Panicum virgatum, and Solidago sempervirens*). Some of the differences in the high marsh mixed community may be due to seasonality of some of the species. The 1992 map was made in April, whereas the 1994 map was made in June.

Percentage cover: Between 1993 and 1994, few substantial changes had occurred in the plant communities of Zones A, B, and C. In the reference zone (A), plant cover is mostly *S. patens*, with less than 10% contributed by *S. alterniflora* and other species (Fig. 26). Inside the 1941 berm (Zones B and C), *S. alterniflora* becomes relatively more important along with *Salicornia europea* and others. Due to colonization of areas that had been pools in 1992, *Salicornia* showed a slight gain in cover in 1994 (Fig. 26).

In Zone D where *Phragmites* is expanding, *S.patens* is dominant, but showed decline in 1994. Interestingly, *Phragmites* did not show an increase in cover where *S.patens* had declined. Although its apparent distribution had increased by 1994 (Fig. 25), its vigor was poor. The rapid decline in vigor of *Phragmites* following the restoration of tidal exchange is shown by declines in the heights of the flowering heads. Reproductive stems decreased an average of 45 cm from 1992 to 1993; a highly significant decline both statistically (α=0.01) and ecologically.

By 1992 when the area was first mapped, *Spartina patens* had been replaced by *Phragmites australis* in Zones E and F. The 1993 data show that the plant cover at E was dominated by *Phragmites*, with minor amounts of *S. patens* and *Juncus* (Fig. 26). Although the cover of *Phragmites* fell dramatically in 1994, it was not being replaced by its competitors; these plants fared poorly as well (Fig. 26).

The high marsh *Spartina* species. *S. pectinata,* was also a dominant in Zone F. The excavation of the dredge spoil from the surface of large areas in Zones F and E eliminated all vegetation, yet by spring 1994, seedlings of *Salicornia* had begun to colonize these areas (Fig. 26).

Biomass: In general, biomass of marsh plants was very high at Awcomin, with some zones averaging 5 kg dry weight /m^2. In 1992, biomass determinations from clip plots were conducted in Zones A through C only. The 1992 results compare favorably with those of the same zones for 1993, except the standing crop in Zone B averaged about twice as much in 1992 as in 1993 (Fig. 27). The relative abundance of the species was similar for the two years, with *S. patens* dominant in Zone A, *S. alterniflora* about twice as great as *S. patens* in Zone B, and *S. patens* about 1 and 1/2 times as great as *S. alterniflora* in Zone C.

Phragmites was found in Zones D, E, and F, with the lowest biomass in Zone D and the greatest in Zone E (Fig. 27). Neither *S. alterniflora* nor *S. patens* were found in clip plots in Zones E and F. While Zone E had virtually no normal high marsh species, Zone F contained a stand of *S. pectinata.*

Canopy structure: As for biomass, canopy structure was only determined for Zones A-C in 1992, then for all Zones in 1993. This measure, which focuses on the dominant plant, integrates stem density and average height to yield a relative measure of the potential of the vegetation to provide habitat structure and to act as a water filter during flooding. In 1992, canopy structure was greatest in Zone A and least in Zone C (Fig. 28), but exhibited a small range (10.5 to 11.5). In 1993, Zones A and C were virtually unchanged, but Zone B dropped over one point,; a decline also observed in the biomass data (Fig. 27). Zone D had a relatively high canopy structure value, whereas those of Zone E and F were the smallest found.

Fish Use

A low density of fish was present along the steep, low marsh bank of the natural creek bordering reference zone A. No fish were captured along the bare bank of the newly excavated creek bordering restoration zone B (Fig. 19b). *Fundulus heteroclitus, Menidia menidia,* and *Pungitius pungitius* were present in the samples.

MILL CREEK STUART FARM, STRATHAM

Hydrology

Tides: Installation of the pipe-arch culvert (ca. 2 meters diameter) and removal of the flap gate on the old drain (ca. 0.8 meters diameter) have radically increased salt water flow into Mill Creek. The tide gate at Stewart Farm excluded virtually all tidal water from entering the marsh above the road. Now the marsh is being inundated on a daily basis by tidal waters (Figure 6). Reestablishment of tidal flooding occurred immediately after hydrologic modifications, extending just over the beaver dam upstream of transect #6.

Water Table Depth: Prior to restoration, the water table was much lower in the upstream zone than the downstream zone (Fig. 22a). After restoration, the water tables in the two zones were essentially the same (Fig. 22b).

Water Table Salinity: Prior to restoration, water table salinity was much greater in the downstream zone than the upstream zone (Fig. 23a). After restoration, the water table salinities were essentially the same (Fig. 23b).

Sediments

Salinity: Soil salinity increased dramatically upstream of the road following installation of the culvert in the fall of 1993 (0 to 12 ppt; Fig. 14). However, soil salinity increased in a similar fashion downstream of the road during this period (5 to 17 ppt). Thus, although it appears obvious, the increases in salinity upstream of the road could not be attributed to the opening of the culvert, but only to differences in sampling period. On the other hand, the ecological significance between the fresh conditions turning to saline upstream (0 to 12 ppt), with the installation of the culvert, is clear. The downstream section of Mill Creek showed increased salinity from high to low (creekbank) stations, while the upstream portion followed no such trend, even following restoration (Fig. 14b).

Soil moisture: Soil moisture was greater in the fall, especially at upstream transects and transect 5; the downstream transect through the *Phragmites* stand (Fig. 15a). Downstream stations at high and mid elevations had soils with relatively greater soil moisture than other stations (Fig. 15b). This is probably because creekbank stations at low elevations have greater mineral content and less organic materials. Upstream, long-term drainage may have led to oxidation and removal of organics, also resulting in lower soil moisture.

Soil organic matter: The organic content of the soil showed no changes following restoration of tidal flow (Fig. 16). The percentage of organic matter was greater in the less-impacted transects (1 and 3). Transect five passes through a stand of *Phragmites* and this site had the lowest organic content downstream of the road (Fig. 16a). The population may have become established when the flap gate was installed and the road improved to support larger milk trucks in the early 1970s. Upstream of the road, low organic matter can be explained by the draining and oxidation of the organic matter in the soil. Creekbank stations had similar, but low, organic contents (12 to 15%), whereas upstream stations at higher elevations had moderate levels (ca. 30%), and the downstream stations at higher elevations averaged 47% organics (Fig. 16b).

Soil redox potential: Soil Eh at 1 cm depth was lower downstream of the road than upstream (Fig. 17a). It also declined with elevation at the downstream stations, but showed no trend at the upstream stations (Fig. 18a). Although soil moisture increased from spring to fall and Eh is usually inversely correlated with soil moisture, soil Eh increased dramatically from spring to fall (Figure 17a). In deeper soils, Eh was low at downstream reference transects 1 and 3 in the spring, and became more oxidized in the fall (Fig. 17b), as was found at the shallower soil depth.

Soil pH: Average pH in the Mill Creek soils was mildly acidic to neutral and did not vary greatly. Soil pH ranged from 6.2 to 6.7 in the spring and was lower in the fall, ranging from 5.7 to 6.7 (Fig. 19). No trends across elevation were noted (Fig. 19b).

Vegetation

Maps: Since the culvert was installed under the access road to Stuart Farm in the fall of 1993 to reestablish tidal flooding, some important vegetation changes have been observed upstream. The first broad meadow has relatively more *Spartina pectinata* and less *Agropyron* and *Agrostis* than it had the previous summer (Figs. 29 and 30). In addition, low elevations near the creek have experienced major changes in vegetation. On the 1994 map, a large area on the western side of upper

Mill Creek is shown to have lost its vegetation and is bare. Although some *Phragmites* exists at Mill Creek (Fig. 29), the main invasive species which is seen as a problem is purple loosestrife (*Lythrum salicaria*). By spring of 1994, *Lythrum* appeared to be greatly stressed by increased salinity in Upper Mill Creek due to the reestablishment of tidal exchange.

Percentage of plant cover: In order to facilitate interpretation and understanding of the most important changes at Mill Creek, we have deleted the data from Transect #5 (through a *Phragmites* stand), and have considered the six upstream transects as replicates and the four downstream transects as replicates. All transects have a high elevation station and a low elevation station at the limits of the emergent wetland vegetation (upland and creek, respectively), and a third station on the transect line equidistant from these two extremes.

In 1993, the downstream marsh was mostly dominated by *S.patens*, with some large stands of *Carex paleacea* (Fig. 31). Both communities were fringed by *S. alterniflora*, as evidenced by its dominance of the low stations along the downstream transects (Fig. 31). Two stands of *Phragmites* were found adjacent to the road, but these data were excluded from the plant cover graphs. From 1993 to 1994, the total percentage of cover for all plants in downstream transects dropped from 80-95% to 60-80%. The downstream marsh appears to have had *S. patens* replaced by other species at high elevations (Fig. 31), and slight drops in other species and *S. alterniflora* in the mid and low elevation stations, respectively. The fall in *S. patens* cover appears to be significant, but may be partly due to a seasonal effect. (*S. patens* is more conspicuous later in the season relative to other plants, and the plant cover was sampled in late July, 1993 and mid June, 1994.)

Upstream of the access road, the vegetation was dominated by non-saline grasses of the genera *Agropyron* and *Agrostis*, as well as *Lythrum* at high and mid elevations in 1993. At low stations, *Lythrum* dominated the vegetation, but was accompanied by many fresh meadow forbs and grasses (*Aster* spp., *Phalaris arundinacea*, *Polygonum* spp., *Typha angustifolia*; Fig. 31). Restoration of tidal exchange severely impacted the plant communities upstream, as shown by changes in plant cover, which have fallen dramatically from about 90% in 1993 to 50% in June, 1994. Most of these losses represent declines in various fresh marsh species, but the major species affected is *Lythrum* (Fig. 31). Younger plants, which were found spreading into the higher elevations of the meadow in 1993, appear to have been killed, while the older, better established shrubs were reduced in vigor as seen in the large decline in cover at lower elevation stations (Fig. 31). Recent observations in July found all Lythrum dead. At the low elevation stations along the upper creek, most of the fresh water plants have been killed, and 37% of the 42% cover was filamentous green algae (*Chaetomorpha*?). As of June 1994, no species were flourishing in the flooded portions of the upper creek, and species dominance was often unclear. Two salt marsh species not present in 1993, *Atriplex patula* and *Juncus gerardi*, had begun to colonize the upstream marsh in 1994.

<u>Biomass:</u> Biomass was assessed in mid-summer 1993, prior to restoration. The aboveground biomass of marsh plants was generally low at Mill Creek, averaging about 640 g/m2. There was a strong trend of increasing biomass with lower elevation, and this trend was evident both upstream and downstream of the tidal restriction (Fig. 32). The high elevation stations averaged about 250 g/m2 and the low elevations reached about 1 kg/m2. Downstream, *S. patens* and *Carex paleacea* were found in patches at high elevations, *S. patens* was dominant in the center of the marsh, and *S. alterniflora* dominated the creekbanks (Fig. 32). Upstream, fresh meadow grasses and forbs were important at all elevations, but *Lythrum salicaria* assumed dominance at the lowest elevation.

<u>Canopy structure:</u> Developed from the 1993 harvest data, canopy structure is a measure of stem density and height. From the mouth of Mill Creek (Transect #1) to the beaver dam (Transect #6), canopy structure gradually declined from mean values over 10 to those under 9 (Fig. 33a). This suggests that the density and complexity of the vegetation decreased up the creek. Canopy structure was examined with respect to elevation down and upstream of the road. Downstream of the road, the canopy structure was relatively greater at mid elevations, with declines at the creekbank and at the upland border sometimes under the shade of trees (Fig. 33b). Upstream, no trend with elevation was apparent, but the canopy structure was relatively low; below 10.

Fish Use
Intermediate densities of fish were present in the low marsh of the Mill Creek channel. Densities were essentially the same in upstream and downstream zones (Fig. 19a). *Fundulus heteroclitus, Apeltes quadracus, Anguilla rostrata,* and *Lepomis sp.* were present in the samples.

INNER NORTH MILL POND, PORTSMOUTH

Hydrology

Tides: The hydrology of this system was not altered by this project, but clean fill was placed on the surface of intertidal mudflats to increase the elevation for establishment of a new *Spartina alterniflora* marsh. The low organic, low nutrient fill was placed in eight lobes, each ca. 25 by 25 meters and graded to elevations that matched the *S. alterniflora* marsh elevations on the north shore of Inner North Mill Pond. (The small *S. alterniflora* patches that were growing naturally on the east ashore are thought to be heavily impacted by railroad construction and represented only the upper portions of this plant's potential distribution (D. McHugh, personal communication).) Both neap and spring high tides flooded the entire area of plantings and natural patches of low marsh in the created marsh area (Figure 7).

Sediments

Salinity and pH: Soil salinity was similar at the created and reference sites, averaging about 33 ppt (Fig. 20). However, average well salinity between the two sites was quite different. In the reference marsh, well salinities averaged 31 ppt, but in the created marsh they averaged 21 ppt (Fig. 20). Low salinity water is available to plant roots at most sites in the created marsh, but surface soils are drained and subject to drying, which increases the salinities. Soil pH averaged slightly lower in the reference marsh soils (6.0) than in the created marsh soils (7.1, Fig. 21).

Soil moisture and organic matter: Percentage wet weight of the soil was significantly greater in the reference marsh than the created marsh (Fig. 22a). The difference is probably a reflection of the amount of water the soil can hold which depends upon the organic matter content. The amount of organic matter of the soils was significantly greater in the reference marsh than the created marsh (Fig. 22b). The amount of organic matter in the created marsh was very low, but showed an increase from the original sediment (0.76% +/-.05 SE).

Soil redox potential: Average Eh values of the reference marsh sediments were always lower than those of the created marsh (Fig. 23). At 1 cm depth, soil redox potentials were fairly similar for the created and reference marshes, but diverged greatly by 10 cm depth (Fig. 23). At 10 cm depth, the created soil was poorly oxidized (+250 mV), while that of the reference marsh was very reduced (-150 mV), and likely was supporting sulfate reduction.

Vegetation

Maps: The size and shape of the eight graded lobes of new sediment define the edges of the created marsh (Fig. 4). Sixteen sampling stations were randomly located in the created area, while eight were established in the marsh across the pond which was chosen as a reference area (Fig. 34). The goal of the mitigation was to create low marsh (marsh areas normally dominated by *Spartina alterniflora* which flood on neap as well as spring tides). Therefore, the mitigation effort only considered marsh dominated by *Spartina alterniflora* (low marsh), thus high marsh areas are not included in the maps nor in the sampling efforts. The entire area of the lobes were planted, totalling about 0.4 ha (1.0 acre), and all areas had fairly even cover at the time of the survey in September (Fig. 34).

Percentage of plant cover:

Plant cover was about 6-fold greater in the reference marsh (90%) than in the created marsh (15%; Fig. 35). Plant cover primarily consisted of *S. alterniflora*, by design, though some seaweeds were noted in the reference marsh. *Salicornia* and *Limonium* seedlings were found in the created marsh, but these represented less than 0.5% of the total plant cover.

Biomass and canopy structure: Biomass, like percentage cover, was about six-fold greater in the reference marsh (ca. 1 kg dry weight/m^2) than in the created marsh (Fig. 35). Plants were not destructively harvested in the created marsh. Biomass was estimated from cover estimates and estimates of the leaf and stem area of the ten tallest plants within each quadrat. Large differences in the mean values obtained for canopy structure were found between the created and natural low *S. alterniflora* marshes (Fig. 35b).

Fish Use

Fish density was much greater in the Inner North Mill Pond reference zone than in the created marsh zone (Fig. 19c). The reference zone had much higher fish density at Inner North Mill Pond than at the reference zones of Awcomin Marsh or Mill Creek. *Fundulus heteroclitus, Menidia menidia,* and *Anguilla rostrata* were present in the samples. Fish density in the created marsh zone of Inner North Mill Pond was intermediate between the densities of the restoration zones of Awcomin Marsh and Mill Creek.

DISCUSSION

AWCOMIN MARSH, RYE

The restoration activities at Awcomin marsh centered around two areas that had been impounded and filled with dredge spoil. The berms severely reduced tidal exchange, impaired fresh water drainage, and were associated with the rapid expansion of *Phragmites* into high marsh typically dominated by *Spartina patens.* The goal of the project was to restore tidal exchange and fresh water drainage by cutting tidal creeks through the berms and into the impounded areas. It was hoped that this action would deter the spread of *Phragmites* and restore natural marsh vegetation and functions.

Because a substantial amount of dredge spoil had been placed on the marsh (ca. 30 cm), only spring tides with a predicted height over 10 feet effectively flood the marsh surface behind the 1941 berm. The highest spring tide observed (10.5), flooded vegetation Zone B and most of Zone C (Fig. 5), but the stands of Phragmites were at elevations above this flood tide. Higher high tides only occur several times a month.

The disappearance of pools around the 1962 berm and the patterns of soil variables in the vegetation zones indicate an important effect of the restoration excavation has been to drain the standing water and remove it from the system. Much of the standing water was relatively fresh. Because the sediment elevation within the berms is relatively high, soils are drying out (high soil redox potential at 10 cm depth). Thus the infrequent tidal flooding is leading more to salinity stress as the vegetation uses the water in the soil (large salinity increases behind the 1941 berm), and less to flooding stress from tidal inundation (since it is so infrequent).

The vegetation has already responded to many of these changes (within one to two years). Relatively low plant cover, biomass and canopy structure in vegetation Zone B for 1993 indicates these plants are stressed and the stress is likely from salinity, which was greatest in Zone B soils following restoration (Fig. 8). The declines in plant cover in Zones D and E were also likely due to soil changes from the hydrological restoration. Fresh and brackish species that dominated pools (*Typha latifolia, Scirpus* spp.) have been killed and replaced by *Salicornia europea*. Outside the 1962 berm, revegetation of pool areas has included *S. alterniflora* and *S. patens*. These areas are labeled as low mixed vegetation on the 1994 map. It is outside the scope of this study to describe the colonization process, but it is well known that *S. europea* can colonize areas quickly from seed, while *Spartina* species usually propagate vegetatively (Bertness 1992). The rapid recovery of the pools suggest that colonization by *Spartina* seedlings is also important in these areas. With only one year of data following restoration, no trend in primary production (biomass) or canopy structure has been noted, but the effects of impoundment and invasion by *Phragmites* are clearly shown by the lack of native salt marsh plant biomass in vegetative Zones E and F (Fig. 17).

The vigor of *Phragmites* has been radically depressed, as indicated by the 45 cm drop in mean height of the flowering stems and the drop in cover from 1993 to 1994. Interestingly, native marsh species have not taken advantage of the increased light within the stands. Nothing appears to compete with the stressed *Phragmites*. Furthermore, *Phragmites* distribution had not decreased, but appeared to increase between 1992 and 1994. Phragmites stands in Zones D and B expanded and outcompeted native plants, but scattered shoots within these zones have disappeared. These results suggest *Phragmites* has consolidated its position in the face of increasing salinity, but has ceased to expand rapidly. It is unknown whether *Phragmites* releases plant toxins to gain competitive advantage or whether it simply dries out the soil by evapotranspiration, and the competing plants succumb to drought stress. As *Phragmites* continues to be impacted and is further reduced in vigor, as seen in 1994, will native species like *S. patens* be able to reclaim these areas?

The pattern of changes in *Phragmites* at Awcomin Marsh suggest that cutting channels between stands of *Phragmites* and native vegetation will exclude *Phragmites* only if the channel brings in saline waters and no plants have invaded beyond the channel. At Awcomin Marsh, a creek was excavated at the edge of a *Phragmites* stand, but the plants had already spread to the other side, and this population has expanded (Fig. 15).

Fish utilization of newly created channel habitat appears to be deterred by the shape and/or elevation of the channel, and by the lack of *Spartina alterniflora* low marsh habitat with tall plants that provide cover.

In conclusion, the hydrological changes effected at Awcomin Marsh through creek excavation and ditching has a strong effect on water and soil variables that structure the plant community. Indeed, many changes in the plant community are occurring, but they are not all as expected. It is likely that several more years will be required to determine if we may expect the desired results at this site. Vegetation in Zones B and C had increased *S. patens* cover and may be becoming more like the reference area, A. Fresh and brackish grasses growing in pools have been killed and replaced by salt marsh plants. *Phragmites* distribution expanded (on the outside of the creeks), but its vigor and cover has declined. As yet, this decline has not yet been accompanied by increased native vegetation in *Phragmites* stands.

MILL CREEK STUART FARM, STRATHAM

Tidal deprivation through use of a tide-gated culvert, as on the Mill Creek at Stuart Farm, is a common form of tidal restriction. Tidal deprivation leads to a drastic change in hydrology for a salt marsh system. However, the physical manipulation required to restore hydrology is relatively simple, compared to hydrologic restoration of filled marsh (Awcomin Marsh), or creation of new marsh (Inner North Mill Pond).

The reconnection of the natural channel severed by the causeway across Mill Creek in September of 1993 led to complete and immediate restoration of tidal flow to the upstream marsh. While the increase in soil salinity in the upstream zone cannot be attributed to the restored tidal flow, the changes in water table level and salinity are indicative. By June of 1994, water table depth and salinity had converged completely with that of the downstream zone. Prior to restoration, the water table in the upstream zone was 10 cm lower than the downstream zone. After restoration, the water table is almost the same in the two zones (1 cm shallower upstream than downstream). It appears that the culvert size chosen is adequate to allow proper drainage from the upstream zone. This zone is subject to extensive flooding on spring tides due to lowered surface elevations (relative to the downstream marsh), caused by soil oxidation during three decades of tidal deprivation. The water table salinity of the upstream zone was essentially zero prior to restoration, 13 ppt lower than the downstream salinity. After restoration, the salinity of the two zones was equal (15 ppt). Soil moisture also increased dramatically upstream after tidal restoration, increasing the ability of the substrate to support wetland vegetation.

A number of changes in the vegetation of the upstream zone were observed in June of 1994, the first growing season after tidal restoration. There was a considerable decline in vegetative cover, due to important declines in the invasive dominant *Lythrum*, and fresh meadow forbs and grasses. Two typical salt marsh plants not present in 1993, *Atriplex patula* and *Juncus gerardi*, were sparsely colonizing the newly opened space. Another typical fringing salt marsh species, *Spartina pectinata*, increased in abundance. It appears that the system has begun to change from fresh marsh to salt marsh vegetation. The rate and extent to which recovery of salt marsh vegetation occurs cannot be predicted from this initial data.

Fish were sampled at Mill Creek in the first month after tidal restoration. Fish densities in the upstream and downstream zones were essentially the same, indicating a rapid colonization of the new tidal habitat. In contrast to the bare, steep banks of the new channel at Awcomin Marsh, the banks of the upstream channel at Mill Creek were gently sloping in places, and there was good cover of freshwater submergent vegetation. On the first sampling date, one strictly freshwater fish (*Lepomis sp.* - a sunfish) was captured. The american eel (*Anguilla rostrata*), a fish that migrates to fresh water during its adult phase, was well represented. Two weeks later, on the second sampling date, only typical salt marsh species were present in the sample. During the spring of 1994, we observed a strong run of alewives (*Alosa pseudoharengus*) in the upstream zone on one date in early June. Alewives were known to enter the downstream zone in years prior to restoration, but access to spawning habitat was blocked by the tide gate. It appears that restoration of tidal flow to the upstream zone could lead to restoration of a self-sustaining population of alewife to Mill Creek.

INNER NORTH MILL POND, PORTSMOUTH

Mitigation activities at INMP focused on creating a 0.4 ha low marsh (dominated by Spartina alterniflora) to replace values lost from a marsh that will be destroyed by expansion of the New Hampshire Port Authority. Spartina alterniflora was planted at a pilot site (two lobes) in November, 1992 that was badly damaged by ice scour that winter (15% survival). The two lobes were replanted in May 1993 and the other six lobes were planted in June. The planted areas are covered by neap and spring high tides, but almost the entire pond drains at low tide as well. Soil organic matter is very low, leading to oxidized soils that dry out and become as saline as the reference site. This is probably a good soil characteristic for excluding undesirable species at this site. Well-established plants can access the lower salinity water found deeper in the soil (5 to 20 cm), because the soil is not severely reduced (as in the reference site at 10 cm). Evaluation of the project after one growing season showed that approximately 15% of the functional values of primary production and percent cover of *Spartina alterniflora*, and fish use were attained relative to the reference marsh across the pond.

The winter of 1994 was very hard and the ice damage was again severe. However, the plants had all summer to grow and only the outer edges (3 to 5 m) of the lobes and one lobe interior exhibited substantial damage. In June 1994, the continued development of salt marsh vegetation was stimulated by the natural establishment of thousands of *S. alterniflora* seedlings. Although ice damage over the past two winters has been severe, the prospects for successful establishment of a valuable salt marsh with functional values approaching those of the reference site by 1997 appear excellent.

TECHNIQUES TO REPLACE SALT MARSH FUNCTIONAL VALUES

In this study we have documented changes in hydrology and soils for three contrasting salt marsh restoration/creation projects and their initial effects on wetland plant and animal communities. At Awcomin Marsh, the increased drainage from the excavated channels and ditches has increased the salinity of the soils, leading to the loss of freshwater plants, deterring the spread of *Phragmites* in some areas, and favoring typical salt marsh plant species. However, the raised elevation of the berm reduces the frequency of tidal flooding. The consequent reduction in tidal exchange makes the system less like a wetland in terms of 1) reduced potential for water filtration, and 2) export of primary production to the water column for use by fish. `Fish utilization could be improved by increasing the depth and reducing the bank slope of the excavated channels. Holding pools for fish could also be excavated. It is not clear what effects the recent removal of dredge spoil in zone F will have on the system; this should be monitored.

At Stuart Farm, the upstream restoration zone is lower in elevation than the reference zone, increasing the potential for exchange of organic matter between water and wetland. The initial changes in vegetation upstream are the loss of plant biomass, productivity and canopy structure. However the underlying hydrology, and the colonization and expansion of salt marsh species suggest that these initial losses of wetland function are transient. The immediate colonization of the upstream zone by fish may actually be a response to a transient spike in organic matter provided by decaying plants exported to the water column. Although the post-restoration phase at Stuart Farm is the shortest of the three systems studied, the changes observed have been the most dramatic. At Inner North Mill Pond, the substrate rather than the hydrology of the system was manipulated. The survival and growth of the planted vegetation in a previously unvegetated area constitutes an increase in wetland functional values. Fish utilization of the habitat should increase with increased vegetative cover. Of the three systems, this is the one site for which clear prediction of a steady increase in functional values is warranted.

The impacts experienced, and the objectives of mitigation for each of the wetlands described above are different. One statement does hold true for all: it is very early in the post-restoration/creation phase for each system. It is not possible at this point to predict the full nature and extent of the responses of these systems to restoration or creation. Figure 41 provides a schematic time line indicating the scales at which underlying conditions and functional values develop in salt marsh systems. Monitoring of these systems must continue beyond the initial phase reported in this study, if the success of these restoration/creation projects is to be accurately assessed.

REFERENCES

Bertness, M. A. 1992. The ecology of a New England salt marsh. American Scientist 80:260-268.

Boumans, R. M. J. and J. W. Day. in press. Effects of two Louisiana marsh management plans on water and materials flux and short-term sedimentation. Wetlands.

Burdick, D. M. 1992. Pre-restoration assessment of sediments and vegetation at Awcomin Marsh, Rye, New Hampshire. Office of State Planning, Concord, NH. 13 pp.

Cook, R. A., A. J. Lindley Stone, and A. Ammann. 1993. Method for the Evaluation and Inventory of Vegetated Tidal Marshes in New Hampshire. (Coastal Method). Audubon Society of New Hampshire, Concord, NH. 77 pp.

Dionne, M. 1994. Coastal Habitat Alteration. Proceedings from the Gulf of Maine Habitat Workshop, April 12, 1994. Boothbay Harbor, ME. The Gulf of Maine Regional Marine Research Program.

Kusler, J. A., and M. E. Kentula. 1990. Executive Summary. *In:* Kusler, J. A., and M. E. Kentula, (eds.). Wetland Creation and Restoration. Island Press, Washington, D.C.

Mendelssohn, I. A. and D. M. Burdick. 1988. The relationship of soil parameters and root metabolism to primary production in periodically inundated soils. pp. 398-428. *In:* D. D. Hook et al. (eds.) Ecology and Management of Wetlands Vol. 1: Ecology of Wetlands. Croom Helm, Breckingham, UK.

Mitsch, W. J., and J. G. Gosselink. 1986. Wetlands. Van Nostrand Rheinhold, New York. 539 pp.

Moy, L. D., and L. A. Levin. 1991. Are *Spartina* marshes a replaceable resource? A functional approach to evaluation of marsh creation efforts. Estuaries 14:1-16.

Rogers, D., B. Rogers and W. Herke 1992. Effects of a marsh management plan on fishery communities in coastal Louisiana. Wetlands 12: 53-62.

Roman, C. T., W. A. Niering and R. S. Warren 1984. Saltmarsh vegetation change in response to tidal restrictions. Environmental Management 8: 141-150.

Shisler, J. K. 1990. Creation and restoration of the coastal wetlands of the northeastern United States. pp. 143-170 *In:* Kusler and M. E. Kentula, (eds.). Wetland Creation and Restoration. Island Press, Washington, D.C.

Sinicrope, T. L., P. G. Hine, R. S. Warren and W. A. Niering. 1990. Restoration of an impounded salt marsh in New England. Estuaries 13:25-30.

Soil Conservation Service. 1994. Draft: Evaluation of Restorable Salt Marshes in New Hampshire. U.S. Department of Agriculture. 30 pp.

Stuckey , R. L. 1980. Distributional history of *Lythrum salicaria* (purple loosestrife) in North America. Bartonia 47:3-20.

Tiner, R. W., Jr. 1987. A Field Guide to Coastal Wetland Plants of the Northeastern United States. University of Massachusetts Press, Amherst, MA. 285 pp.

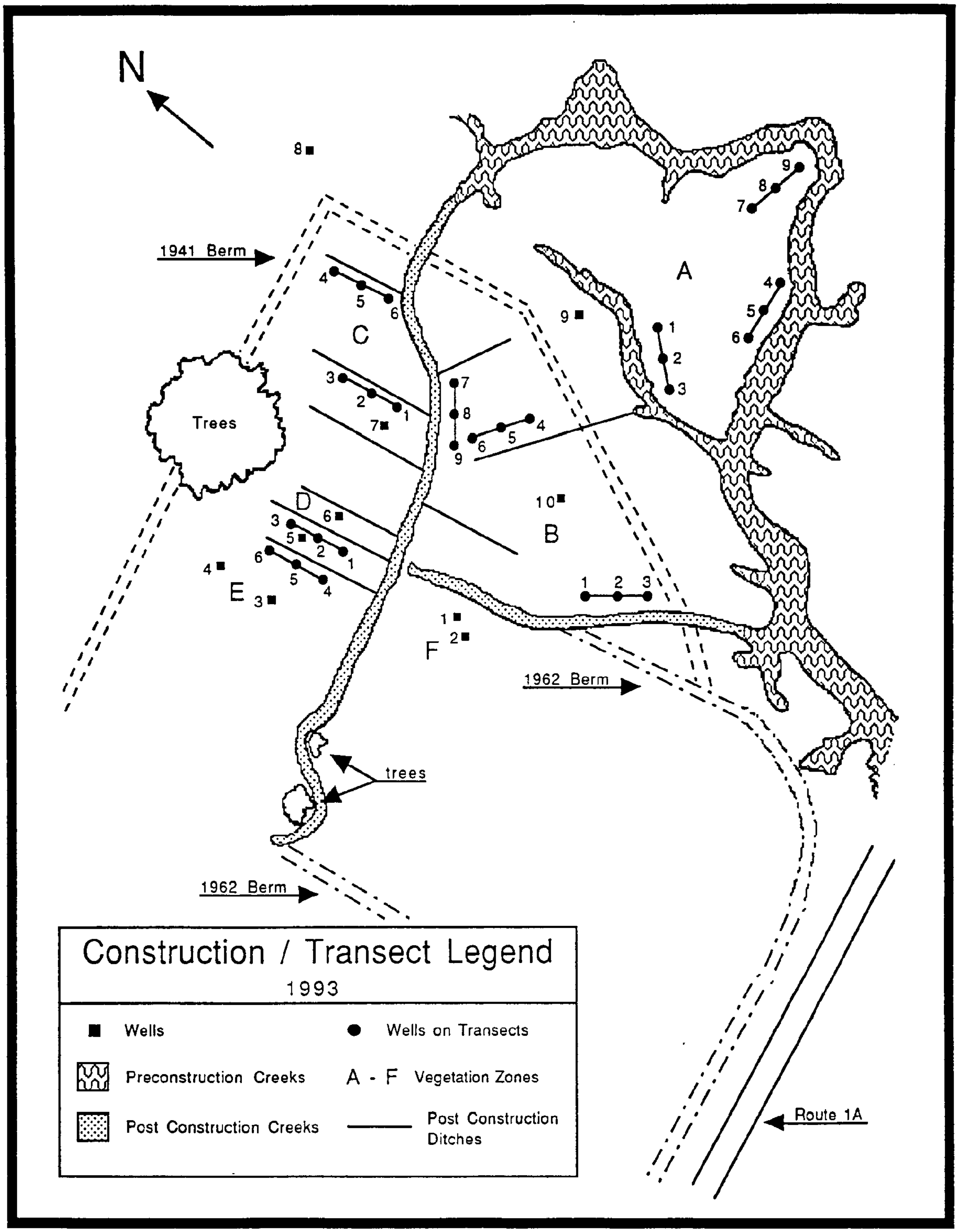


Figure 1. Awcomin Marsh, Rye. Sampling wells, transects, and construction activities completed before the growing season in 1993.

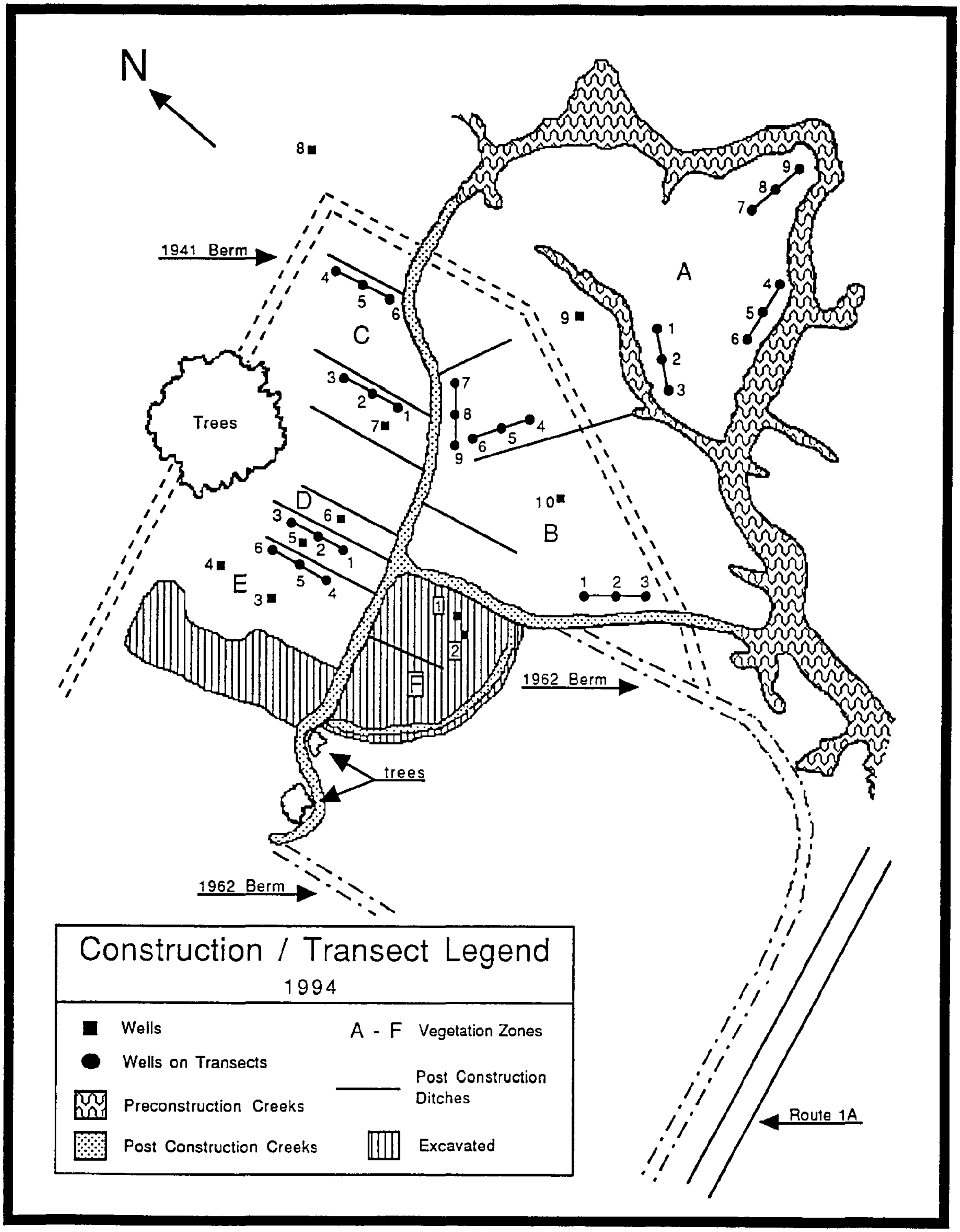


Figure 2. Awcomin Marsh. Sampling wells and construction activities completed before the growing season in 1994.

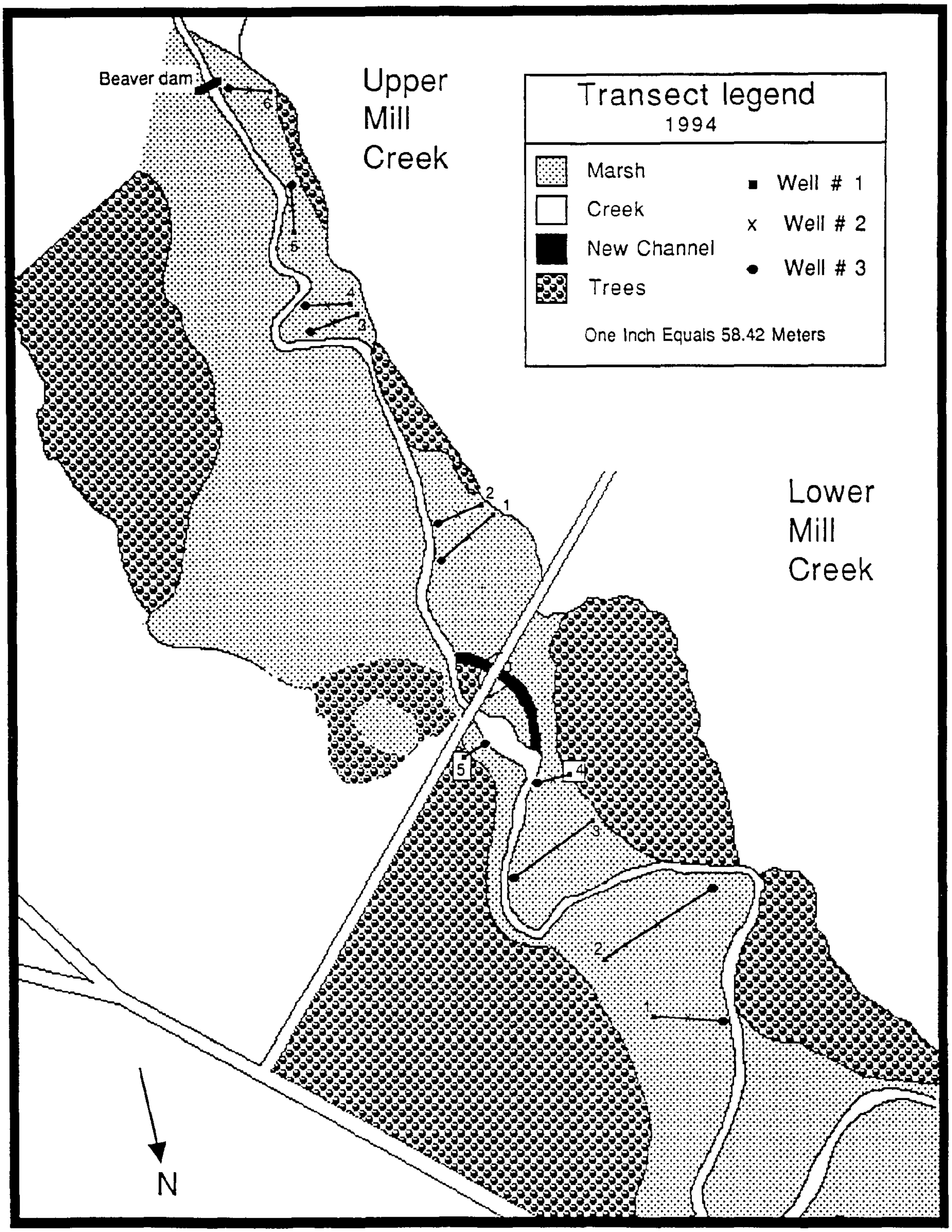


Figure 3. Mill Creek at Stuart Farm, Stratham. Sampling wells along transects and the new channel for the arched culvert installed under the access road in October 1993.

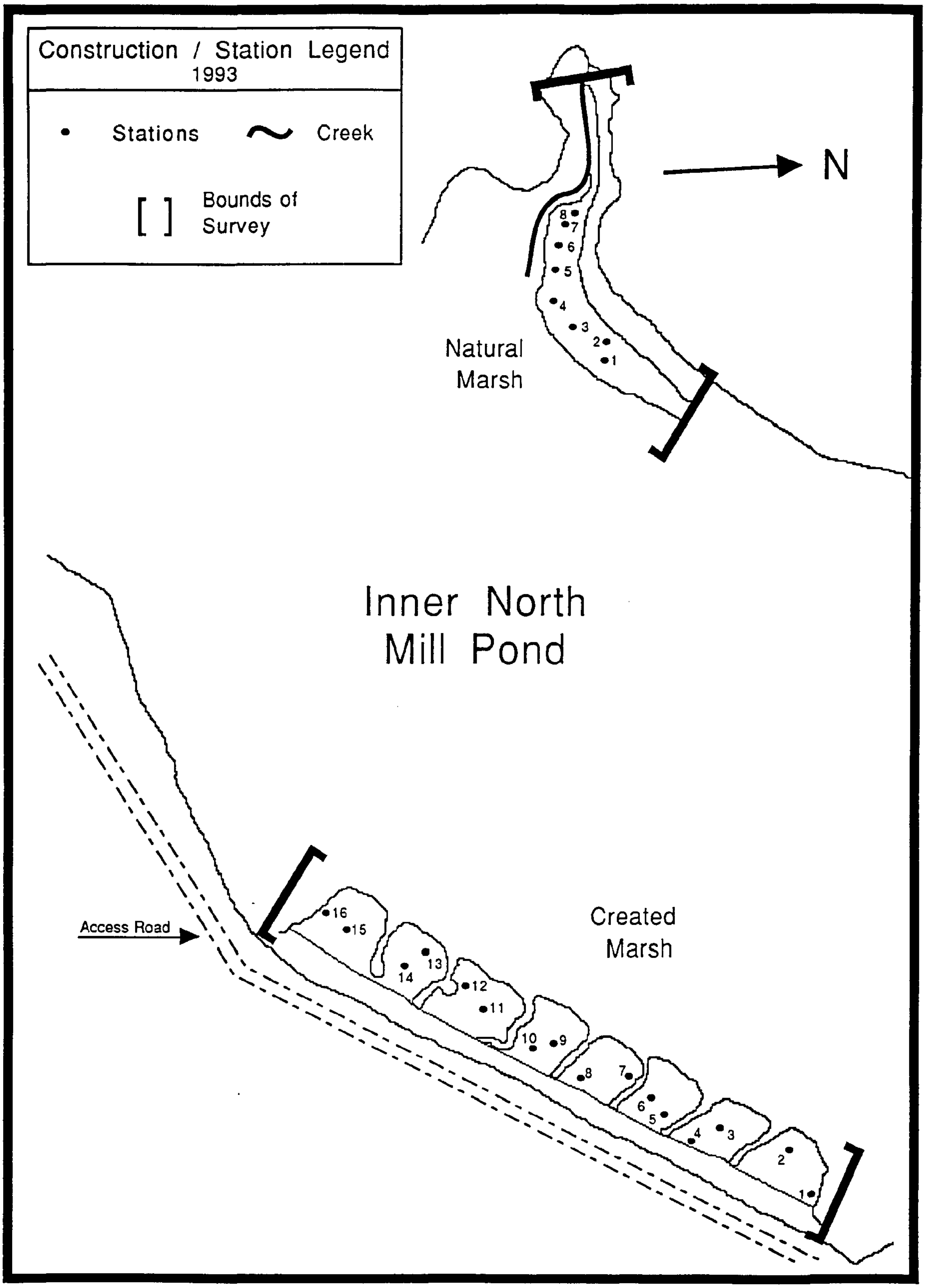


Figure 4. Inner North Mill Pond, Portsmouth. Sampling wells at the created and reference marshes, and lobes of fill needed for establishing low marsh.

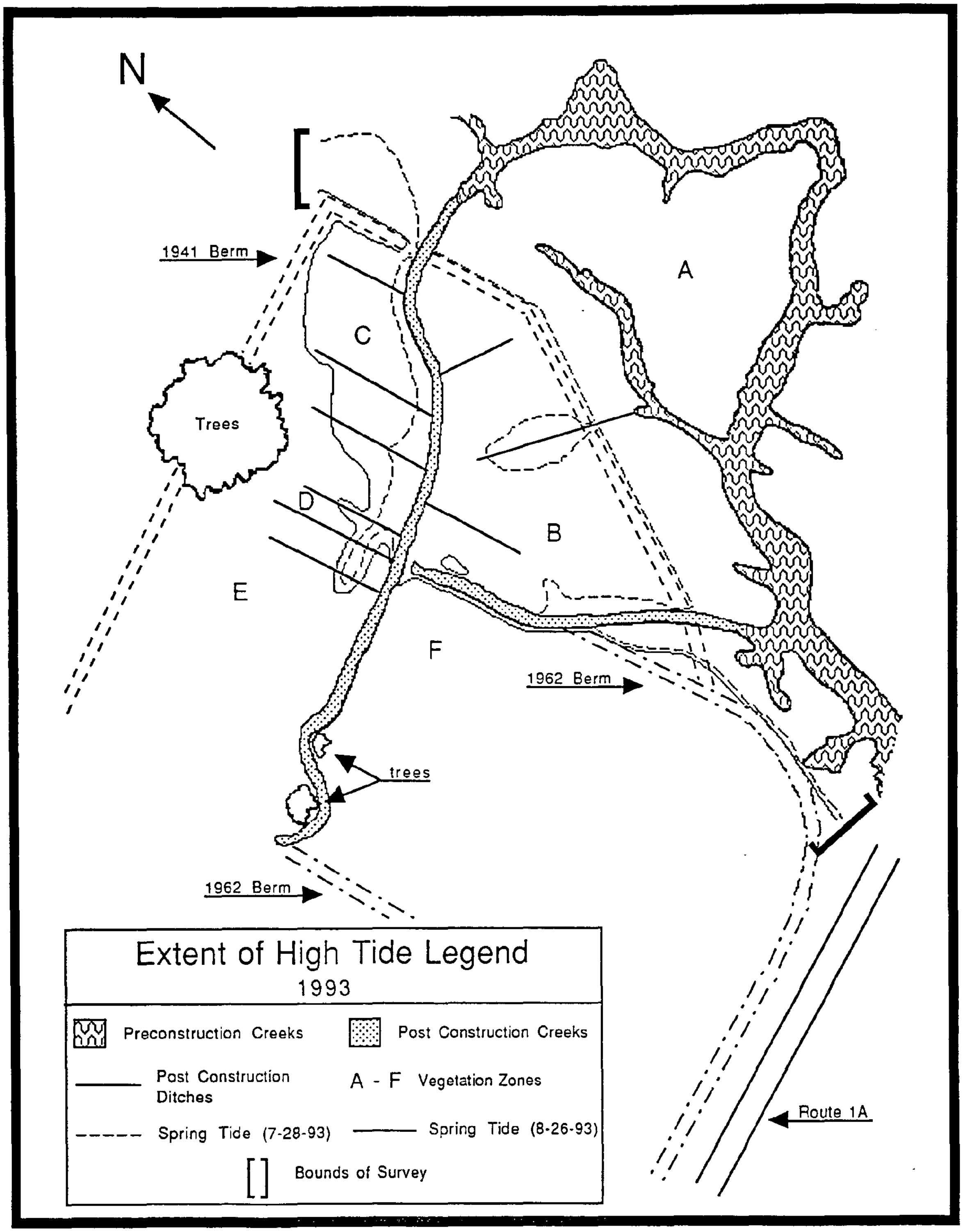


Figure 5. Awcomin Marsh. Extent of tidal flooding on two spring tides following restoration activities of 1992. Flooding on neap tides was confined to inside natural and restoration creeks for all areas.

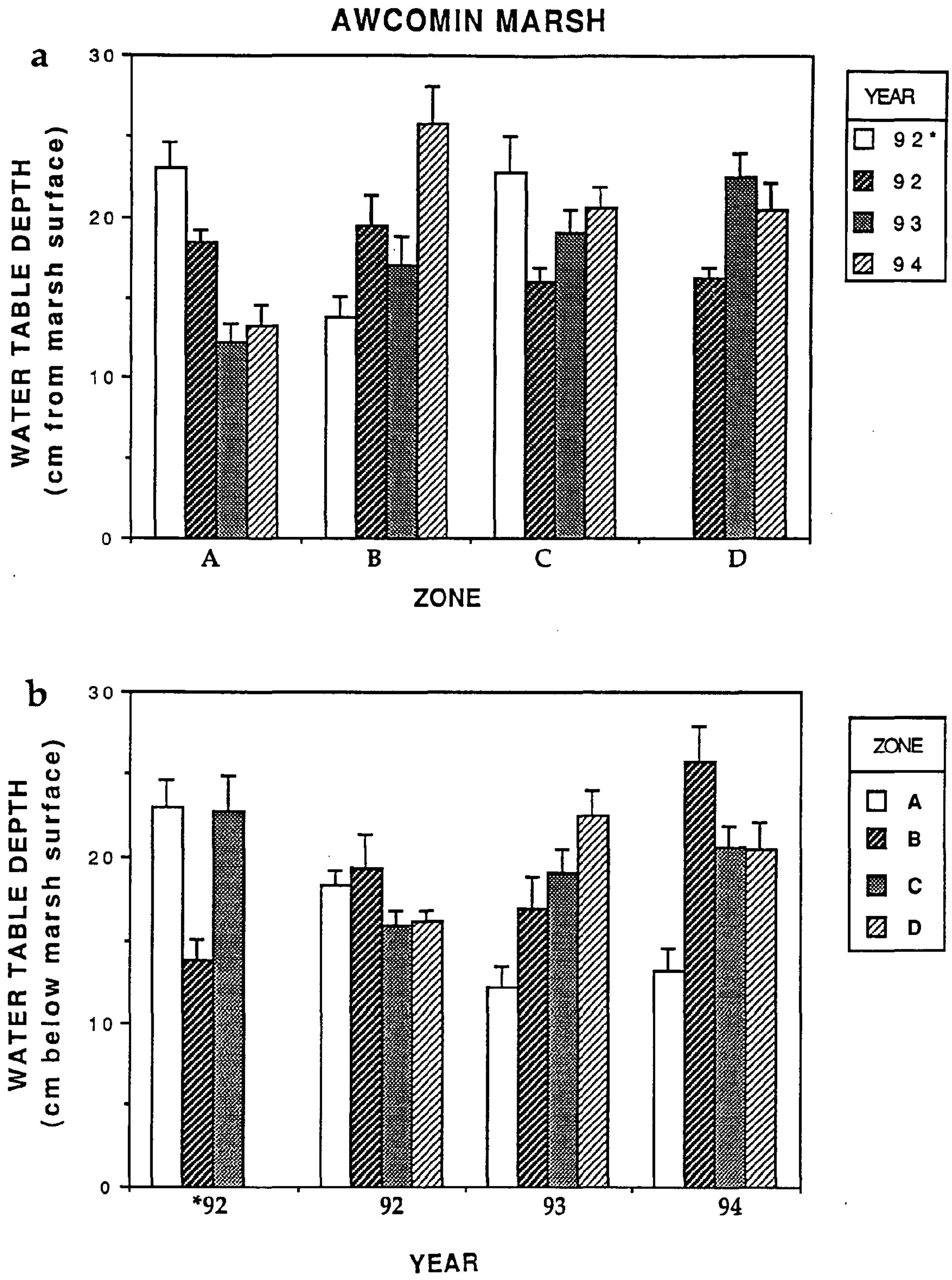


Figure 6. Awcomin Marsh. Water table depths expressed as distance (cm) from the marsh surface to the water table as measured in wells. Depths measured in 1992 prior to hydrologic restoration are denoted by 1992*.

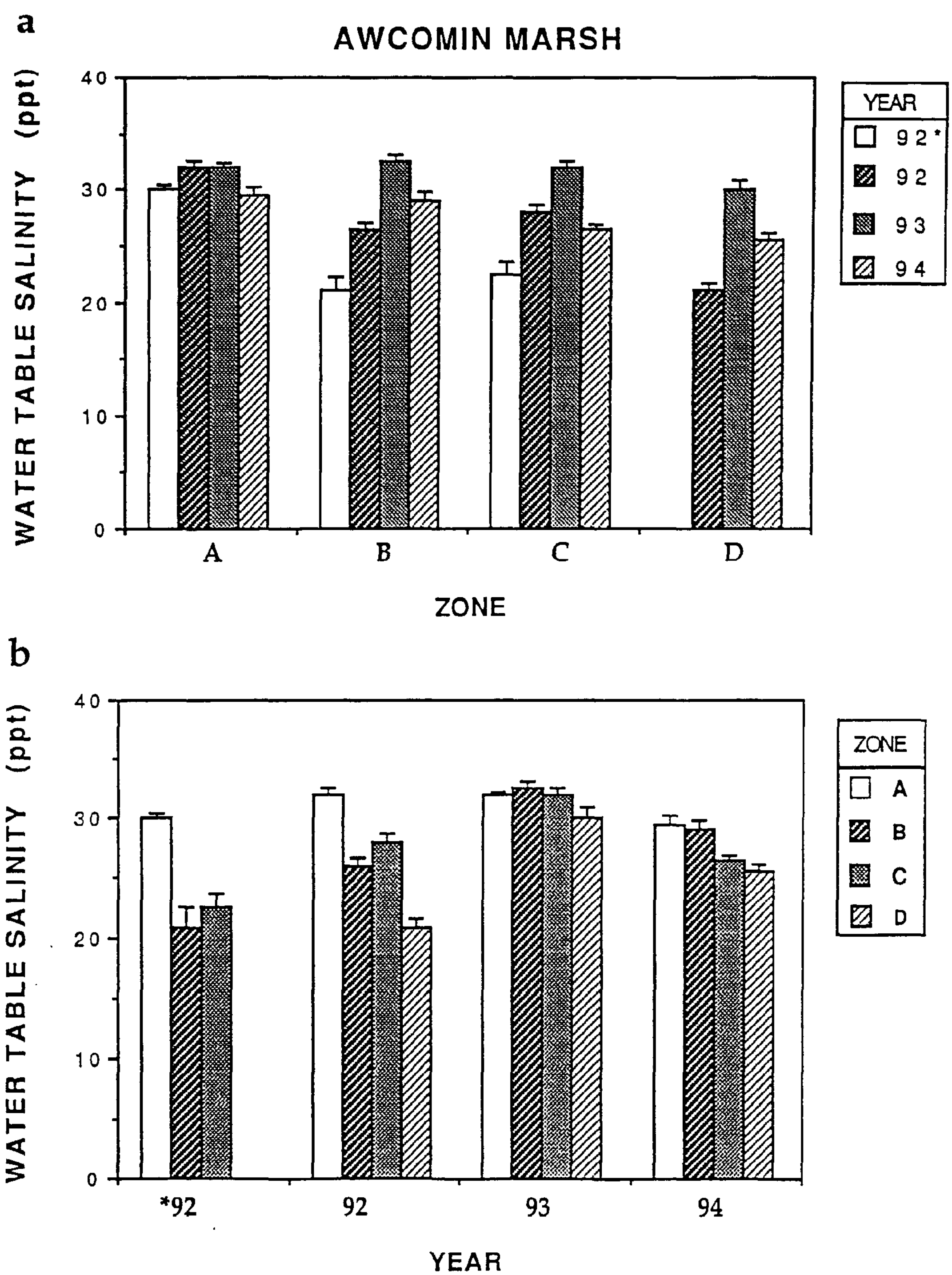
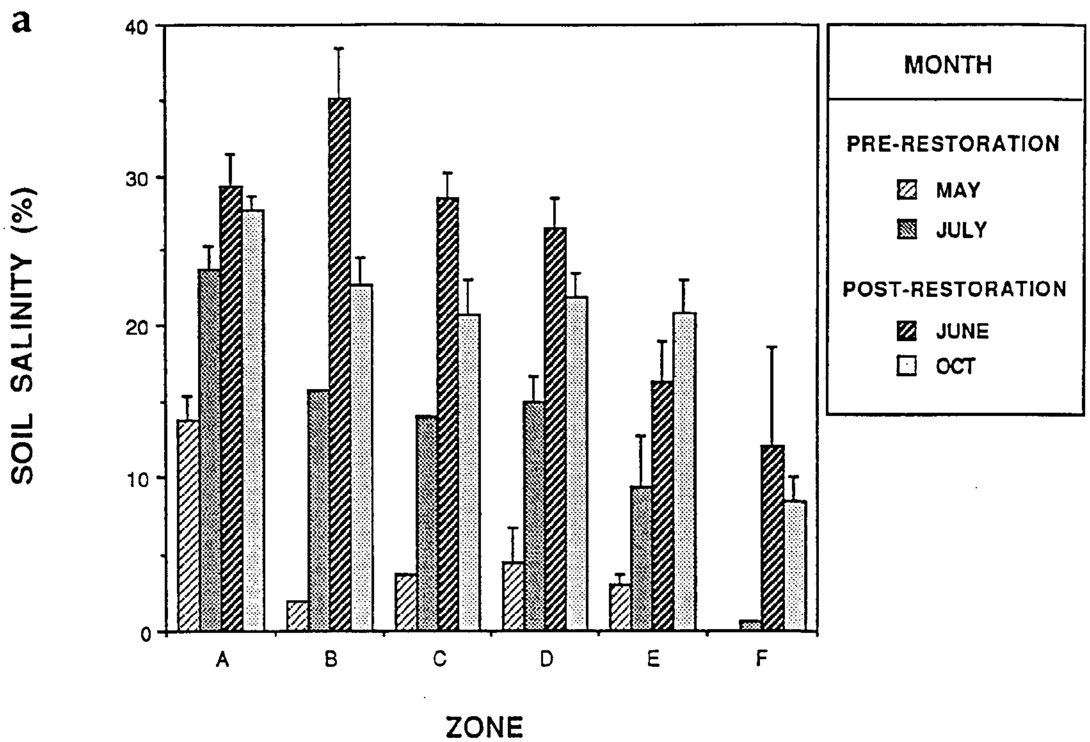


Figure 7. Awcomin Marsh. Water table salinities expressed in parts per thousand (ppt) as measured in water sampled from wells. Salinities measured in 1992 prior to hydrologic restoration are denoted by 1992*.



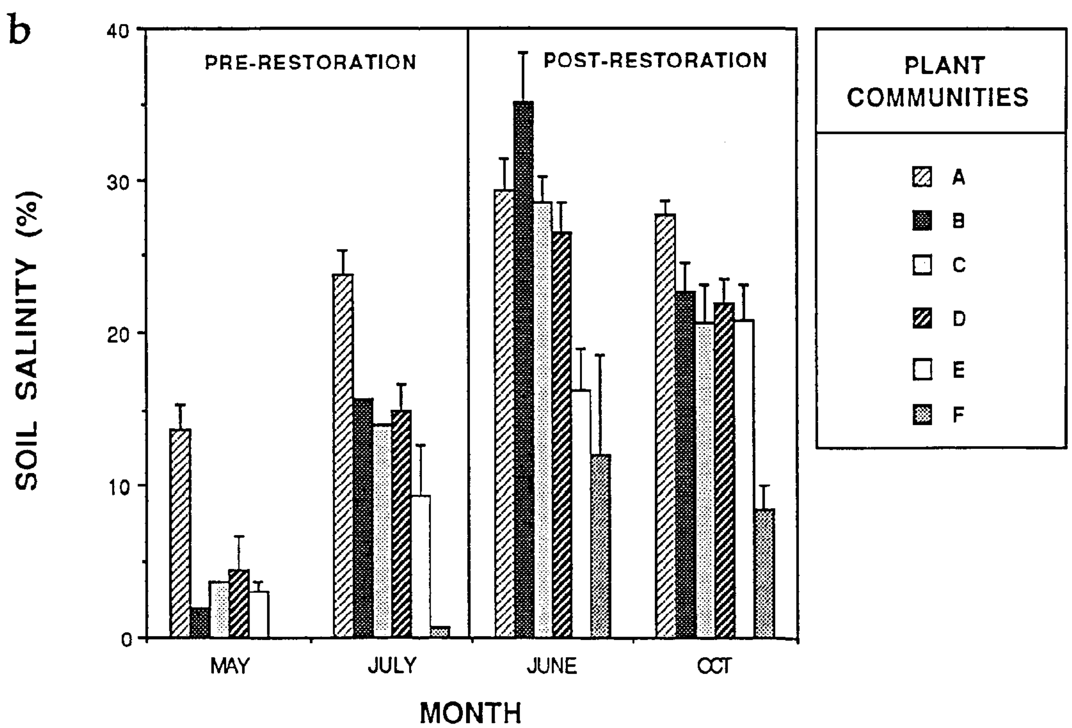


Figure 8. Awcomin Marsh. Soil salinity of interstitial water from 1 to 5 cm depth. Values are means for each vegetative zone +/- standard error. a. Salinity means for each month by zone. b. Salinity means for each zone by month.

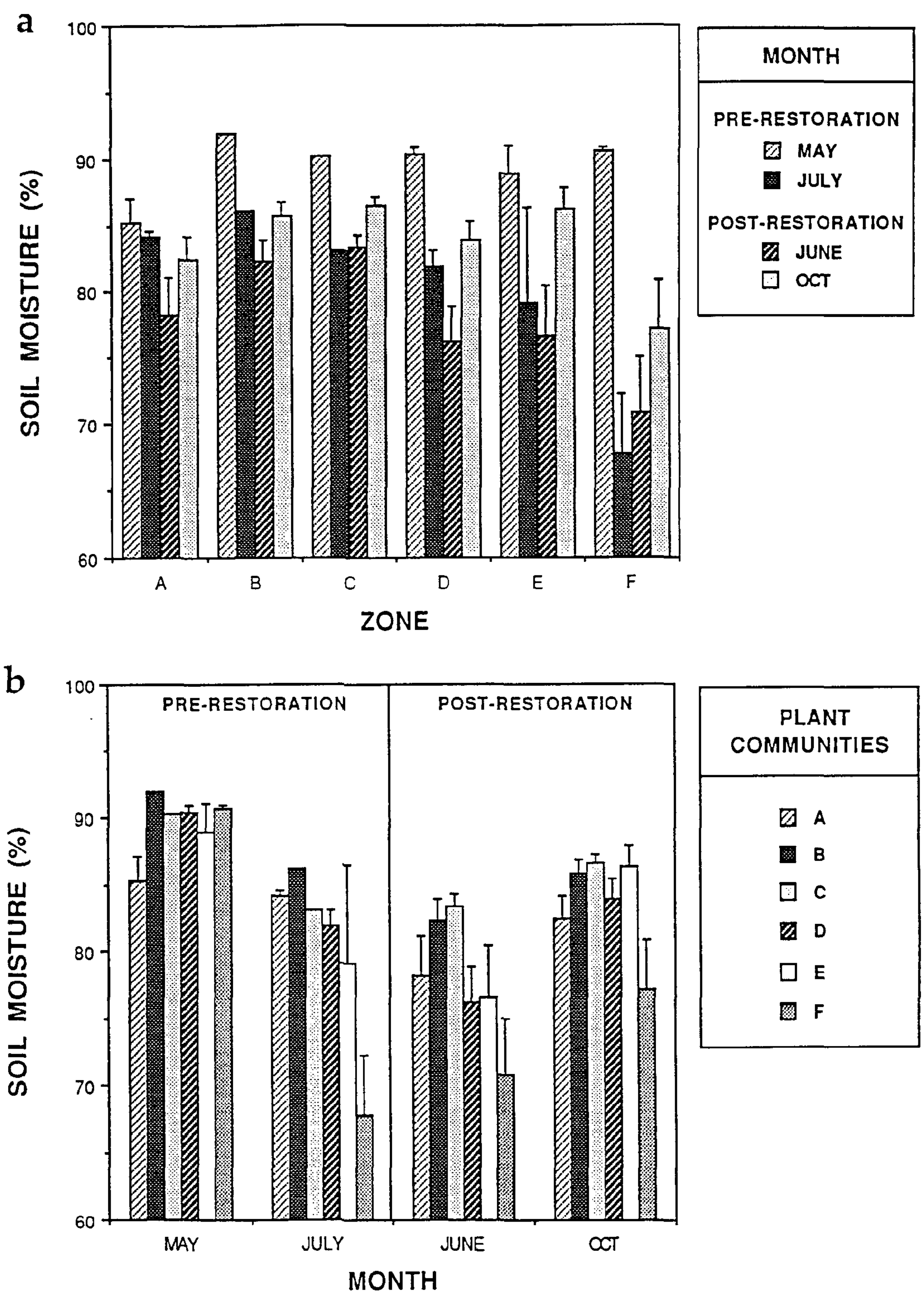


Figure 9. Awcomin Marsh. Soil moisture reported as a percentage on a wet weight basis from 1 to 5 cm depth. Values are means for each vegetative zone +/- standard error. a. Moisture means for each month by zone. b.Moisture means for each zone by month.

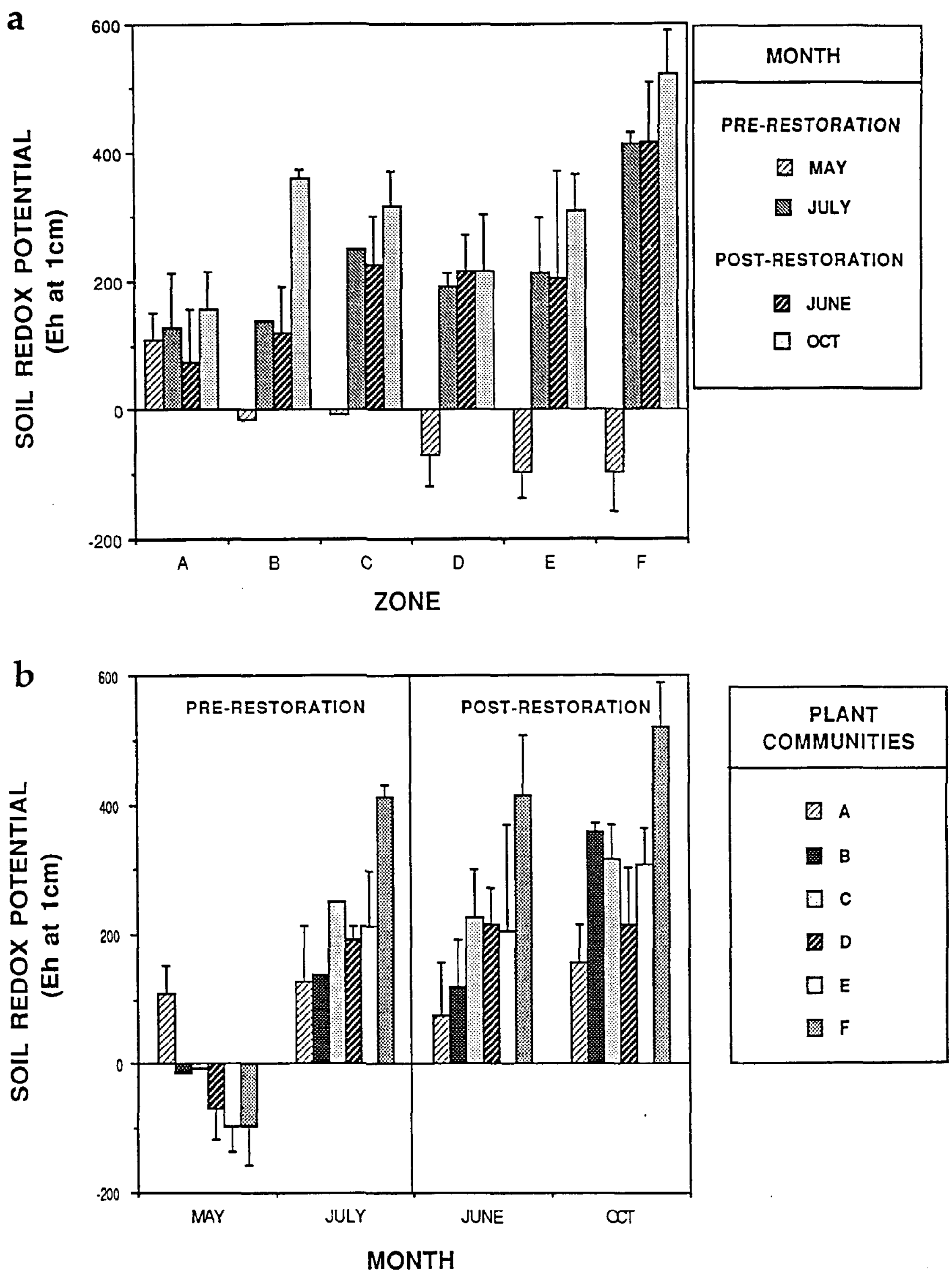


Figure 10. Awcomin Marsh. Soil redox potential (Eh) at 1 cm depth. Values are means for each vegetative zone +/- standard error. a. Eh means for each month by zone. b. Eh means means for each zone by month.

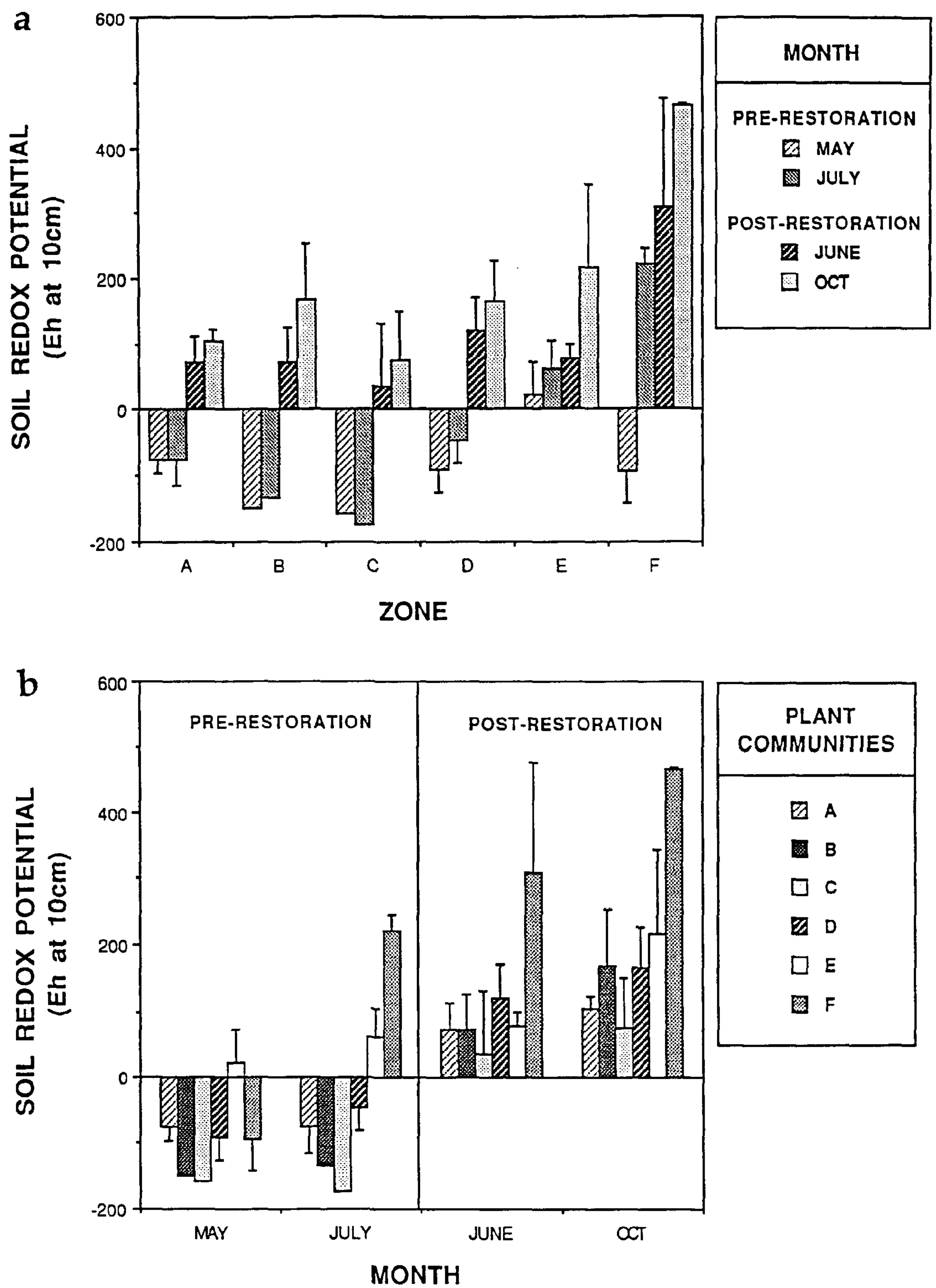


Figure 11. Awcomin Marsh. Soil redox potential (Eh) at 10 cm depth. Values are means for each vegetative zone +/- standard error. a. Eh means for each month by zone. b. Eh means means for each zone by month.

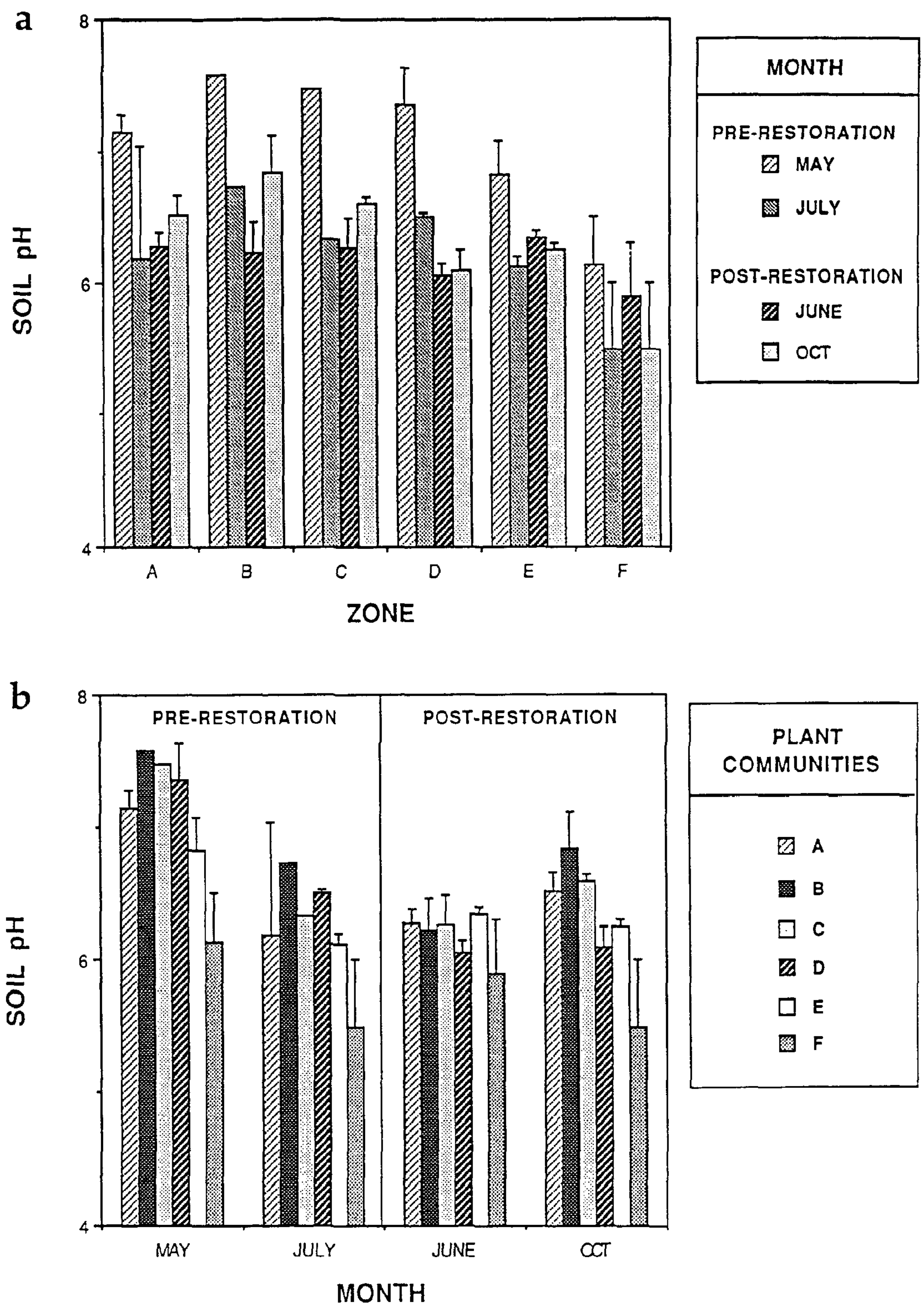


Figure 12. Awcomin Marsh. Soil pH of interstitial water from 1 to 5 cm depth. Values are means for each vegetative zone +/- standard error. a. pH means for each month by zone. b. pH means means for each zone by month.

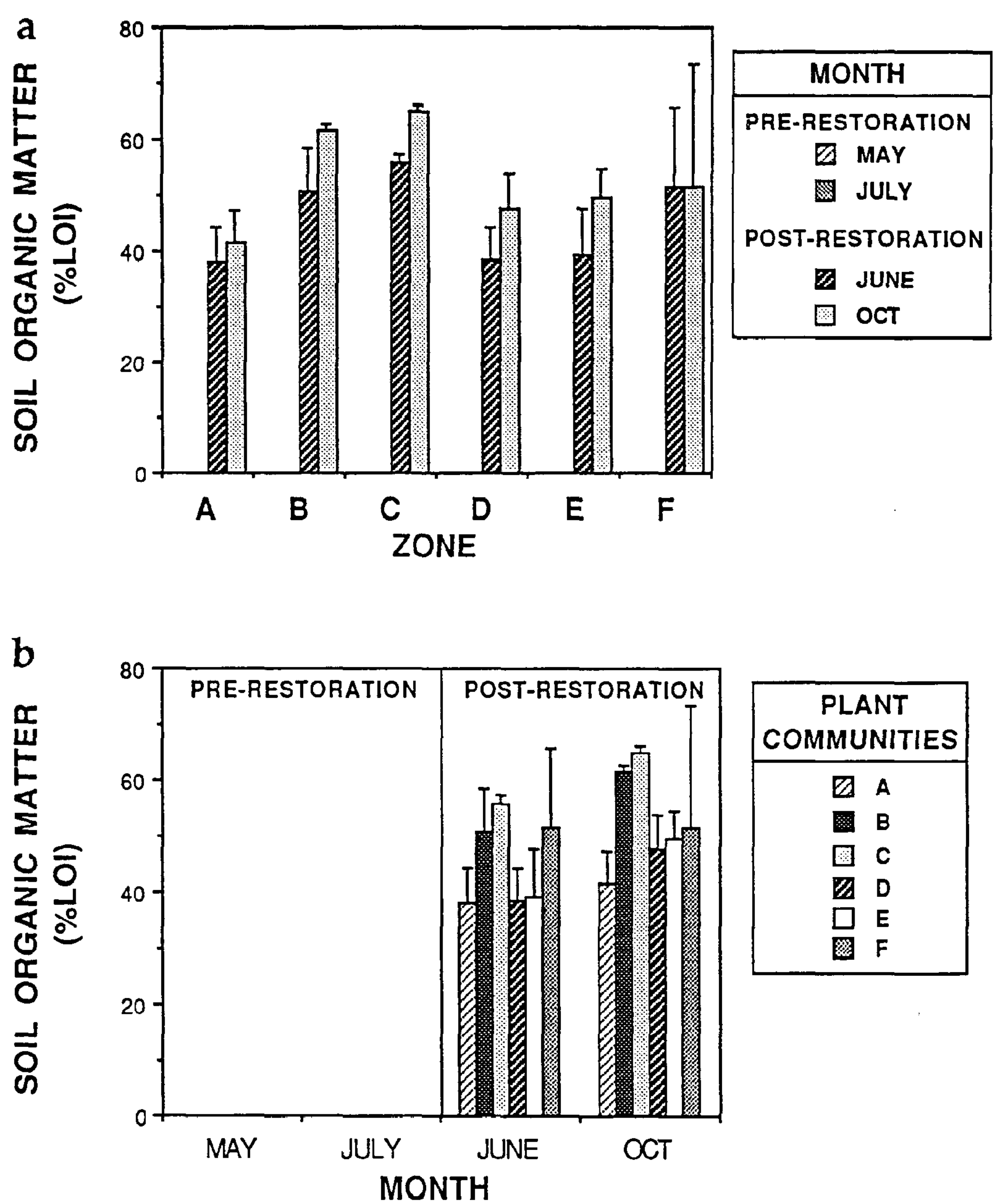


Figure 13. Awcomin Marsh. Soil organic matter from 1 to 5 cm depth, reported as loss on ignition (LOI). Values are means for each vegetative zone +/- standard error. a. Percentage organic matter means for each month by zone. b. Percentage organic matter means for each zone by month.

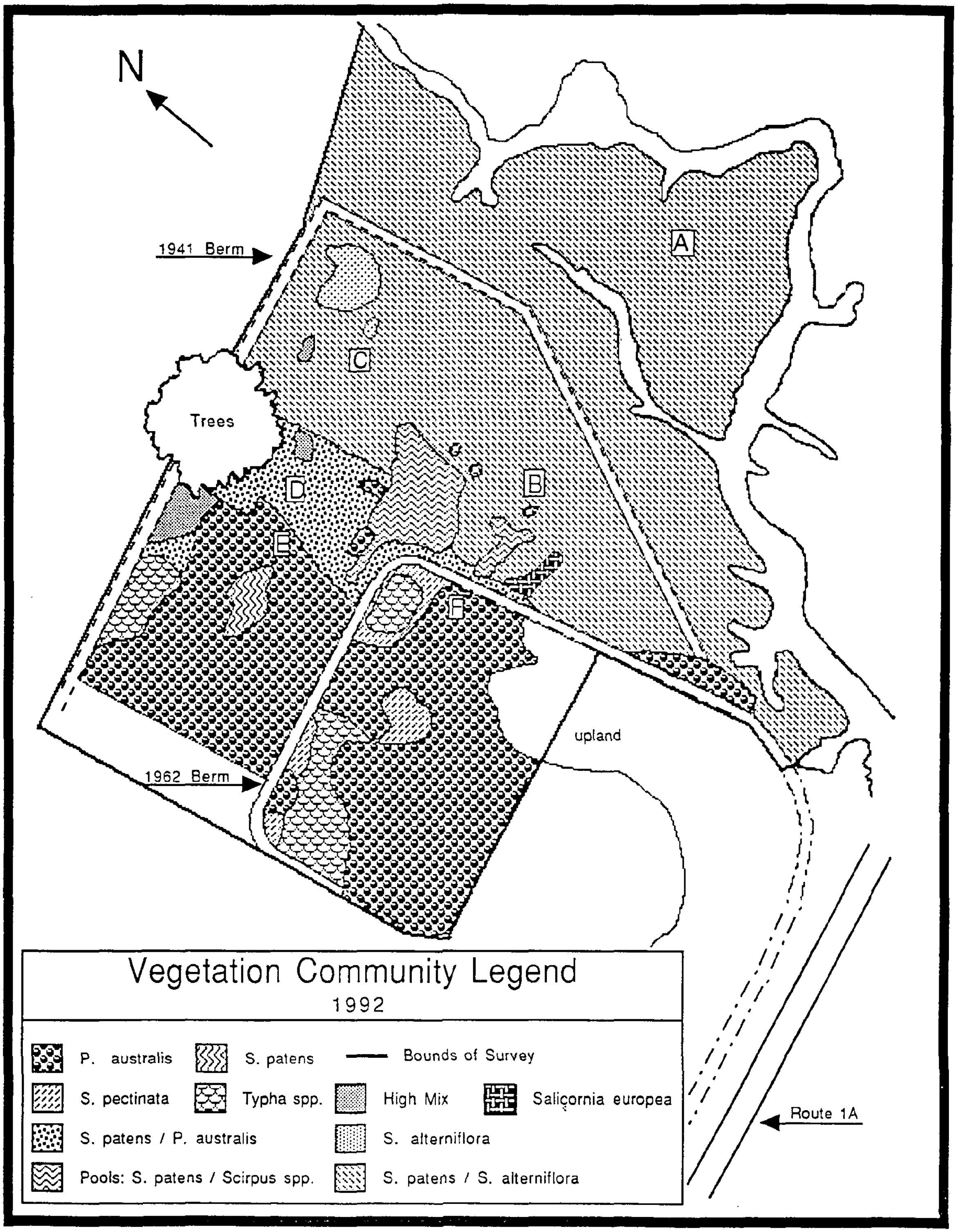


Figure 14. Awcomin Marsh. Vegetation mapped by community, 1992. Outside of the 1941 berm, the *S. patens/S. alterniflora* community denotes *S. patens* dominant in high marshes and *S. alterniflora* dominant at the creek banks.

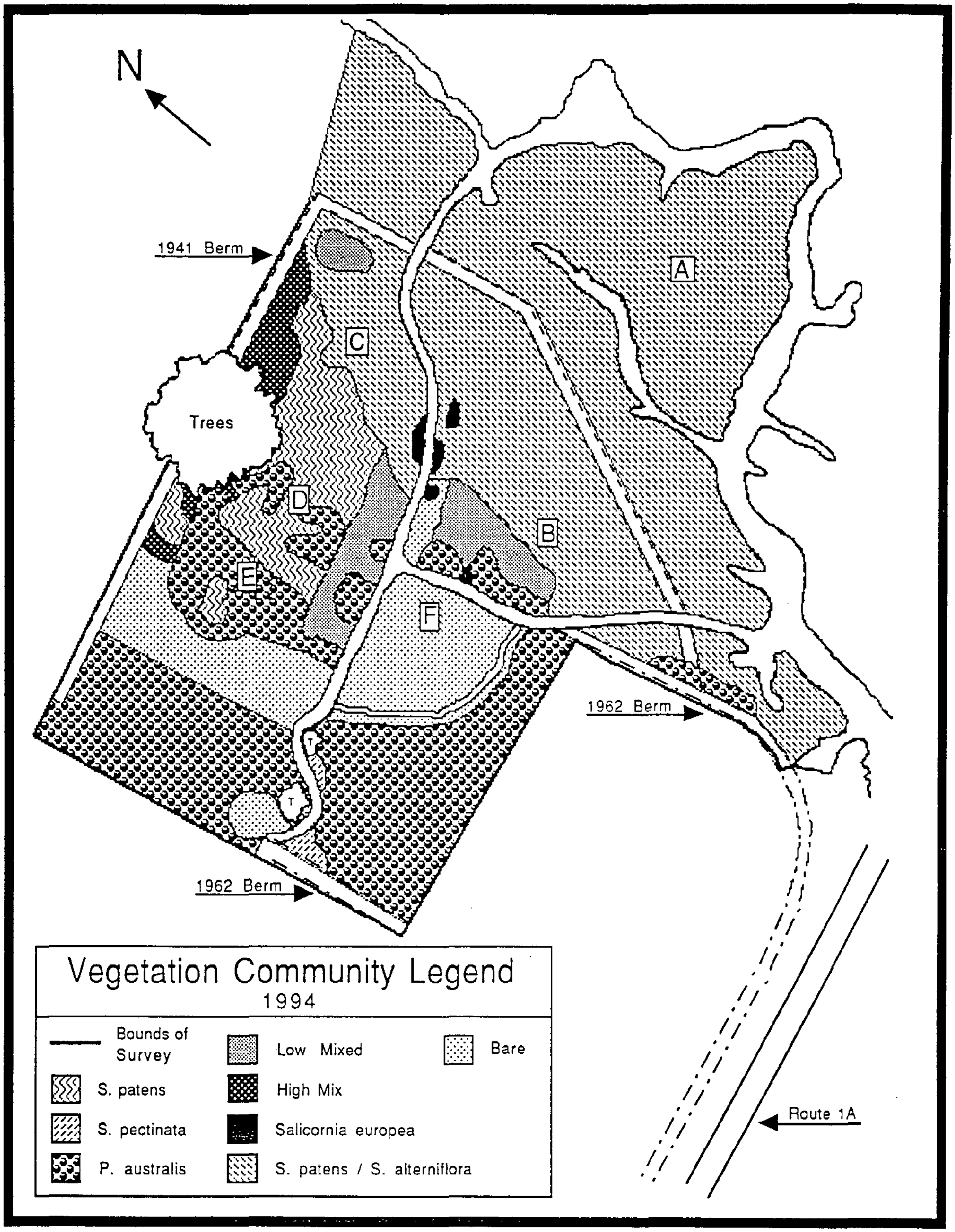


Figure 15. Awcomin Marsh. Vegetation mapped by community, 1994. Outside of the 1941 berm, the *S. patens/S. alterniflora* community denotes *S. patens* dominant in high marshes and *S. alterniflora* dominant at the creek banks.

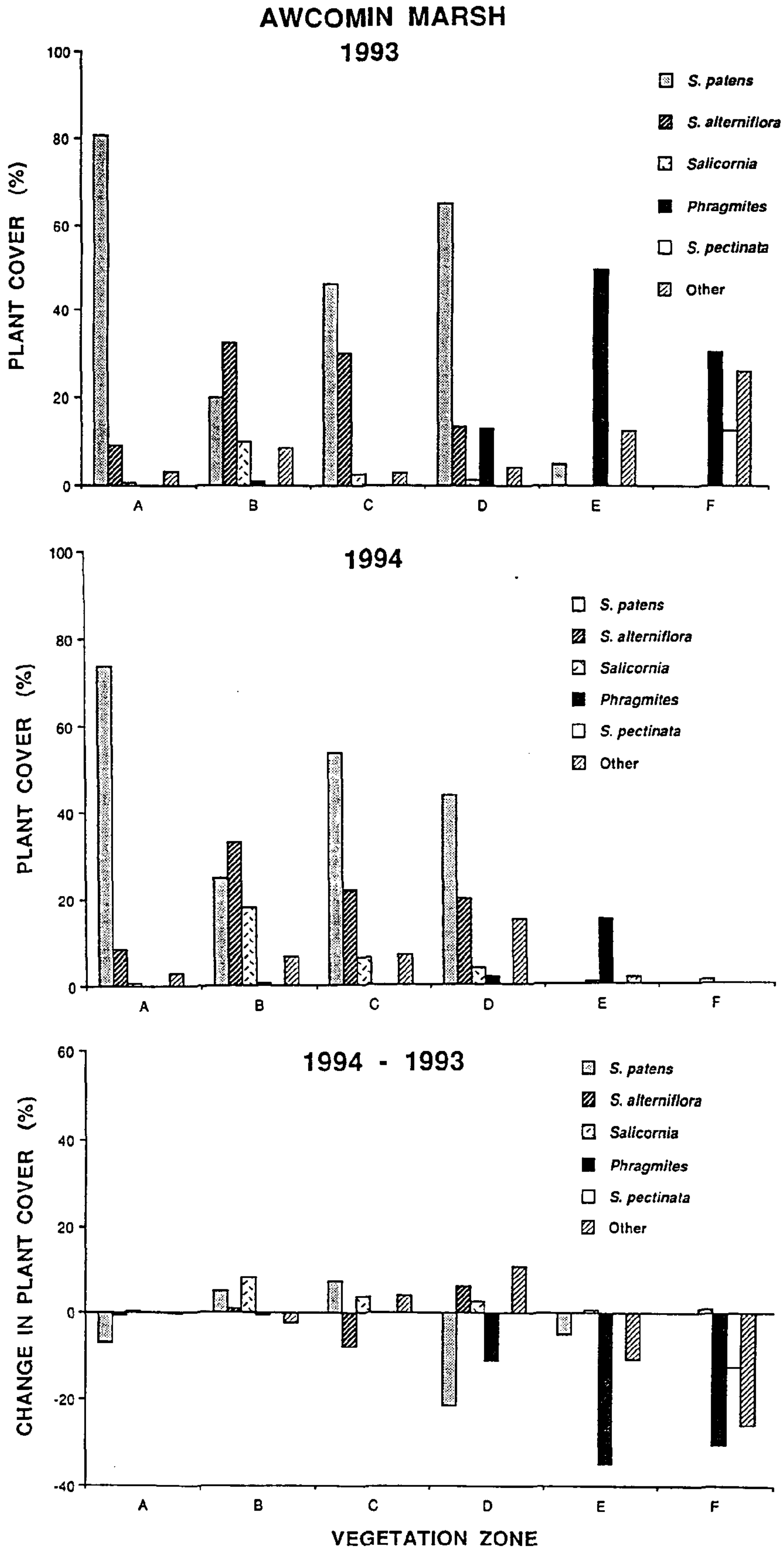
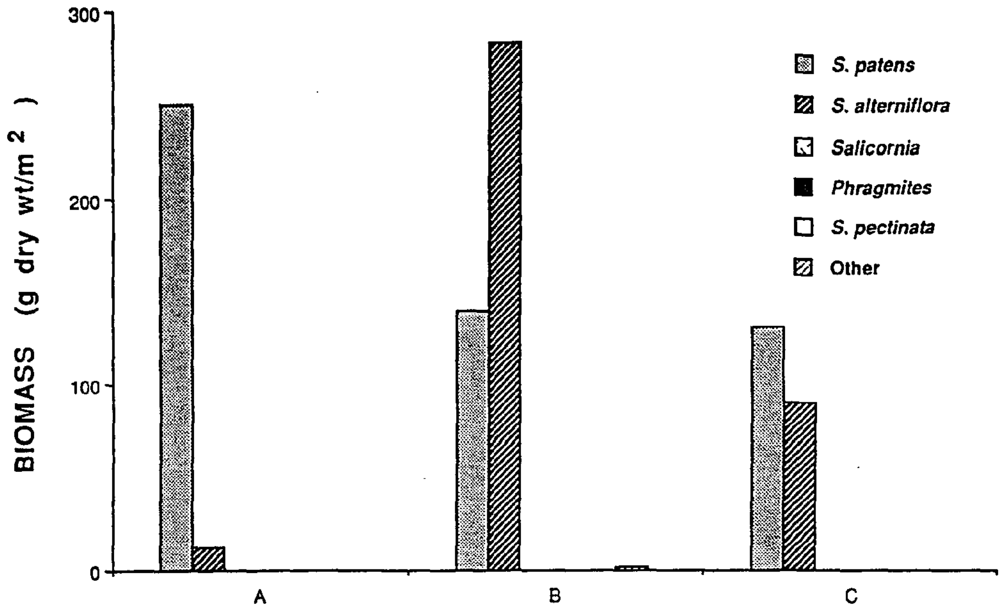


Figure 16. Awcomin Marsh. Percentage of plant cover by indicator species 1993, 1994 and change (1994 - 1993). Values are means for each vegetative zone.

AWCOMIN MARSH PLANT BIOMASS 1992



1993

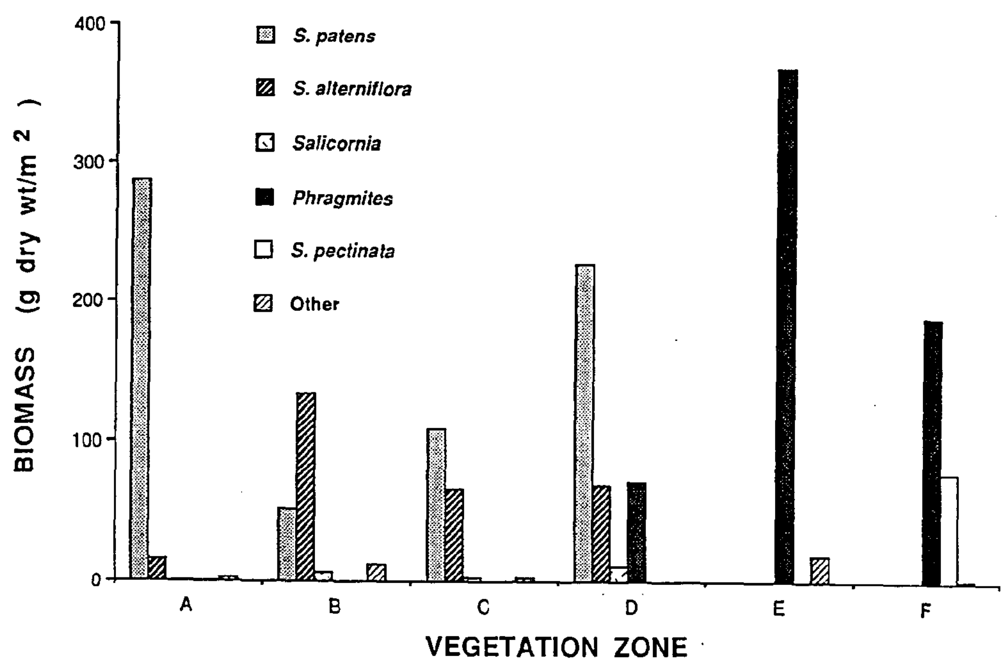


Figure 17. Awcomin Marsh. Aboveground biomass (end of season live standing crop) by indicator species 1992 and 1993. Values are means for each vegetative zone.

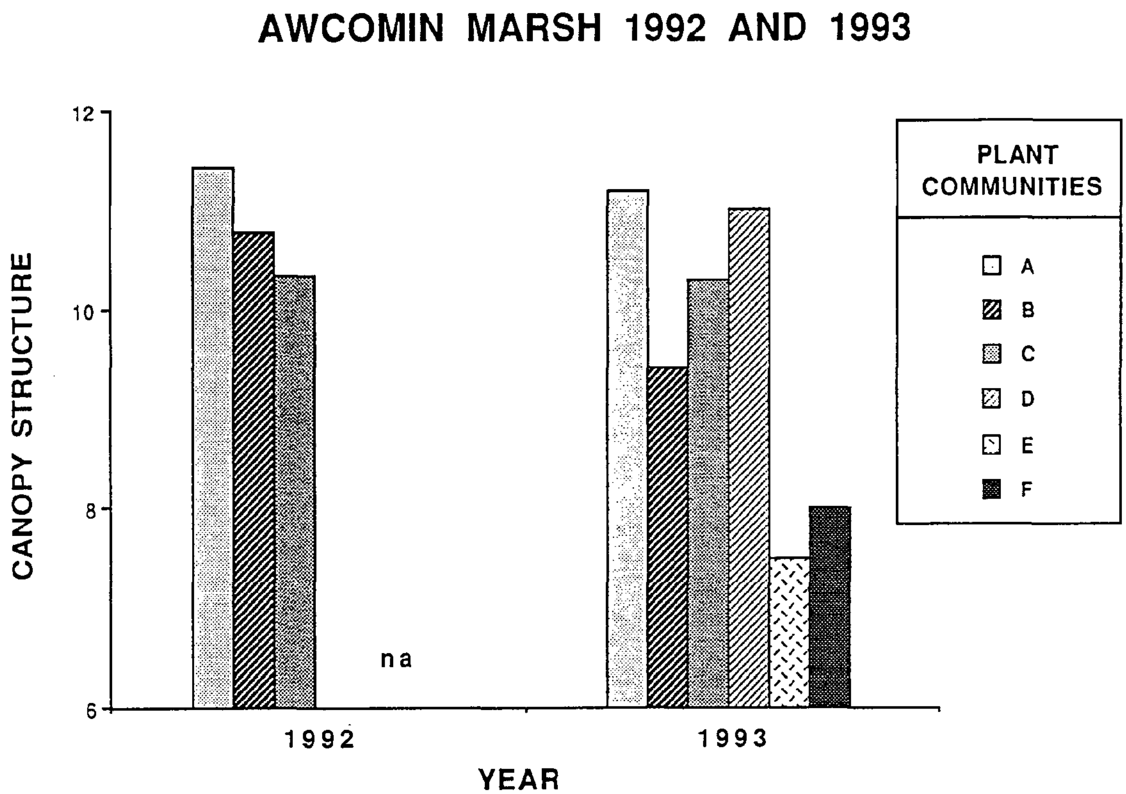


Figure 18. Awcomin Marsh. Canopy structure, an indicator of habitat complexity and potential for water filtration (developed in Table 1) for plants harvested in 1992 and 1993. Values are means +/- standard error for each vegetative zone.

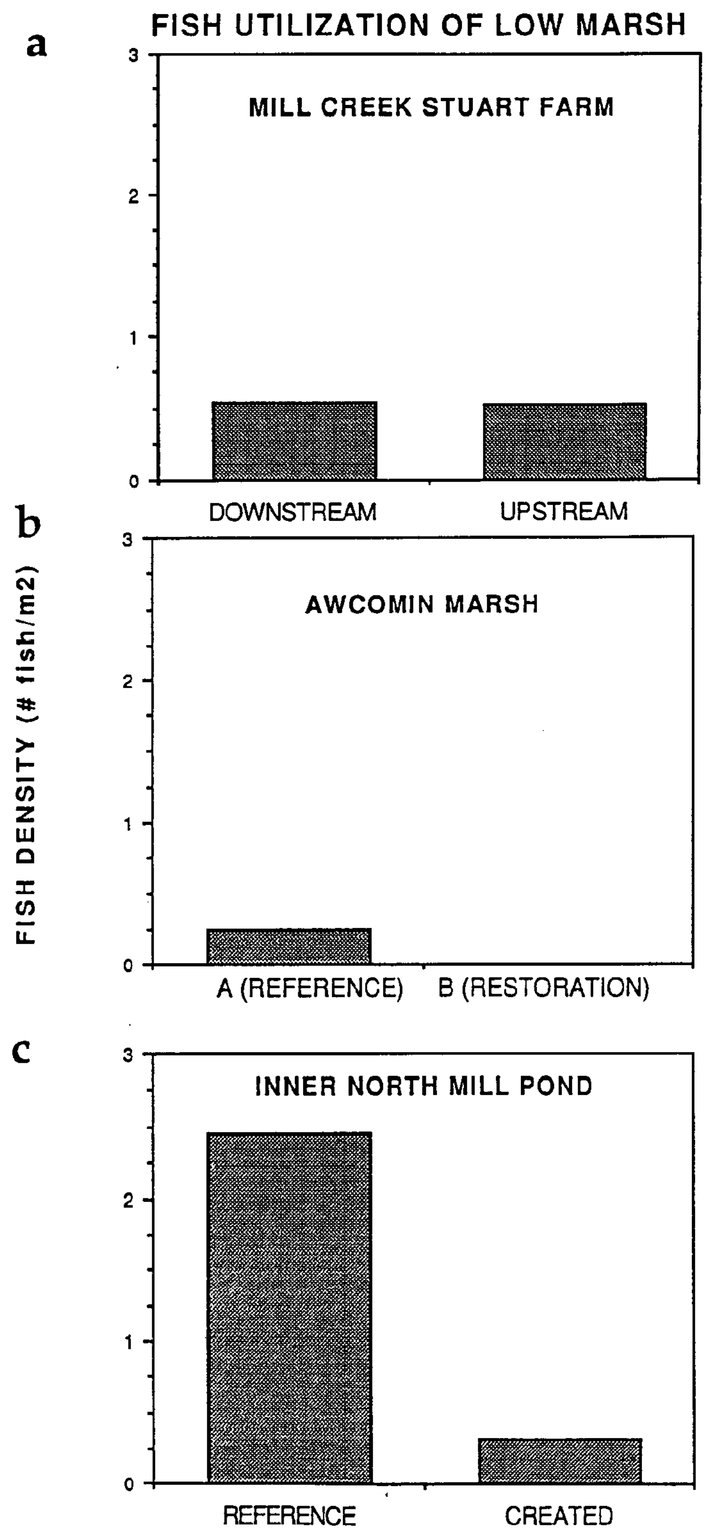


Figure 19. All Marshes. Fish densities expressed per m^2 of low marsh habitat sampled. Densities represent combined catches for two sampling dates for each zone sampled.

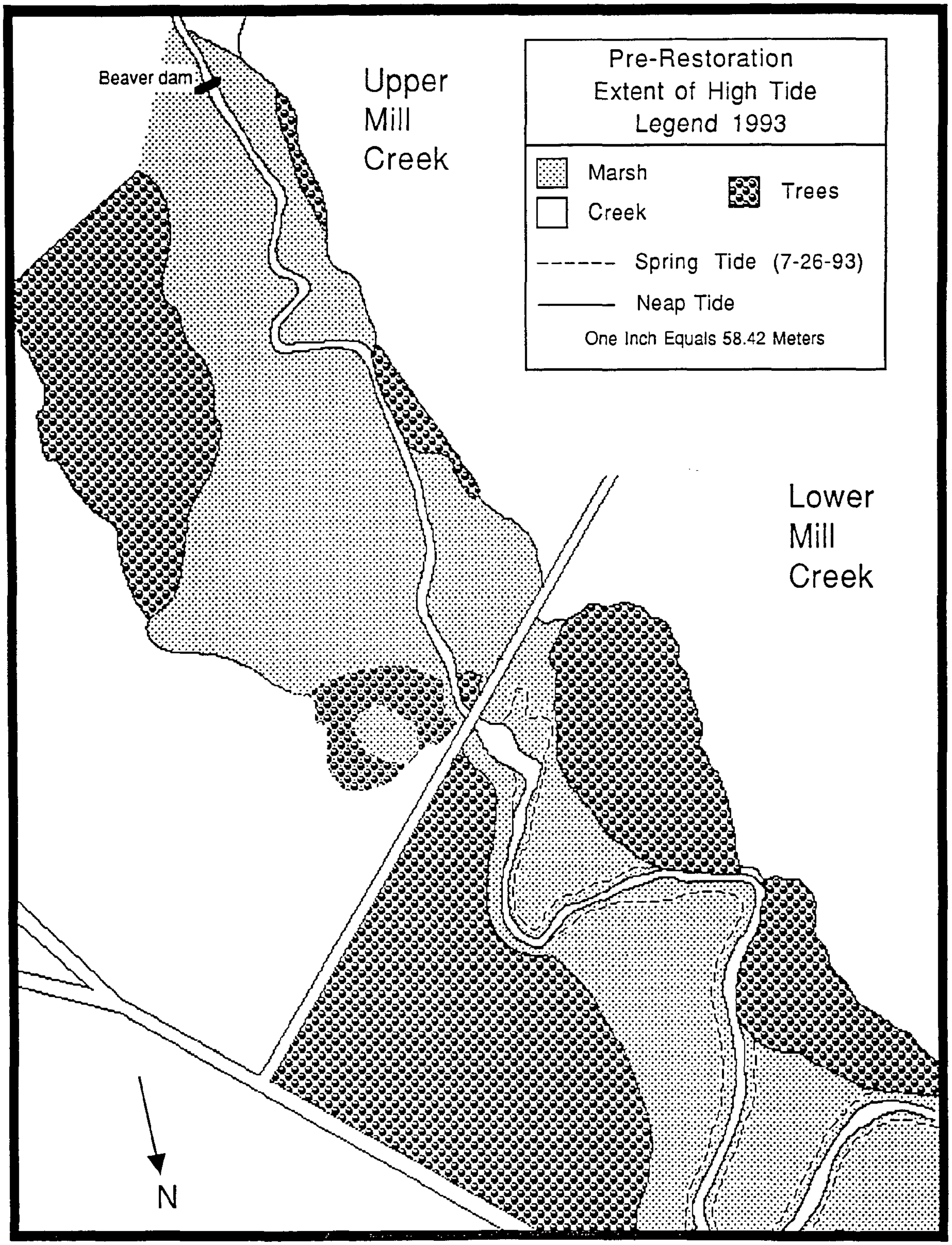


Figure 20. Mill Creek Stuart Farm. Extent of tidal flooding on spring tides before restoration, 1993. Flooding on neap tides was confined within natural creeks downstream of access road.

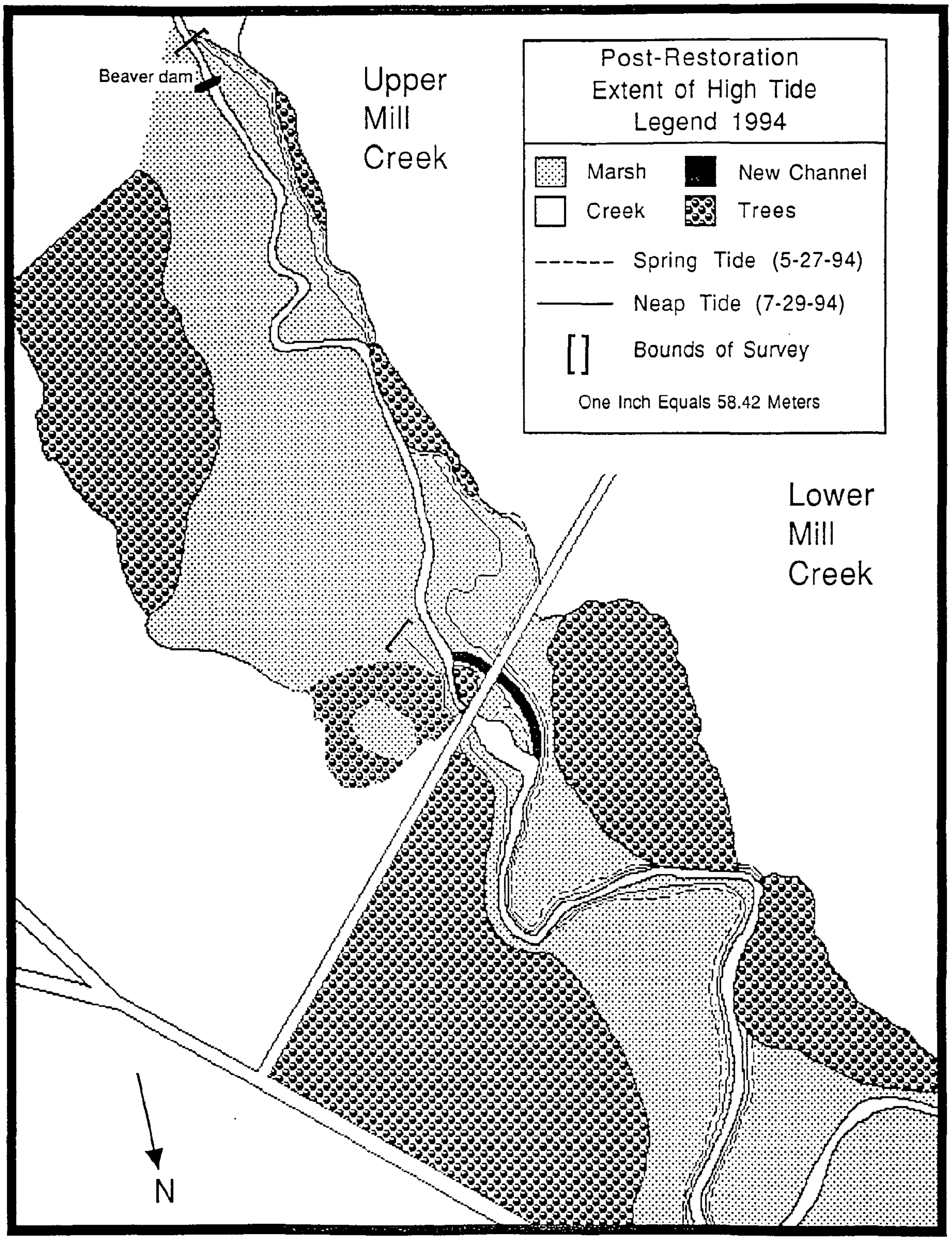


Figure 21. Mill Creek Stuart Farm. Extent of tidal flooding on spring tides after restoration, 1994. Flooding on neap tides was confined within natural creeks downstream of access road.

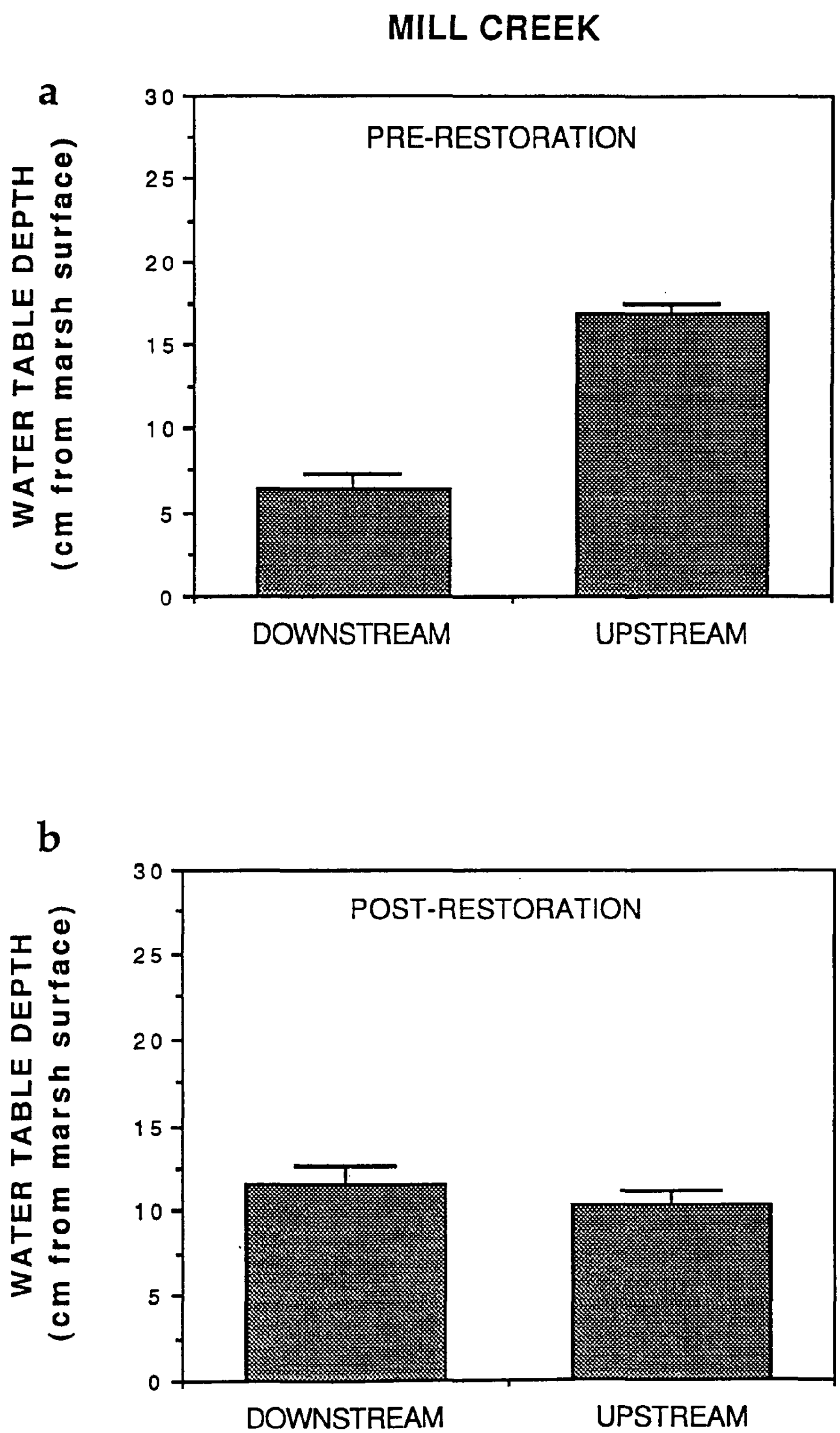


Figure 22. Mill Creek Stuart Farm. Water table depths expressed as distance (cm) from the marsh surface to the water table as measured in wells.

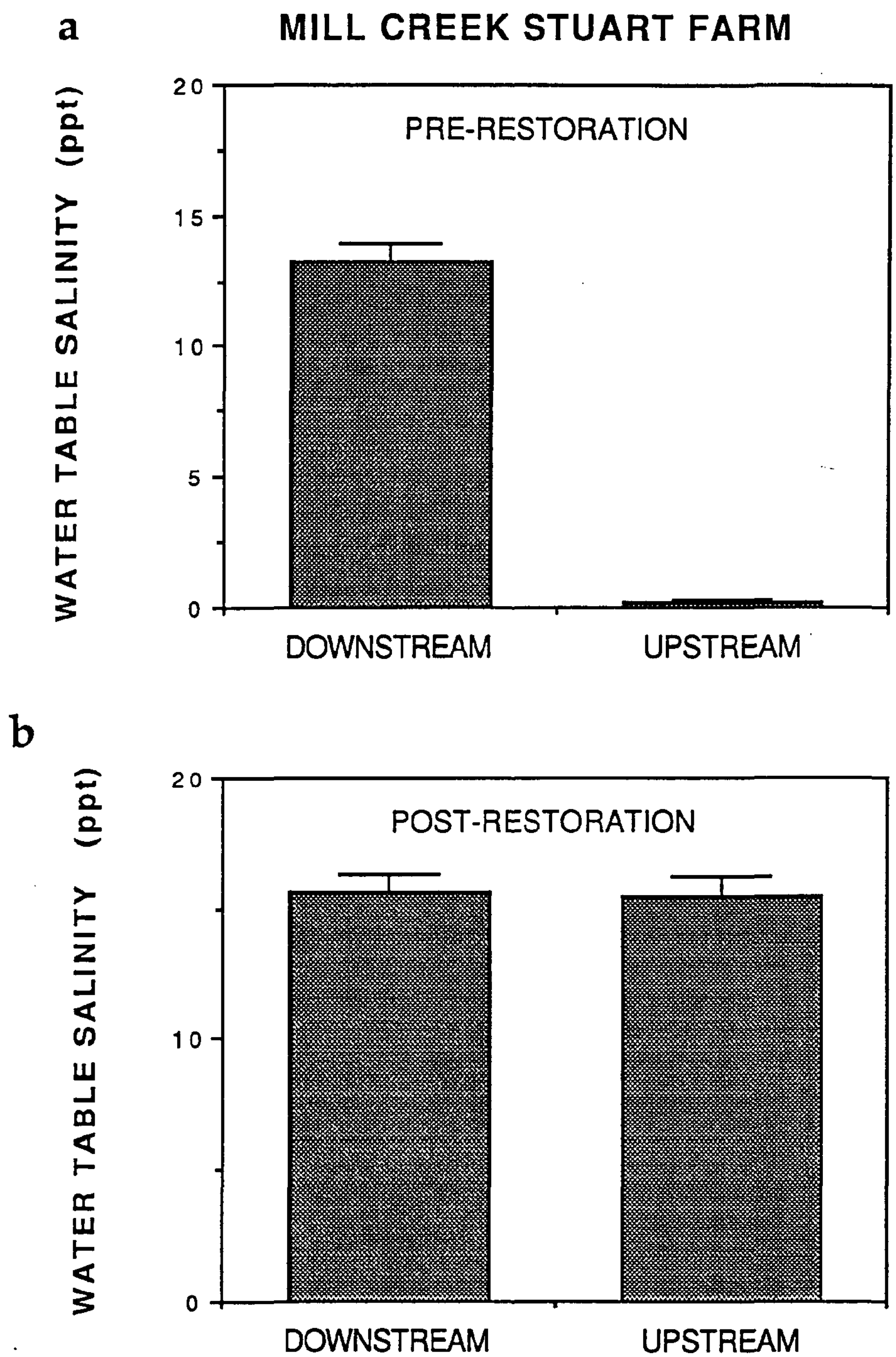


Figure 23. Mill Creek Stuart Farm. Water table salinities expressed in parts per thousand (ppt), as measured in water sampled from wells.

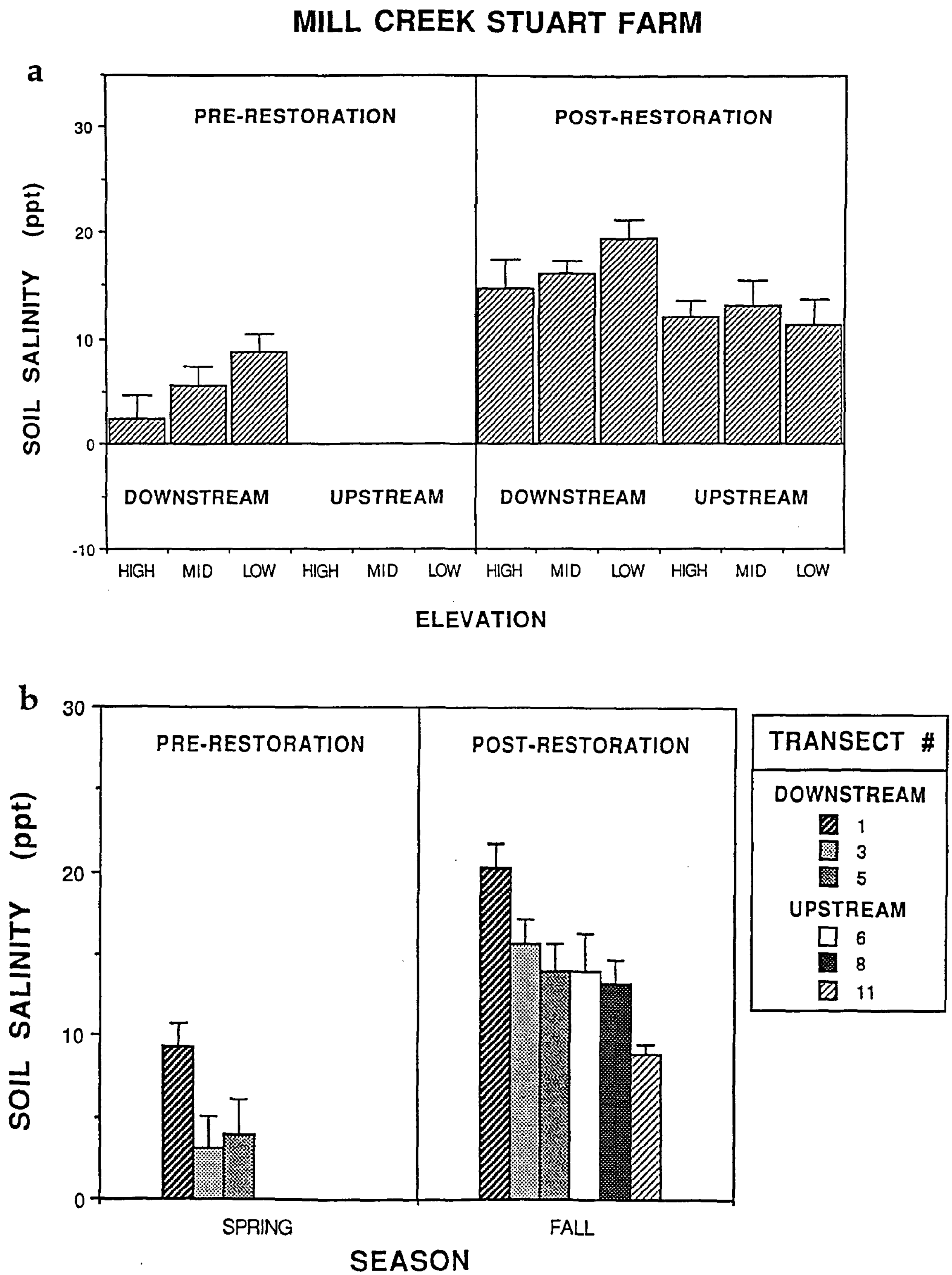


Figure 24. Mill Creek Stuart Farm. Soil salinity of interstitial water from 1 to 5 cm depth. Values are means for each elevation or transect +/- standard error. a. Salinity means for each period and zone by elevation. b. Salinity means for each period by transect.

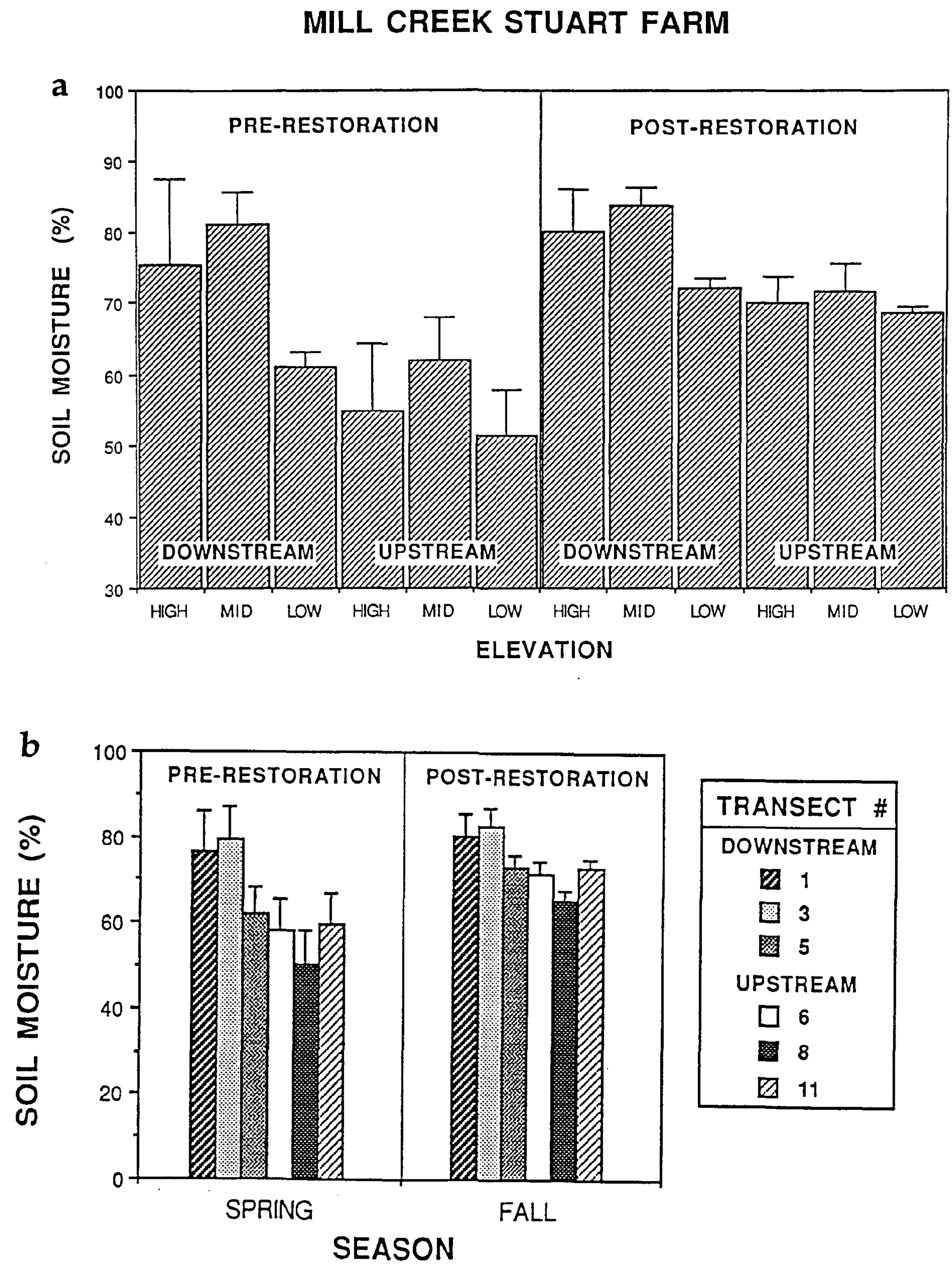


Figure 25. Mill Creek Stuart Farm. Soil moisture reported as a percentage on a wet weight basis from 1 to 5 cm depth. Values are means for each elevation or transect +/- standard error. a. moisture means for each period and zone by elevation. b. Moisture means for each period by transect. .

MILL CREEK STUART FARM

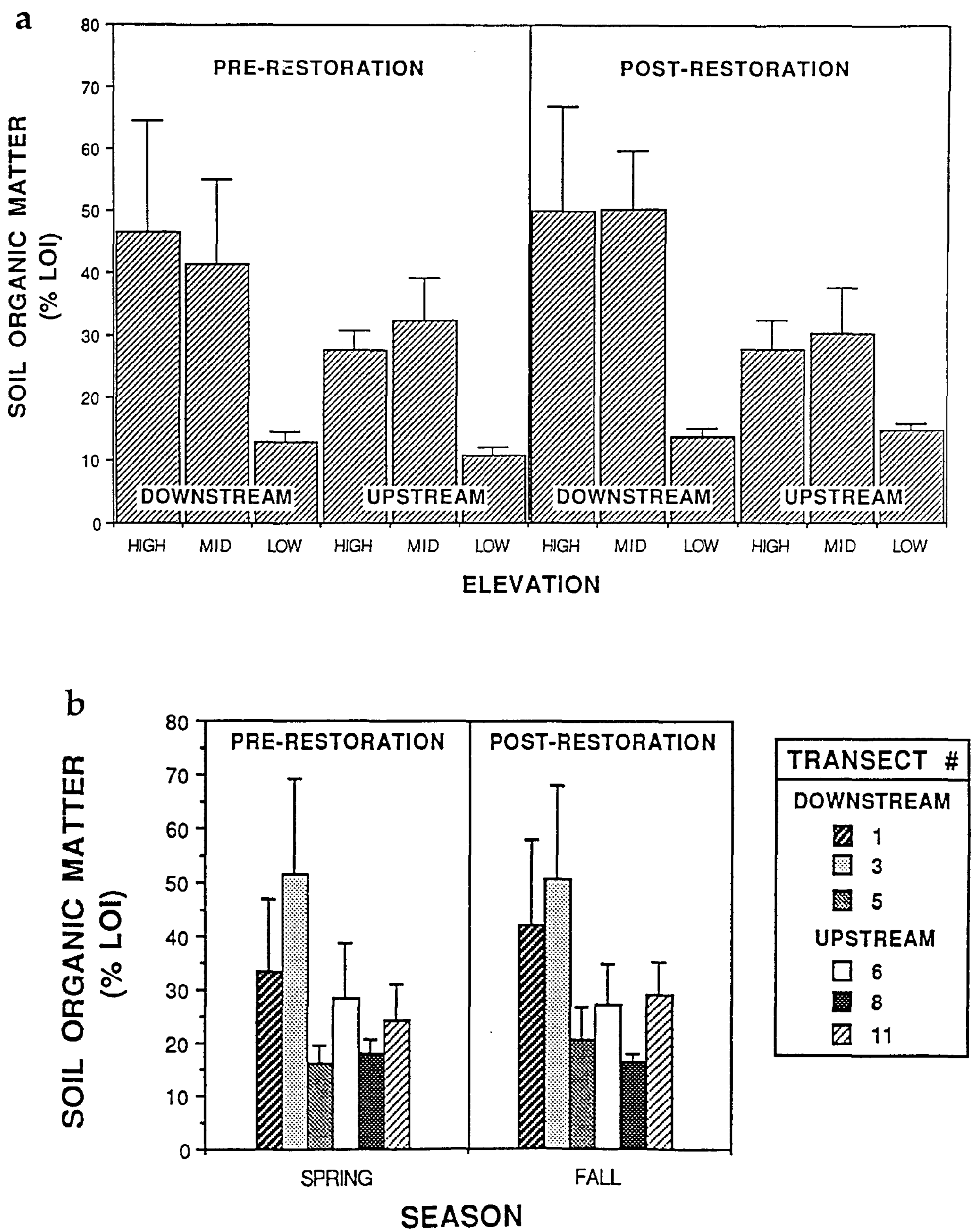


Figure 26. Mill Creek Stuart Farm. Soil organic matter reported as a percentage from 1 to 5 cm depth and based on loss on ignition (LOI). Values are means for each elevation or transect +/- standard error. a. Percentage organic matter means for each period and zone by elevation. b. Percentage organic matter means for each period by transect.

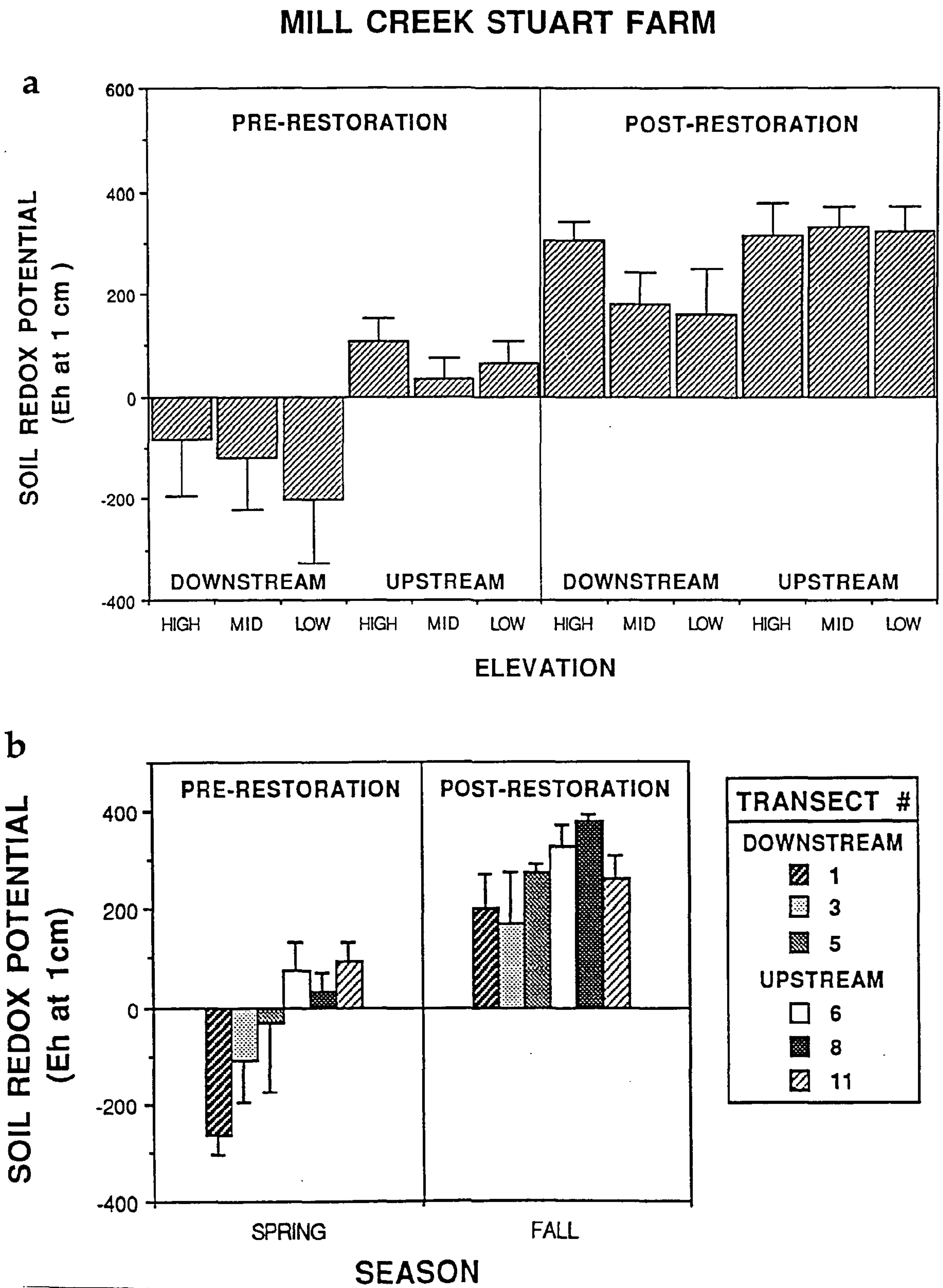


Figure 27. Mill Creek Stuart Farm. Soil redox potential (Eh) at 1 cm depth. Values are means for each elevation or transect +/- standard error. a. Eh means for each period and zone by elevation. b. Eh means for each period by transect.

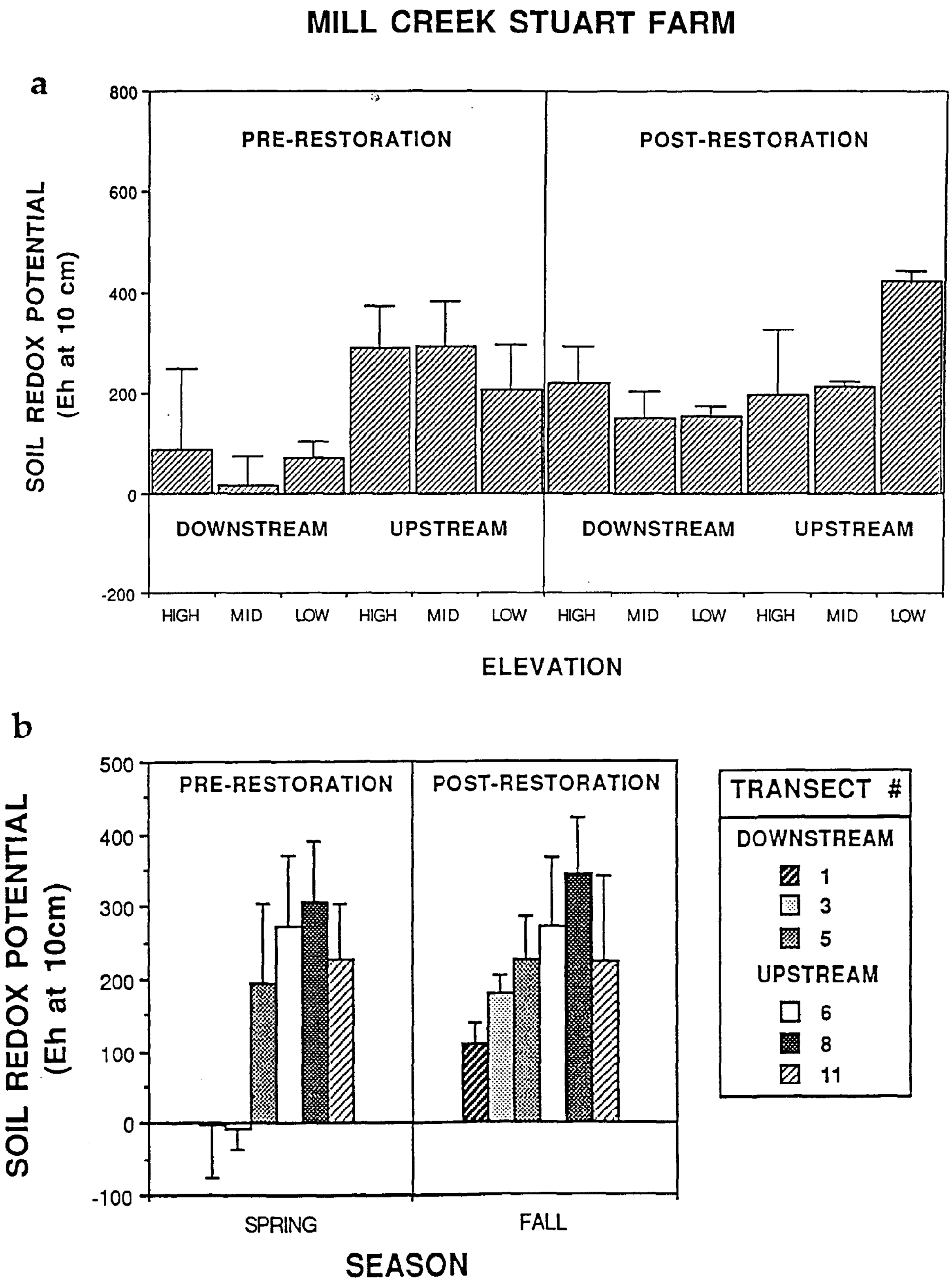


Figure 28. Mill Creek Stuart Farm. Soil redox potential (Eh) at 10 cm depth. Values are means for each elevation or transect +/- standard error. a. Eh means for each period and zone by elevation. b. Eh means for each period by transect.

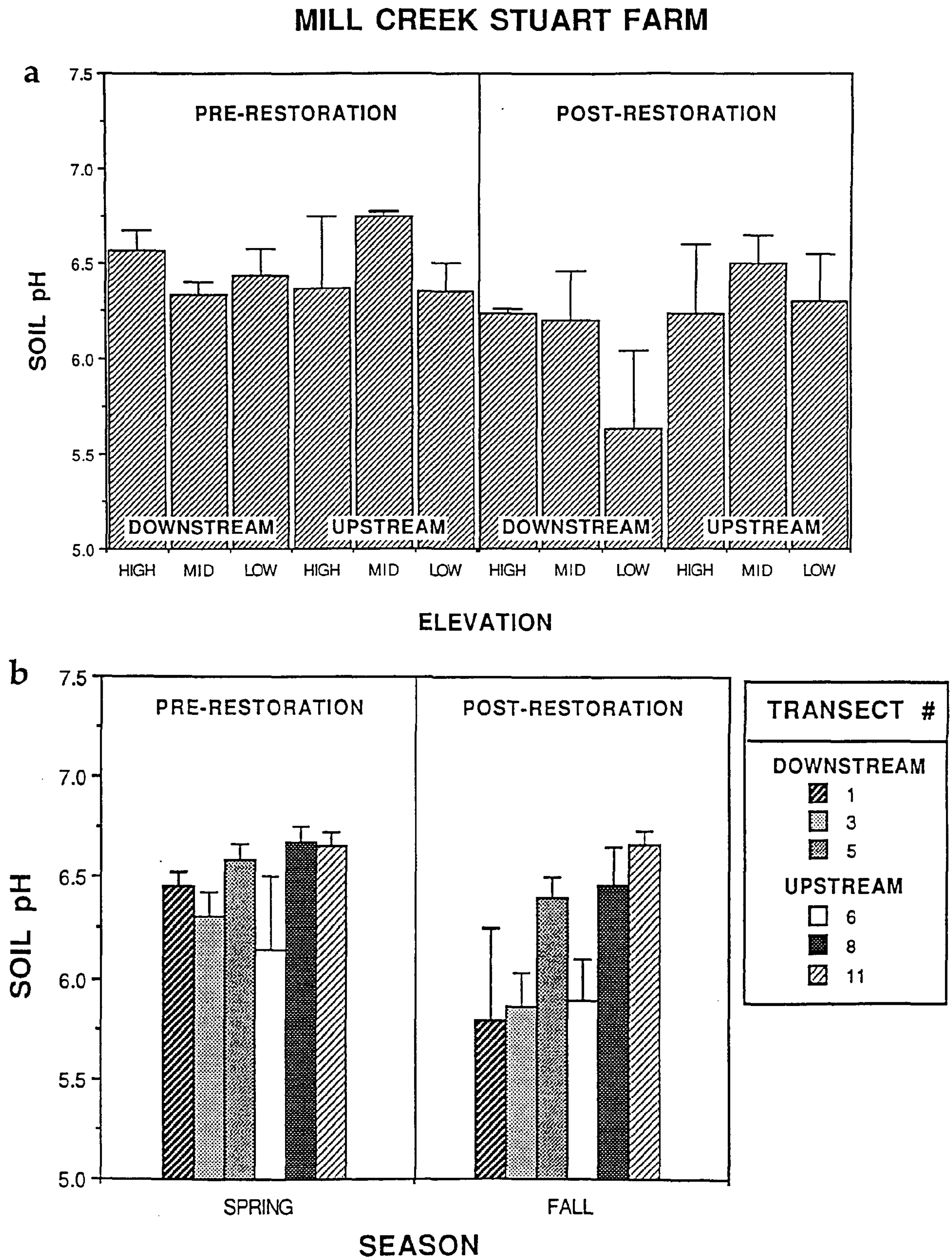


Figure 29. Mill Creek Stuart Farm. Soil pH of interstitial water from 1 to 5 cm depth. Values are means for each elevation or transect +/- standard error. a. pH means for each period and zone by elevation. b. pH means for each period by transect.

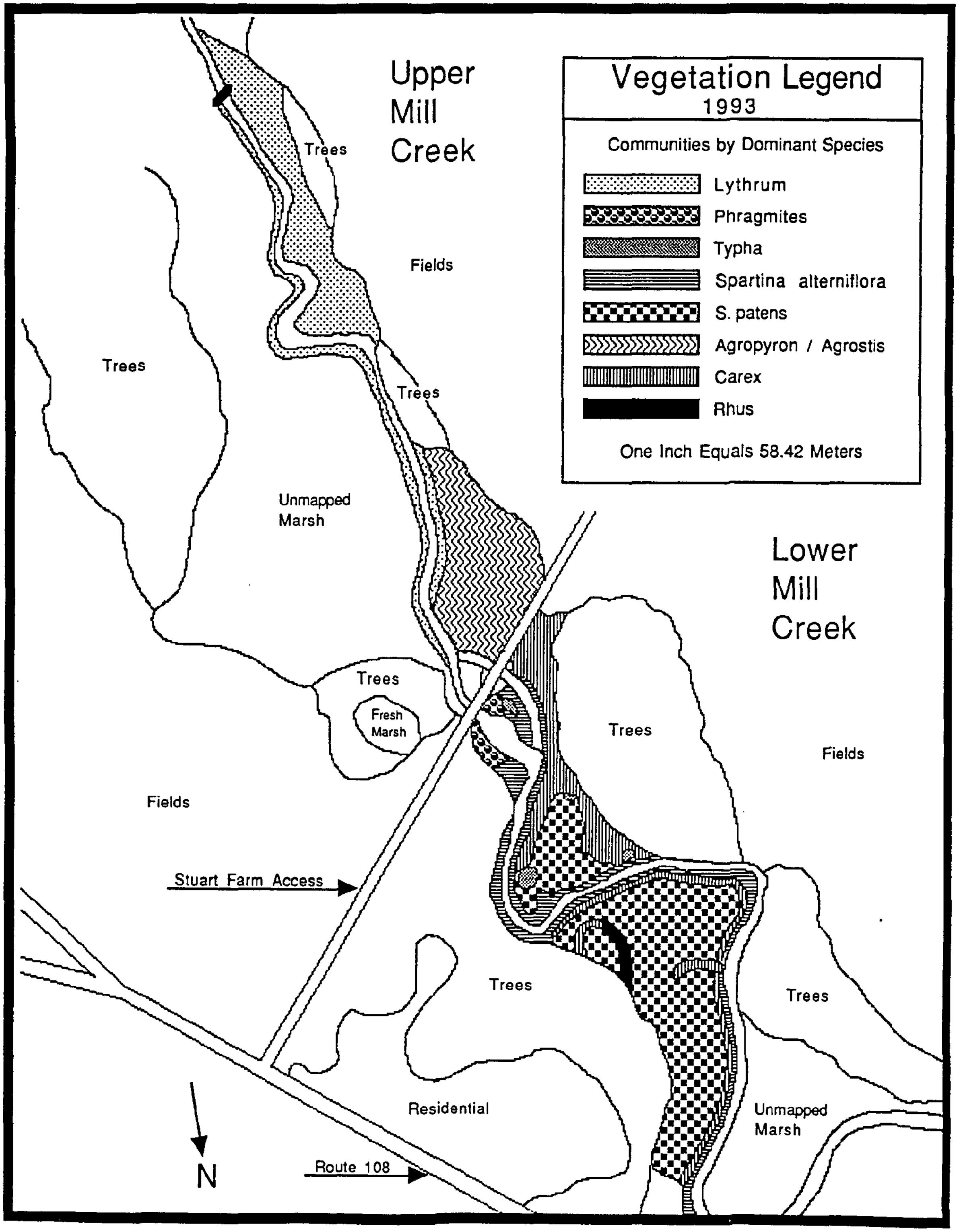


Figure 30. Mill Creek Stuart Farm. Vegetation mapped by community, 1993.

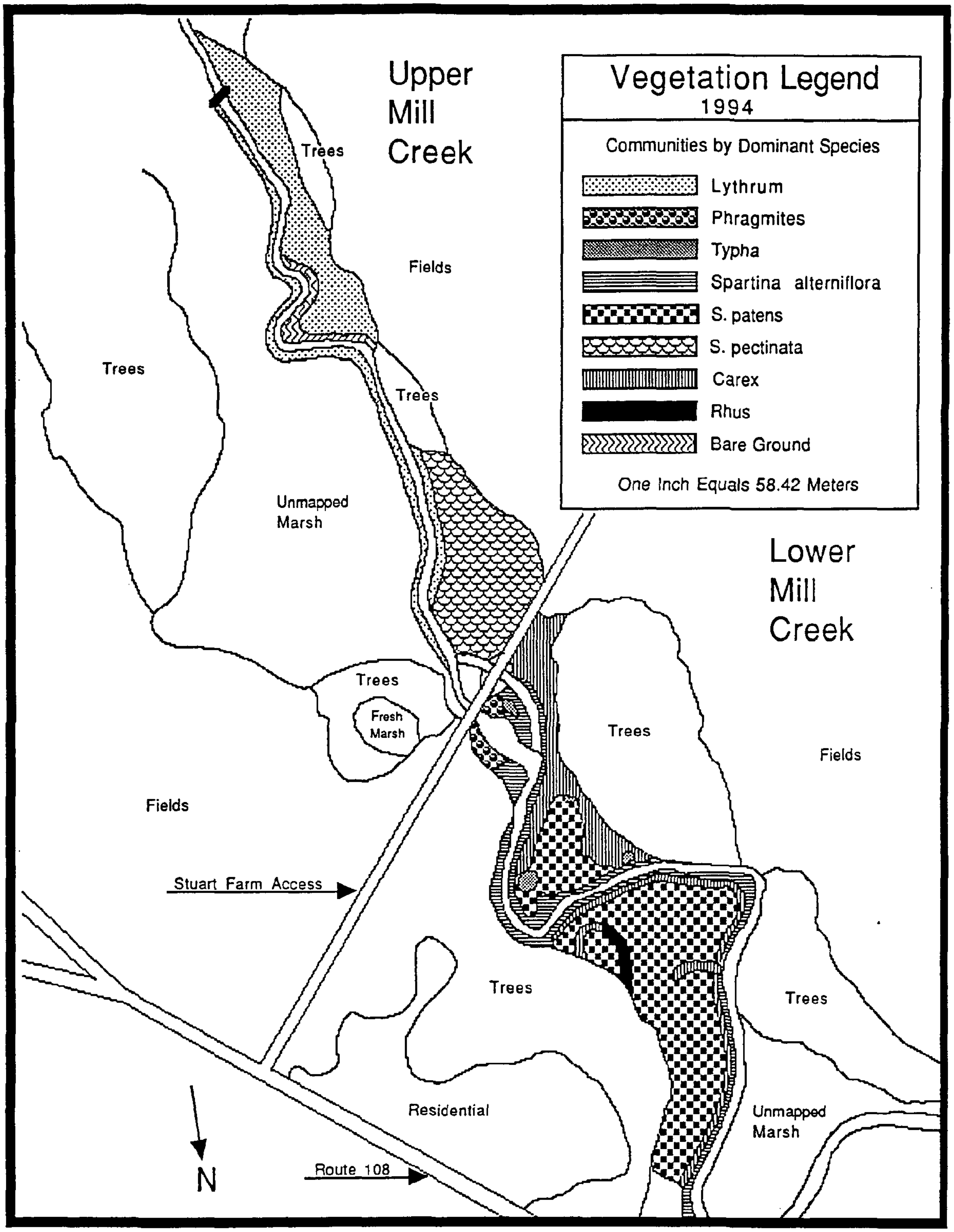


Figure 31. Mill Creek Stuart Farm. Vegetation mapped by community, 1994.

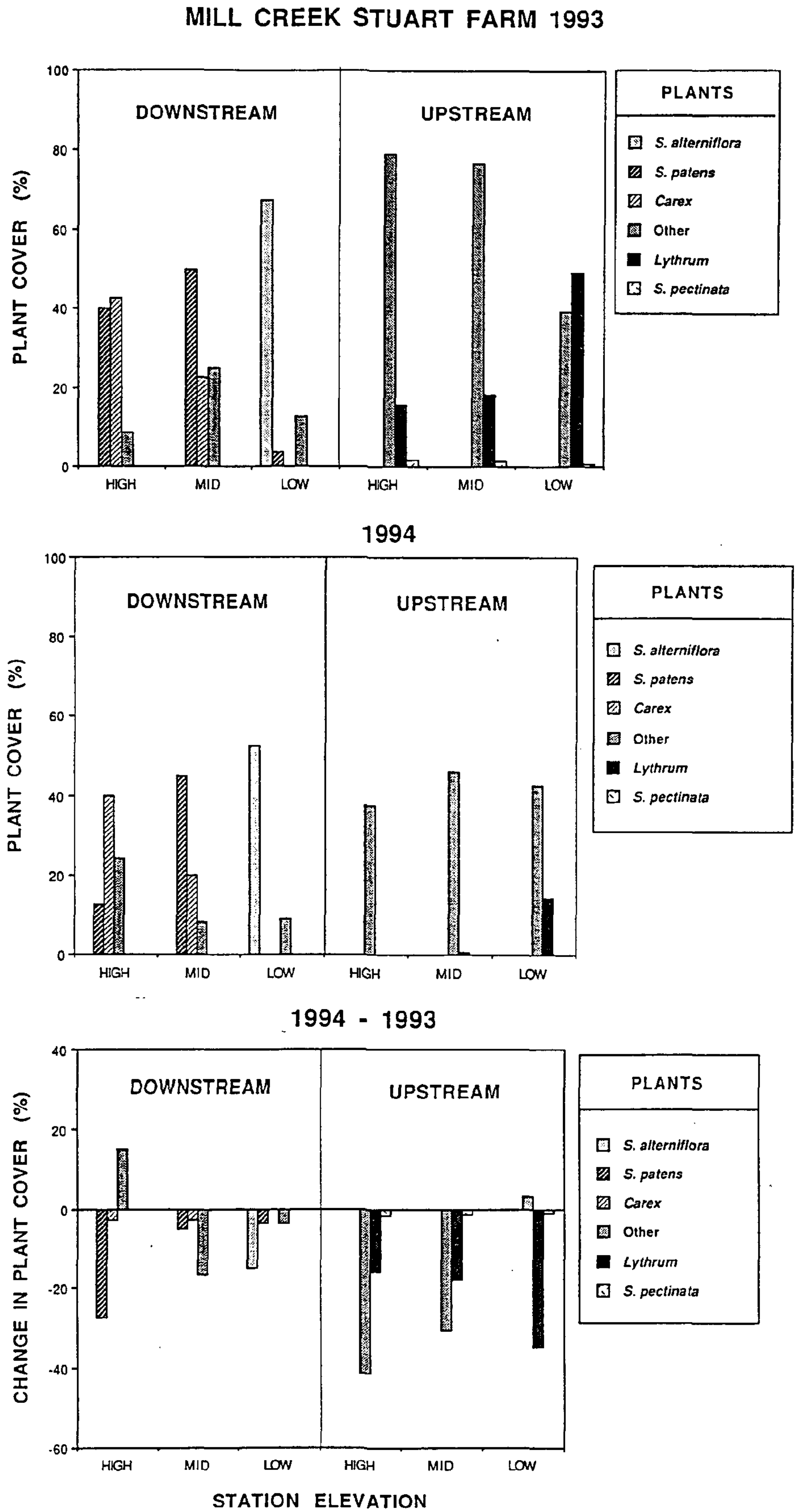


Figure 32. Mill Creek Stuart Farm. Percentage of plant cover by indicator species 1993, 1994 and change (1994 - 1993). Values are means for each elevation of the downstream transects and the transects upstream of the access road.

MILL CREEK STUART FARM 1993

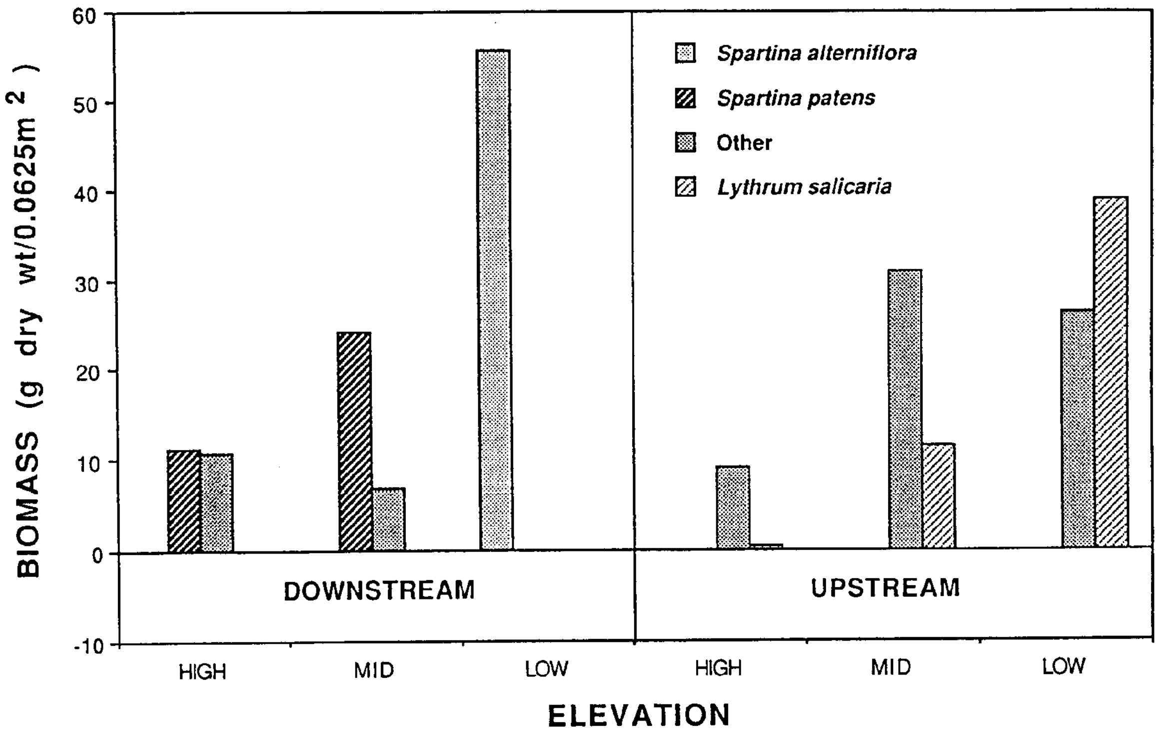


Figure 33. Mill Creek Stuart Farm. Aboveground biomass (end of season live standing crop) by indicator species 1993. Values are means for each elevation of the downstream transects and the transects upstream of the access road.

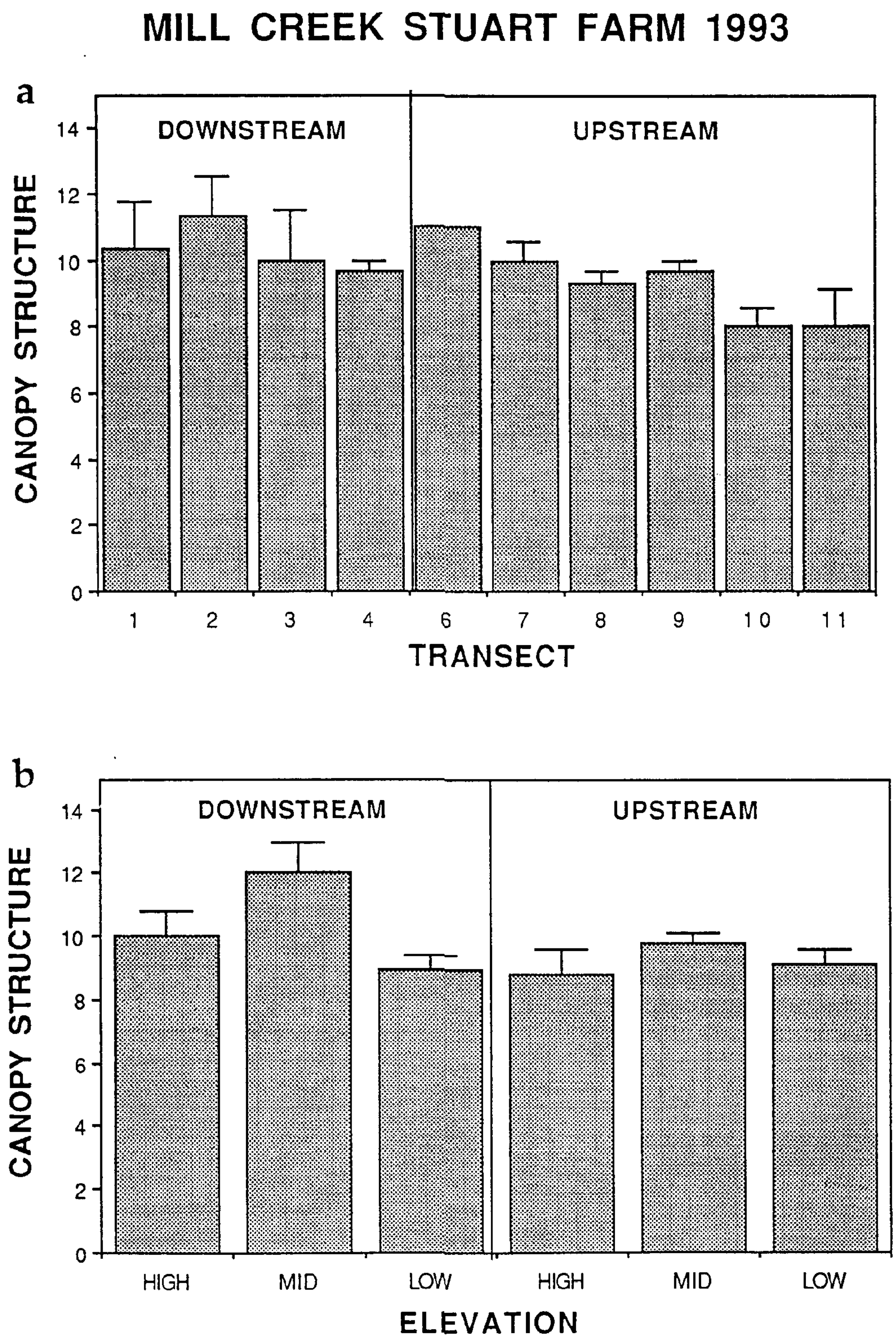


Figure 34. Mill Creek Stuart Farm. Canopy structure, an indicator of habitat complexity and potential for water filtration (developed in Table 1) for plants harvested in 1993. Values are means +/- standard error for each transect or elevation. a. Canopy structure for the means of each transect. b. Canopy structure for the means of each elevation of the downstream transects and the transects upstream of the access road..

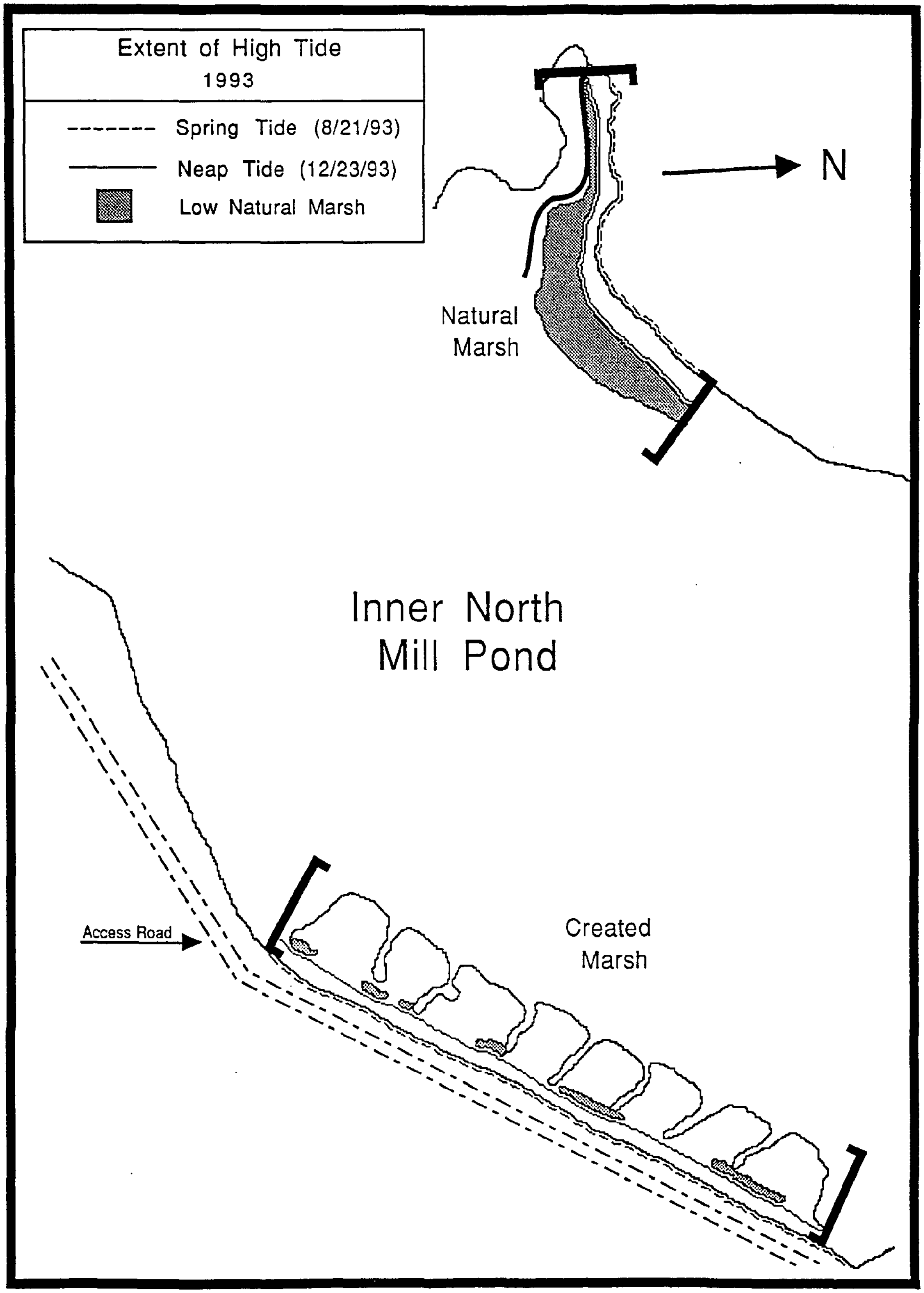


Figure 35. Inner North Mill Pond. Extent of tidal flooding on spring and neap high tides following marsh construction and planting, 1993.

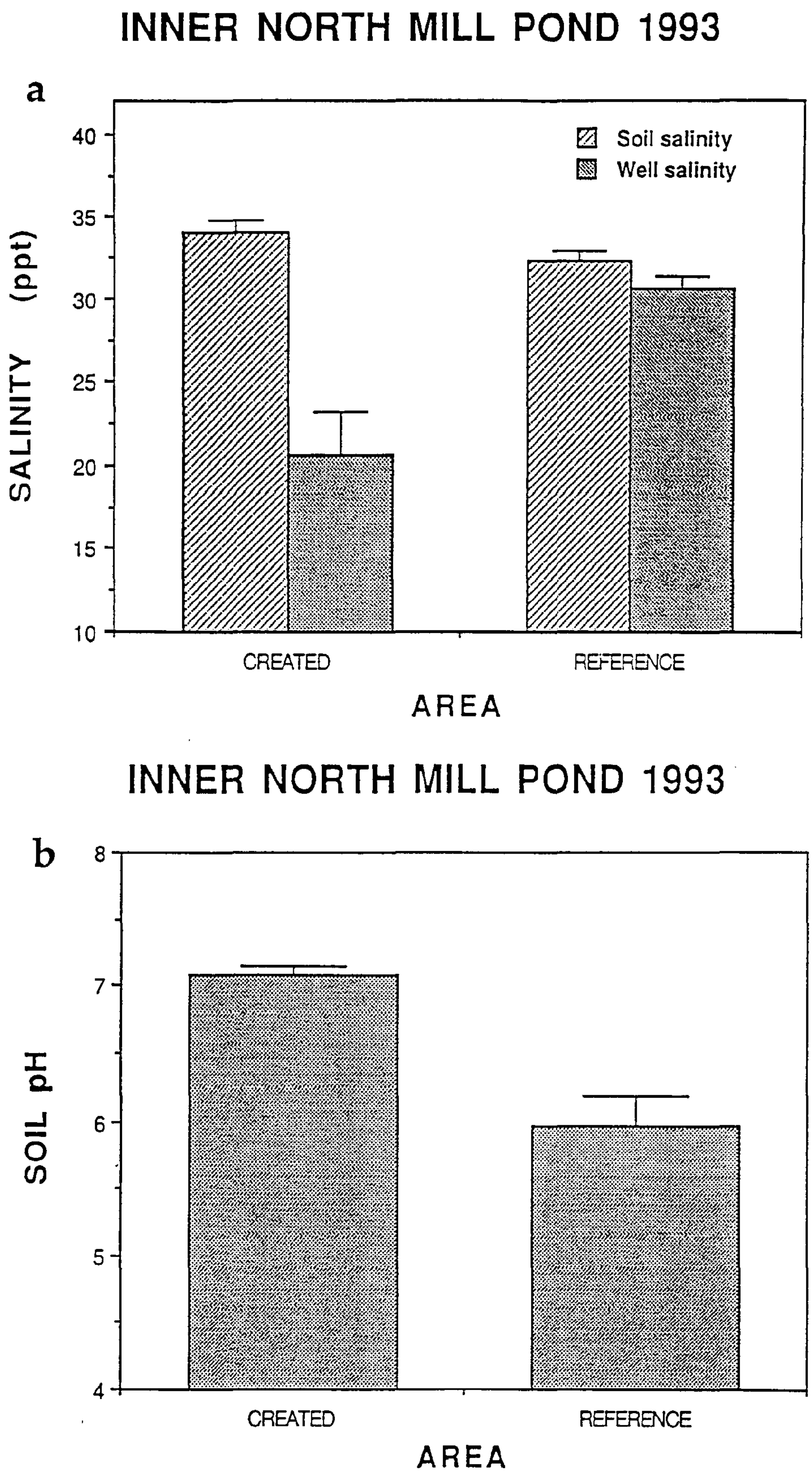
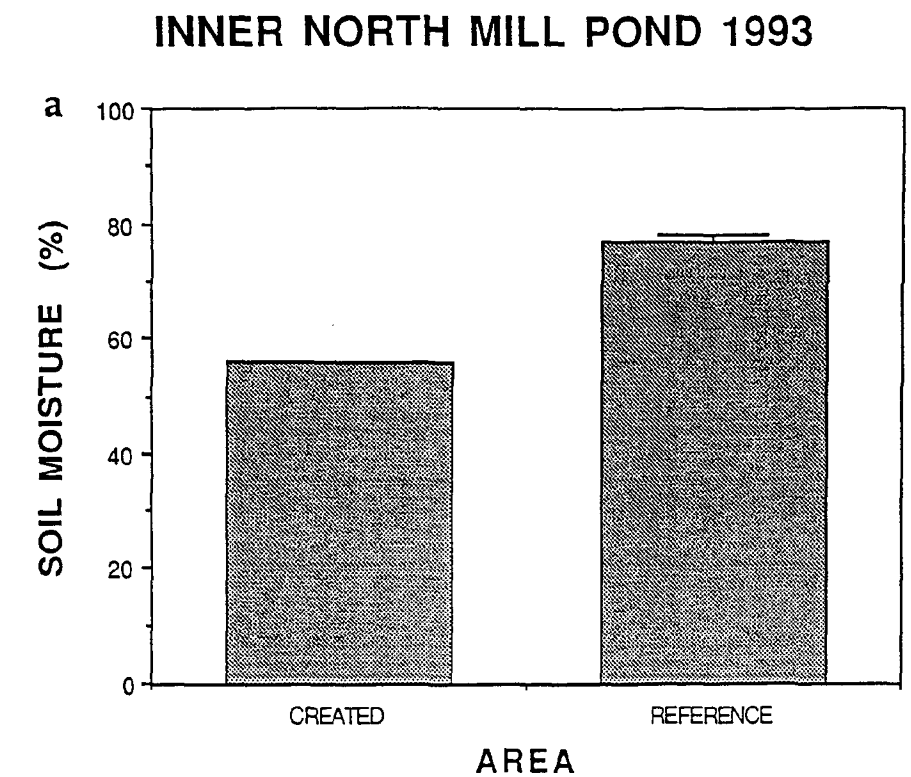


Figure 36. Inner North Mill Pond. Salinity and pH. Values are means +/- standard error for created and reference marshes. a. Soil salinity of interstitial water from 1 to 5 cm depth and well salinity from 5 to 20 cm depth. b. pH means of interstitial water from 1 to 5 cm depth.



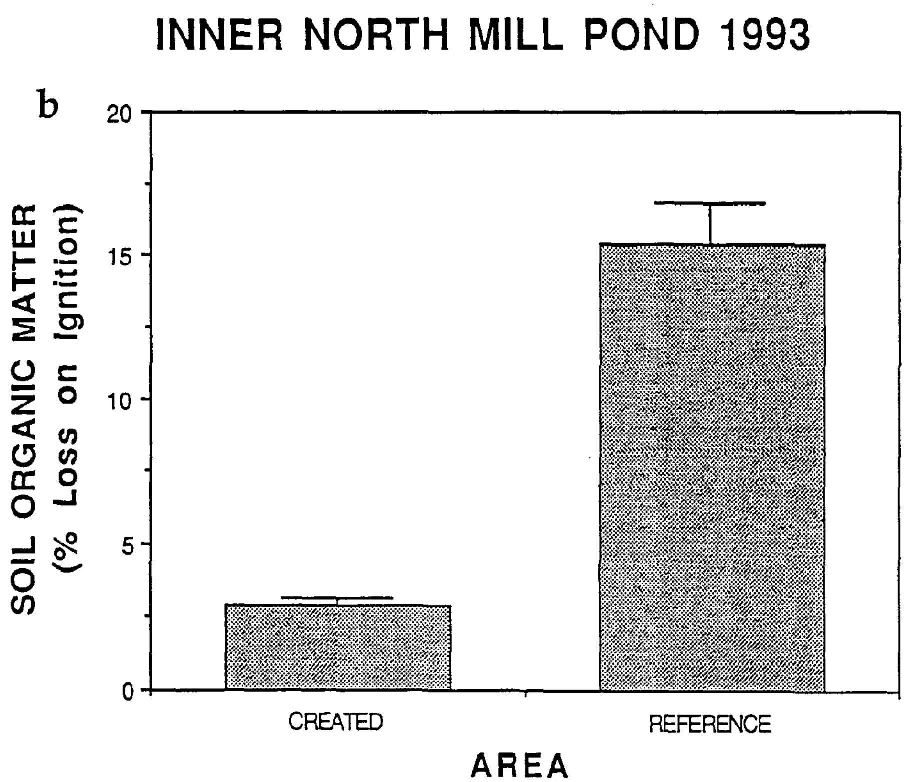


Figure 37. Inner North Mill Pond. Soil moisture reported as a percentage on a wet weight basis and organic matter reported as loss on ignition (LOI), from 1 to 5 cm depth. Values are means +/- standard error for created and reference marshes. a. Moisture means for created and reference marshes. b. Organic matter means for created and reference marshes.

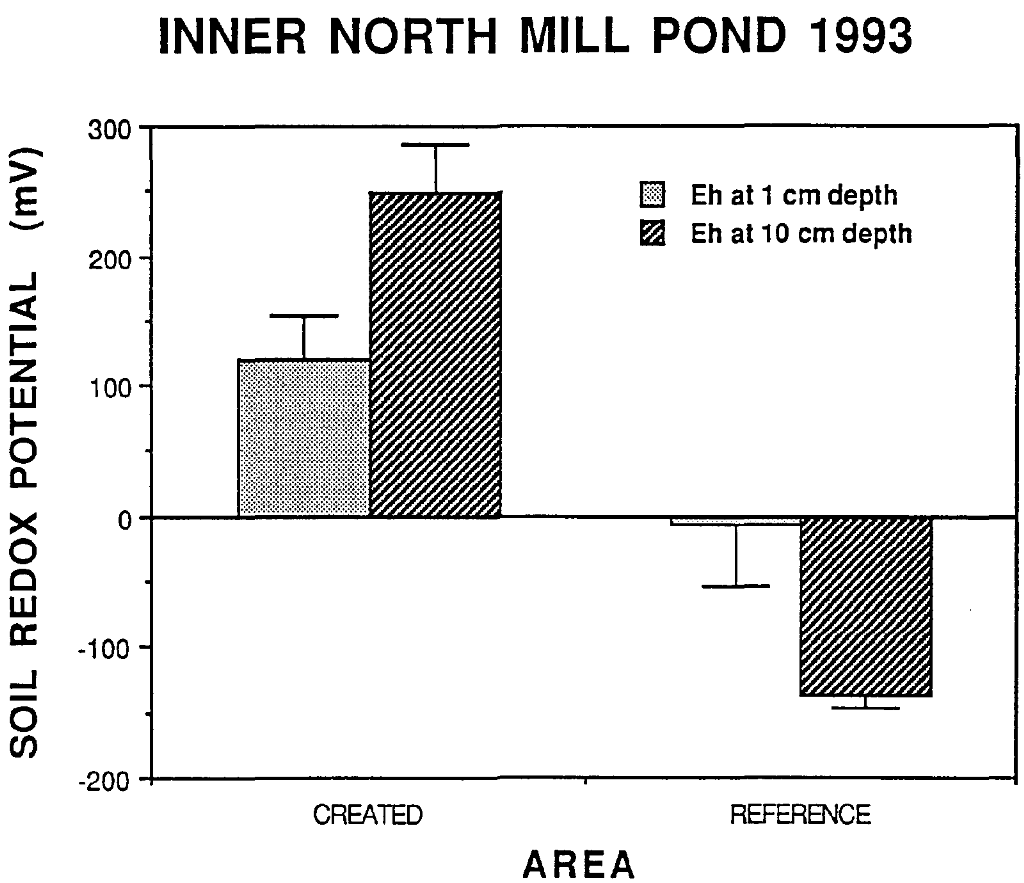


Figure 38. Inner North Mill Pond. Soil redox potential (Eh) at 1 and 10 cm depths. Values are means +/- standard error for created and reference marshes.

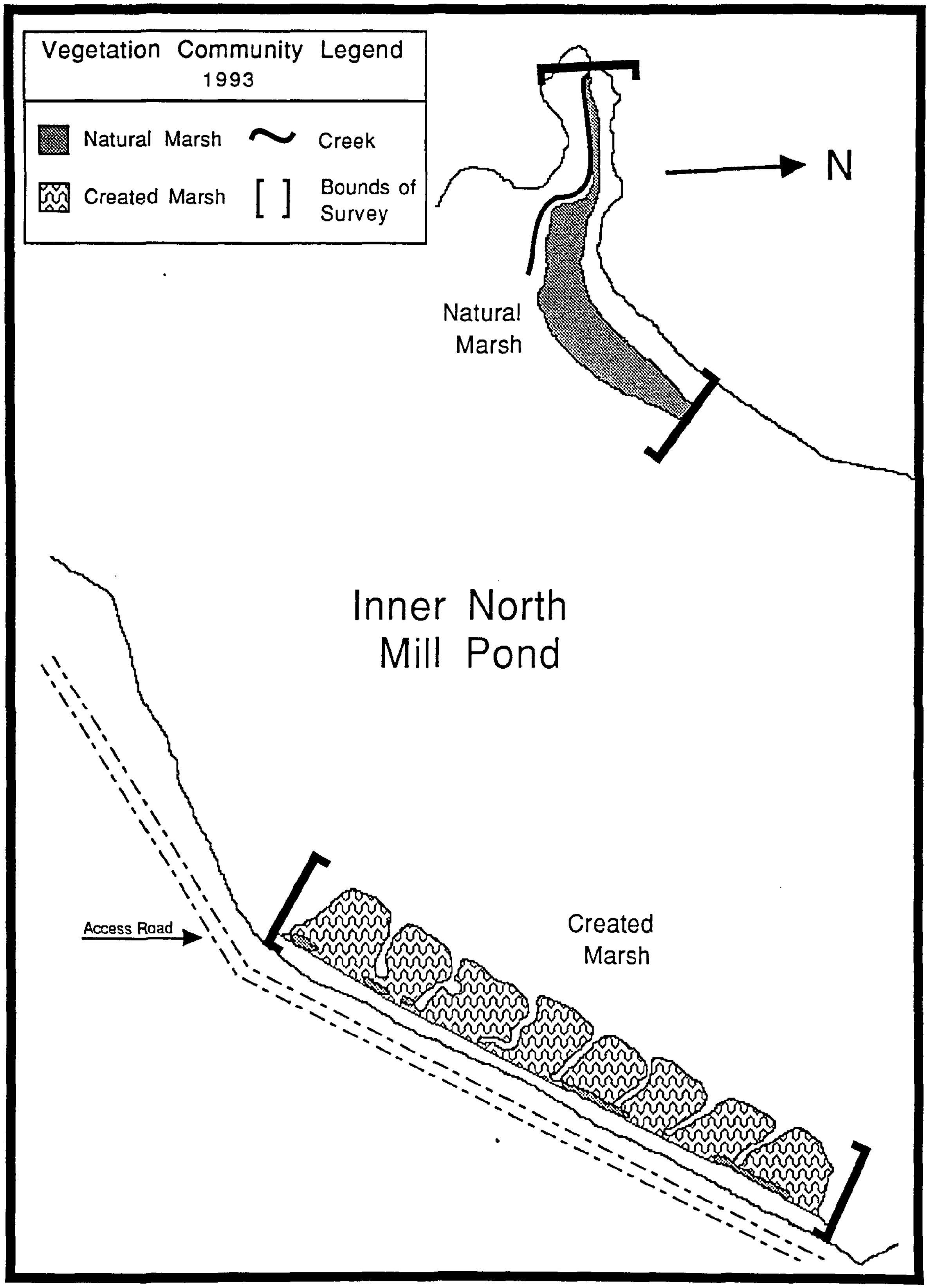


Figure 39. Inner North Mill Pond. Vegetation mapped as natural and created low marsh dominated by *S. alterniflora*, 1993.

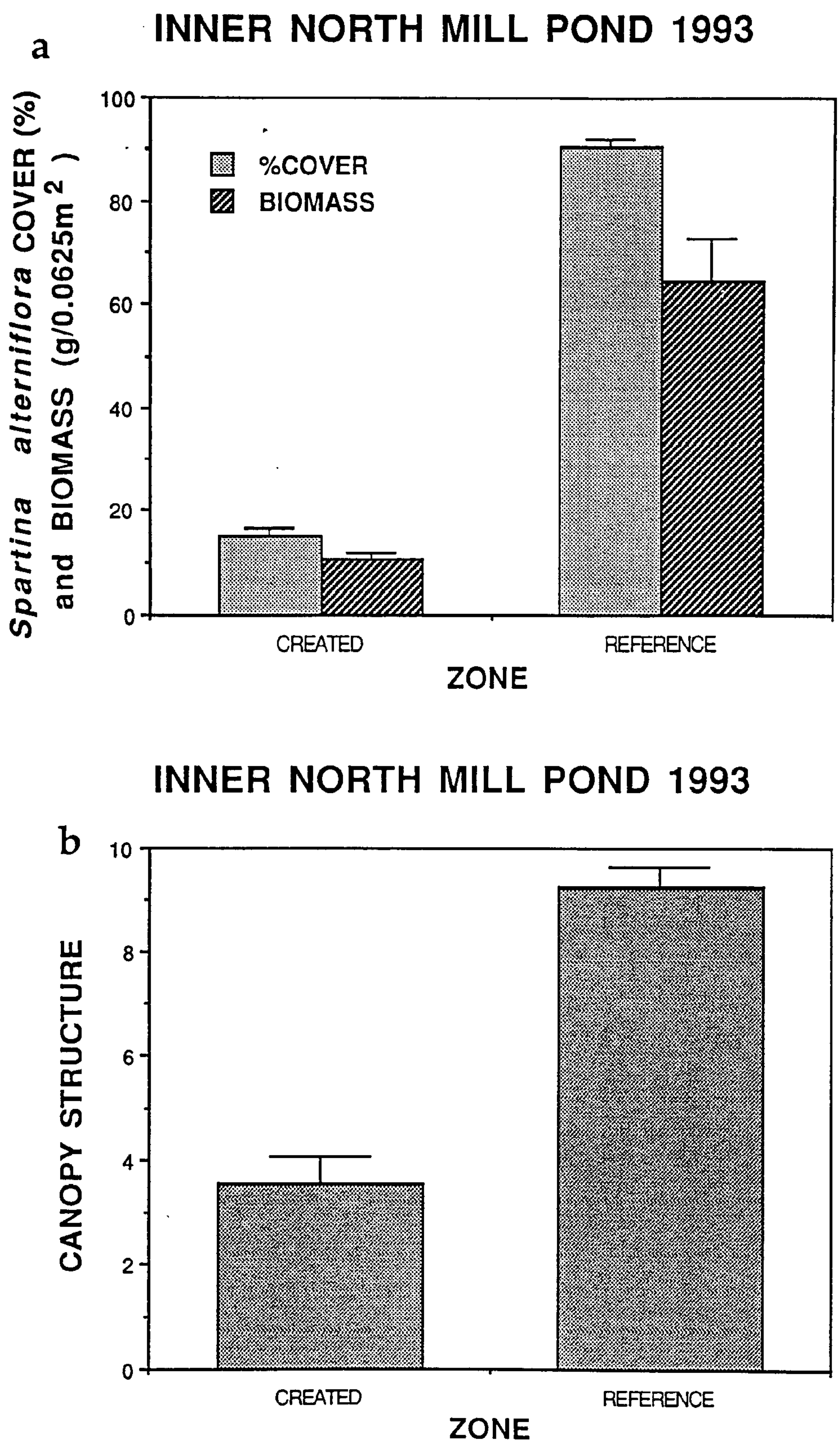


Figure 40. Inner North Mill Pond. Vegetation characteristics of created marsh compared to reference marsh, 1993. Values are means +/- standard error for created and reference marshes. a. Percentage of plant cover and biomass (end of season live standing crop) of *S. alterniflora*. b. Canopy structure.

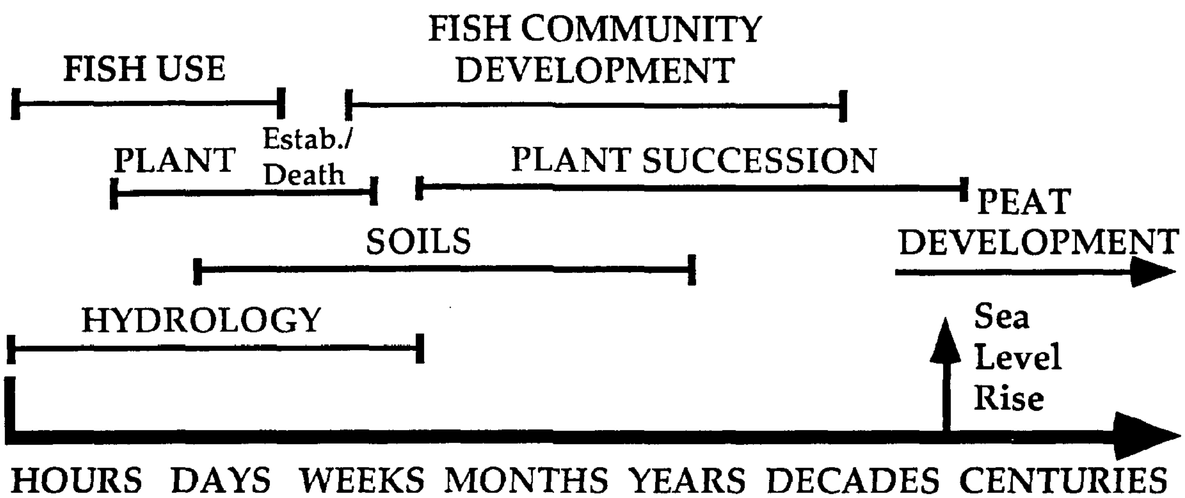


Figure 41 Chronology and ecological time scales important for assessing salt marsh restoration/creation projects.

APPENDIX I

COMMUNITY EDUCATION AND OUTREACH

New Hampshire has lost approximately half of its coastal marshes since colonial times, and many remaining marshes continue to be degraded due to human impacts and invasion by weedy plants such as Phragmites and Lythrum. Recently, it has been estimated that 20% of these impacts involve hydrological modifications to the salt marshes (SCS, 1994), now considered a form of non-point source pollution. While many people realize salt marshes are important and need protection, they rarely know why. This is because ecologists are just beginning to understand how these systems function in the coastal landscape to improve our quality of life, from water quality to fish production (Dionne 1994). How can restored marshes regain functional values to support our coastal ecosystems? As scientists we recognize the need to share our findings with students and the public.

During and after the study period, this work will provide answers and further questions to several basic research questions. Coupling our results with field trips to the sites provide hands-on case studies that make the concepts and questions of wetland alteration, restoration, and functional values come to life.

Our diverse bases (Wells National Estuarine Research Reserve, Jackson Estuarine Lab, and Departments of Plant Biology, Zoology, and Natural Resources at the University of New Hampshire) will be foci for attracting students to aid in research as well as dissemination of this information to the public.

We have used two of these sites for field trips and special projects on our course:

Coastal Wetland Restoration and Mitigation, Department of Natural Resources, NR719/819 in fall, 1993. Some of the data presented here is a direct result of those field trips.

We have used one site as a special projects course for a two-term project.
Zoology 705, Univeristy of New Hampshire.

We have had several undergraduates as paid interns, 6 undergraduate volunteers, and four high school students along with two high school teachers working on this project.

We have given the following public seminars:

Approaches to Salt Marsh Restoration and Mitigation in New Hampshire
Department of Natural Resources seminar series, James Hall, University of New Hampshire.

We have attended, and have presented our preliminary results in poster form the RARGOM regional planning conference in Boothbay Harbor, April 1994.

We plan to present the results of this project at the New England Estuarine Research Society Meeting, October, 1994.

APPENDIX II

CORRECTED, UNREDUCED DATA

AWCOMIN MARSH SAMPLING 1992									
			Temp.	Temp.	Corr.	Corr.	Soil	Soil	% Soil
Month	Well	Rep.	at 1 cm	at 10 cm	Eh 1cm	EH 10cm	Sal.	pH	Moisture
MAY	1	A	7.7	7.6	-175	-110	0	6.7	87.6
MAY	1	B	7.9	7.6	-95	-149	0	6.4	92.3
MAY	1	C	7.1		-171	-132	0	6.4	92.8
MAY	2	A	6.8	6.6	-35	-96	0	5.5	92.2
MAY	2	B	6.8	6.5	-75	98	0	6.2	91.8
MAY	2	C	6.8		39	-97	0	5.6	87.1
MAY	3	A	7.9	7.7	-68	-20	2	7.1	86.6
MAY	3	B	8.1	7.8	-164	15	2	7.1	88.3
MAY	3	C	8.7	7.7	-145	-47	3	7.0	85.1
MAY	4	A	9.3	8.4	-40	-44	4	6.4	91.4
MAY	4	B	8.9	8.5	-55	251	4	6.6	91.1
MAY	4	C	8.9	8.4	-49	47	3	6.7	90.5
MAY	5	A	6.4	6.4	-140	-63	3	6.9	89.9
MAY	5	B	6.3	6.4	-85	22	2	7.2	88.8
MAY	5	C	7.1	6.5	-89	-102	2	7.1	90.4
MAY	6	A	9.3	8.7	-37	-122	5	7.9	91.8
MAY	6	B	10.8	9.0	5	-107	7	7.6	90.1
MAY	6	C	9.7	9.0	-3	-114	8	7.4	90.8
MAY	7	A	7.3	6.9	14	-135	2	7.6	90.8
MAY	7	B	7.0	6.8	-55	-141	3	7.4	90.5
MAY	7	C	6.9	6.8	55	-155	6	7.4	89.4
MAY	8	A	7.0	6.9	100	-20	13	6.9	86.0
MAY	8	B	7.4	6.9	143	-45	12	6.9	88.2
MAY	8	C	7.1	7.0	1	-65	12	7.2	87.3
MAY	9	A	6.8	6.7	179	-85	17	7.5	83.6
MAY	9	B	6.6	6.7	143	-78	16	7.2	85.7
MAY	9	C	6.6	6.6	173	-91	13	7.1	80.7
MAY	10	A	8.0	7.7	-64	-151	2	7.4	92.1
MAY	10	B	7.5	7.6	33	-145	2	8.0	92.1
MAY	10	C	7.3	7.5	25	-116	2	7.3	91.6
JULY	2	A	17.0	15.6	278	-31	0	4.9	82.1
JULY	2	B	17.4	15.5	510	474	1	5.1	64.8
JULY	2	C	16.5	15.4	405	305	1	5.0	70.0
JULY	1	A	18.1	16.5	419	72	0	6.0	69.6
JULY	1	B	17.7	16.4	448	275	1	6.0	53.7
JULY	1	C	19.5	16.9	425	251	1	6.0	67.1
JULY	3	A	20.5	17.8	255	-60	13	5.9	72.9
JULY	3	B	20.3	17.9	265	145	13	6.0	73.3
JULY	3	C	19.9	17.9	370	-18	12	6.2	69.7
JULY	4	A	20.1	18.8	-47	186	7	6.1	85.4
JULY	4	B	20.4	18.6	220	-128	7	6.2	86.7
JULY	4	C	20.9	18.7	217	260	4	6.3	87.3
JULY	5	A	20.8	18.4	299	-12	11	6.2	79.4
JULY	5	B	20.8	18.7	225	-71	15	6.6	78.0
JULY	5	C	19.5	18.4	114	42	14	6.8	85.0

			Temp.	Temp.	Corr.	Corr.	Soil	Soil	% Soil
Month	Well	Rep.	at 1 cm	at 10 cm	Eh 1cm	EH 10cm	Sal.	pH	Moisture
JULY	6	A	21.1	20.0	-161	-43	17	6.4	83.6
JULY	6	B	21.6	20.2	383	-108	16	7.0	84.4
JULY	6	C	23.1	21.2	277	-93	17	6.0	81.3
JULY	7	A	23.5	20.0	175	-170	15	6.3	80.8
JULY	7	B	24.6	19.7	265	-171	13	6.3	83.9
JULY	7	C	23.7	19.8	301	-181	14	6.4	84.6
JULY	8	A	24.7	20.2	-91	-53	25	5.0	84.9
JULY	8	B	24.9	19.8	-73	-118	26	6.1	83.3
JULY	8	C	21.7	19.2	277	-175	25	4.9	85.1
JULY	9	A	18.4	17.4	201	89	23	6.9	83.2
JULY	9	B	17.8	17.3	225	-99	21	7.0	84.8
JULY	9	C	18.2	17.3	218	-90	22	7.2	83.4
JULY	10	A	20.2	19.0	137	-115	15	6.8	87.3
JULY	10	B	19.5	18.0	5	-135	15	6.6	88.8
JULY	10	C	20.2	19.1	275	-149	17	6.8	82.5

AWCOMIN MARSH SAMPLING 6/24/93										
			Temp.	Temp.	Corr	Corr	Soil	Soil	% Soil	%LOI
ZONE	WELL	Rep.	at 1 cm	at 10 cm	Eh 1cm	Eh 10cm	sal	pH	Moisture	
A	2	A	17.5	14.5	-142	1	31	6.1	74.9	34.5
A	2	B	16.7	14.4	-220	155	32	6.6	74.7	33.0
A	5	A	16.7	13.6	188	119	31	6.0	70.3	23.1
A	5	B	15.1	13.6	208	74	31	6.1	72.7	28.9
A	7	A	18.1	14.8	-22	193	32	6.5	74.1	25.2
A	7	B	18.5	14.8	208	218	31	6.0	75.1	31.7
B	2	A	18.0	14.8	198	-158	32	6.5	83.7	60.2
B	2	B	17.4	15.2	-137	458	31	6.5	84.7	52.6
B	5	A	19.8	15.7	23	-2	32	6.5	87.3	36.0
B	5	B	18.5	15.4	98	-12	32	5.6	68.8	21.2
B	8	A	24.5	16.4	78	18	48	6.1	79.0	54.2
B	8	B	22.3	16.9	38	-84	42	5.1	85.0	59.7
C	2	A	17.6	15.6	313	174	30	6.1	83.0	54.6
C	2	B	18.9	15.9	-112	-160	30	6.1	84.6	58.7
C	5	A	18.5	16.3	101	46	30	6.1	83.2	60.6
C	5	B	18.8	16.4	348	378	20	5.9	79.9	44.7
D	2	A	19.2	17.1	373	444	29	6.2	77.9	38.2
D	2	B	17.6	16.8	372	50	26	6.0	71.0	28.0
D	5	A	16.2	15.2	-43	224	24	6.4	74.3	31.7
D	5	B	15.9	15.4	405	68	25	6.1	65.9	20.3
F	11	A	18.4	15.2	570	327	22	5.0	74.7	54.3
F	11	B	21.6	16.0	440	623	15	5.9	75.5	76.8
F	12	A	15.9	14.6	210	121	7	6.6	57.2	17.8
F	12	B	15.3	14.7	428	156	4	5.9	76.1	57.1
E	13	A	15.3	14.6	433	95	19	6.3	67.6	22.3
E	13	B	16.1	14.6	303	103	19	6.5	77.8	38.7
E	14	A	15.9	15.6	-12	-112	14	6.5	79.9	46.8
E	14	B	15.7	15.3	90	218	13	6.1	81.1	48.6
D	15	A	14.8	13.8	409	-54	23	5.3	79.5	48.0
D	15	B	14.7	13.8	-39	70	22	6.4	76.3	38.5
D	16	A	16.8	14.9	-42	58	32	6.2	81.8	49.8
D	16	B	15.2	14.9	288	90	31	5.6	83.4	53.6
C	17	A	15.2	14.4	343	-105	31	6.7	83.7	53.8
C	17	B	16.5	14.5	362	-129	30	6.6	85.6	62.4
A	18	A	19.3	16.7	98	34	2.7	6.0	86.7	59.1
A	18	B	19.8	16.9	-142	-35	15	5.9	85.3	62.0
A	19	A	16.7	15.0	278	-12	31	6.7	84.9	45.5
A	19	B	18.0	15.2	288	-27	32	6.4	84.1	37.0
B	20	A	17.4	14.8	313	69	33	6.6	85.1	61.2
B	20	B	18.6	15.1	348	278	31	6.8	85.3	61.6

AWCOMIN MARSH SAMPLING Oct 26, 1993										
			Temp.	Temp.	Corr.	Corr.	Soil	Soil	% Soil	%LOI
Zone	Well	Rep.	at 1 cm	at 10 cm	EH 1CM	EH 10CM	Sal	pH	Moisture	
F	11	A	7.9	9.0	569	489	10.0	6.0	77.0	40.1
F	11	B	8.2	8.8	604	444	10.0	6.0	69.8	18.6
F	12	A	6.8	8.2	464	539	7.0	5.5	77.1	68.2
F	12	B	7.0	8.1	441	378	7.0	4.5	84.7	78.9
E	13	A	6.2	7.2	224	376	22.0	6.2	86.9	44.2
E	13	B	6.5	7.1	282	310	24.0	6.2	88.8	64.9
E	14	A	6.6	7.5	392	-127	20.0	6.4	80.4	23.6
E	14	B	6.7	7.4	334	302	17.0	6.2	89.0	65.7
D	15	A	6.7	7.9	344	374	22.0	6.4	84.5	49.4
D	15	B	6.6	7.6	364	-193	22.0	6.3	84.9	48.9
D	16	A	7.0	7.4	80	204	19.0	5.6	87.5	65.1
D	16	B	6.7	7.5	-106	-61	17.0	5.8	85.5	59.0
C	17	A	8.0	8.2	307	-56	26.0	6.4	87.4	66.9
C	17	B	7.5	8.0	119	-78	22.0	6.7	86.9	63.1
A	18	A	7.2	7.7	374	194	27.0	6.4	87.2	60.7
A	18	B	7.4	7.8	224	-4	25.0	5.9	87.7	59.2
A	19	A	8.7	6.9	154	139	29.0	6.5	85.6	53.0
A	19	B	7.1	6.9	294	179	28.0	7.1	84.7	47.0
B	20	A	8.1	7.7	349	154	20.0	7.6	87.2	67.2
B	20	B	6.8	7.3	402	-154	19.0	7.1	87.1	62.8
A	2	A	7.9	6.6	239	-66	29.0	6.1	80.8	34.5
A	2	B	7.5	6.5	189	244	31.0	6.7	80.5	35.8
A	5	A	8.4	6.7	214	-156	27.0	6.6	78.3	27.8
A	5	B	7.5	6.6	-96	234	30.0	6.1	78.4	31.1
A	8	A	7.6	6.3	-76	9	29.0	7.4	82.0	27.0
A	8	B	8.0	6.8	36	249	22.0	6.4	80.0	38.1
B	2	A	9.0	6.9	266	261	21.0	6.8	83.5	55.3
B	2	B	8.5	7.3	416	170	18.0	7.6	83.2	66.1
B	5	A	7.9	7.2	424	84	26.0	6.8	88.3	62.7
B	5	B	7.5	7.0	342	45	28.0	6.5	86.8	60.2
B	8	A	8.5	6.9	544	312	27.0	6.1	86.2	64.6
B	8	B	9.4	6.3	111	454	22.0	6.2	83.8	52.0
C	2	A	7.2	7.5	334	62	22.0	6.8	86.7	62.3
C	2	B	7.3	7.7	339	174	22.0	6.6	87.8	62.9
C	5	A	9.2	7.6	373	230	18.0	6.5	84.6	63.5
C	5	B	10.1	7.7	417	116	14.0	6.6	85.6	70.9
D	2	A	8.5	7.4	389	244	22.0	5.9	83.8	47.0
D	2	B	8.5	7.2	319	450	22.0	6.0	85.6	48.3
D	5	A	9.5	7.7	14	-42	27.0	6.3	81.8	37.7
D	5	B	7.8	7.8	314	326	24.0	6.4	77.7	25.6

AWCOMIN MARSH % COVER					
MARSH	ZONE	WELL	DATE	SPECIES	PERCENT
AM	A	1	7/29/93	SA	5
AM	A	1	7/29/93	SP	70
AM	A	2	7/29/93	SA	15
AM	A	2	7/29/93	SP	100
AM	A	3	7/29/93	SA	5
AM	A	3	7/29/93	SP	80
AM	A	4	7/29/93	AP	4
AM	A	4	7/29/93	SA	12
AM	A	4	7/29/93	SE	3
AM	A	4	7/29/93	SP	80
AM	A	5	7/29/93	AP	10
AM	A	5	7/29/93	SA	10
AM	A	5	7/29/93	SP	100
AM	A	6	7/29/93	AP	10
AM	A	6	7/29/93	SA	15
AM	A	6	7/29/93	SP	75
AM	A	7	7/29/93	AP	3
AM	A	7	7/29/93	SE	1
AM	A	7	7/29/93	SP	100
AM	A	8	7/29/93	AP	1
AM	A	8	7/29/93	SP	95
AM	A	9	7/29/93	AP	1
AM	A	9	7/29/93	SP	100
AM	B	1	7/29/93	AP	5
AM	B	1	7/29/93	Or2	5
AM	B	1	7/29/93	SA	50
AM	B	1	7/29/93	SE	20
AM	B	1	7/29/93	SM	2
AM	B	2	7/29/93	AP	2
AM	B	2	7/29/93	SA	40
AM	B	2	7/29/93	SP	30
AM	B	3	7/29/93	AP	2
AM	B	3	7/29/93	SA	30
AM	B	3	7/29/93	SP	50
AM	B	4	7/29/93	SA	40
AM	B	4	7/29/93	SP	20
AM	B	5	7/29/93	AP	5
AM	B	5	7/29/93	SA	70
AM	B	5	7/29/93	SE	15
AM	B	6	7/29/93	AP	2
AM	B	6	7/29/93	P	10
AM	B	6	7/29/93	SA	50
AM	B	6	7/29/93	SE	5
AM	B	6	7/29/93	SL	2
AM	B	6	7/29/93	SP	30
AM	B	7	7/9/93	AP	7
AM	B	7	7/9/93	AP	7
AM	B	7	7/9/93	LN	2
AM	B	7	7/9/93	SA	2
AM	B	7	7/9/93	SE	15
AM	B	7	7/9/93	SM	5
AM	B	7	7/9/93	SP	12
AM	B	8	7/29/93	AP	40
AM	B	8	7/29/93	SA	5
AM	B	8	7/29/93	SE	40
AM	B	8	7/29/93	SL	5
AM	B	8	7/29/93	SP	5
AM	B	9	7/29/93	AP	1

MARSH	ZONE	WELL	DATE	SPECIES	PERCENT
AM	B	9	7/29/93	SA	8
AM	B	9	7/29/93	SE	3
AM	B	9	7/29/93	SP	15
AM	C	1	7/29/93	AP	5
AM	C	1	7/29/93	SA	40
AM	C	1	7/29/93	SE	2
AM	C	1	7/29/93	SL	1
AM	C	1	7/29/93	SP	40
AM	C	2	7/29/93	AP	5
AM	C	2	7/29/93	SA	10
AM	C	2	7/29/93	SE	1
AM	C	2	7/29/93	SP	70
AM	C	3	7/29/93	AP	2
AM	C	3	7/29/93	SA	35
AM	C	3	7/29/93	SP	50
AM	C	4	7/29/93	AP	3
AM	C	4	7/29/93	SA	75
AM	C	4	7/29/93	SE	15
AM	C	4	7/29/93	SL	1
AM	C	4	7/29/93	SP	10
AM	C	5	7/29/93	AP	1
AM	C	5	7/29/93	SA	1
AM	C	5	7/29/93	SP	70
AM	C	6	7/21/93	AP	2
AM	C	6	7/21/93	SA	40
AM	C	6	7/21/93	SE	1
AM	C	6	7/21/93	SL	1
AM	C	6	7/21/93	SP	30
AM	D	1	7/29/93	AP	7
AM	D	1	7/29/93	SA	10
AM	D	1	7/29/93	SP	100
AM	D	2	7/29/93	P	30
AM	D	2	7/29/93	SA	30
AM	D	2	7/29/93	SE	10
AM	D	2	7/29/93	SP	30
AM	D	3	7/29/93	LN	1
AM	D	3	7/29/93	P	20
AM	D	3	7/29/93	SA	30
AM	D	3	7/29/93	SE	1
AM	D	3	7/29/93	SP	60
AM	D	4	7/29/93	Gr1	10
AM	D	4	7/29/93	SA	1
AM	D	4	7/29/93	SP	90
AM	D	5	7/29/93	AP	1
AM	D	5	7/29/93	Gr1	10
AM	D	5	7/29/93	SP	80
AM	D	6	7/29/93	SP	100
AM	F	11	7/29/93	AP	2
AM	F	11	7/29/93	H1	10
AM	F	11	7/29/93	Or3	10
AM	F	11	7/29/93	P	1
AM	B	10	7/29/93	SA	30
AM	B	10	7/29/93	SP	40
AM	B	10	7/29/93	AP	2
AM	F	12	7/29/93	AP	15
AM	F	12	7/29/93	P	60
AM	F	12	7/29/93	Ru	5
AM	F	12	7/29/93	SPp	5
AM	F	12	7/29/93	URB1	5

MARSH	Zone	WELL	DATE	SPECIES	PERCENT
AM	F	12	7/29/93	URB2	5
AM	E	13	7/29/93	AP	10
AM	E	13	7/29/93	P	40
AM	E	14	7/29/93	AP	10
AM	E	14	7/29/93	JG	5
AM	E	14	7/29/93	P	60
AM	E	14	7/29/93	SP	10
AM	D	15	7/29/93	Or2	1
AM	D	15	7/29/93	P	35
AM	D	15	7/29/93	SA	20
AM	D	15	7/29/93	SP	40
AM	D	16	7/29/93	AP	5
AM	D	16	7/29/93	P	20
AM	D	16	7/29/93	SA	25
AM	D	16	7/29/93	SP	50
AM	C	17	7/29/93	SA	15
AM	C	17	7/29/93	SP	55
AM	A	18	7/29/93	PM	5
AM	A	18	7/29/93	SA	10
AM	A	18	7/29/93	SP	70
AM	A	18	7/29/93	TM	5
AM	A	19	7/29/93	AP	3
AM	A	19	7/29/93	SA	40
AM	A	19	7/29/93	SE	2
AM	A	19	7/29/93	SP	40

AWCOMIN MARSH % COVER					
MARSH	ZONE	STATION	DATE	SPECIES	PERCENT
AM	A	1	6/15/94	SA	1
AM	A	1	6/15/94	SP	70
AM	A	1	6/15/94	SE	2
AM	A	1	6/15/94	LN	1
AM	A	1	6/15/94	BG	10
AM	A	1	6/15/94	DTR	5
AM	A	1	6/15/94	AP	1
AM	A	2	6/15/94	SA	7
AM	A	2	6/15/94	SP	85
AM	A	2	6/15/94	DTR	8
AM	A	3	6/15/94	SA	10
AM	A	3	6/15/94	SP	75
AM	A	3	6/15/94	BG	5
AM	A	3	6/15/94	DTR	10
AM	A	4	6/15/94	SA	10
AM	A	4	6/15/94	SP	80
AM	A	4	6/15/94	AP	1
AM	A	4	6/15/94	DTR	9
AM	A	5	6/15/94	SA	10
AM	A	5	6/15/94	SP	80
AM	A	5	6/15/94	AP	1
AM	A	5	6/15/94	DTR	9
AM	A	6	6/15/94	SA	20
AM	A	6	6/15/94	SP	60
AM	A	6	6/15/94	AP	5
AM	A	6	6/15/94	LN	1
AM	A	6	6/15/94	BG	5
AM	A	6	6/15/94	DTR	9
AM	A	7	6/15/94	SP	85
AM	A	7	6/15/94	SE	3
AM	A	7	6/15/94	AP	1
AM	A	7	6/15/94	LN	1
AM	A	7	6/15/94	DTR	10
AM	A	8	6/15/94	SP	90
AM	A	8	6/15/94	SE	1
AM	A	8	6/15/94	AP	1
AM	A	8	6/15/94	DTR	8
AM	A	9	6/15/94	SP	85
AM	A	9	6/15/94	AP	1
AM	A	9	6/15/94	DTR	14
AM	B	1	6/15/94	SA	50
AM	B	1	6/15/94	SE	30
AM	B	1	6/15/94	AP	1
AM	B	1	6/15/94	DTR	15
AM	B	1	6/15/94	BG	5
AM	B	2	6/15/94	SA	40
AM	B	2	6/15/94	SP	30
AM	B	2	6/15/94	SE	10
AM	B	2	6/15/94	AP	1
AM	B	2	6/15/94	DTR	19
AM	B	3	6/15/94	SA	30
AM	B	3	6/15/94	SP	40
AM	B	3	6/15/94	SE	3
AM	B	3	6/15/94	AP	1
AM	B	3	6/15/94	DTR	26
AM	B	4	6/15/94	SA	30
AM	B	4	6/15/94	SP	40
AM	B	4	6/15/94	SE	3

MARSH	ZONE	STATION	DATE	SPECIES	PERCENT
AM	B	4	6/15/94	AP	5
AM	B	4	6/15/94	DTR	22
AM	B	5	6/15/94	SA	50
AM	B	5	6/15/94	SP	5
AM	B	5	6/15/94	SE	20
AM	B	5	6/15/94	AP	10
AM	B	5	6/15/94	DTR	10
AM	B	5	6/15/94	BG	5
AM	B	6	6/15/94	SA	15
AM	B	6	6/15/94	SP	70
AM	B	6	6/15/94	SE	3
AM	B	6	6/15/94	AP	2
AM	B	6	6/15/94	P	5
AM	B	6	6/15/94	DTR	5
AM	B	7	6/15/94	SA	70
AM	B	7	6/15/94	SE	15
AM	B	7	6/15/94	AP	5
AM	B	7	6/15/94	LN	1
AM	B	7	6/15/94	DTR	5
AM	B	7	6/15/94	BG	4
AM	B	8	6/15/94	SA	10
AM	B	8	6/15/94	SE	50
AM	B	8	6/15/94	AP	1
AM	B	8	6/15/94	PV	15
AM	B	8	6/15/94	BG	20
AM	B	8	6/15/94	DTR	4
AM	B	9	6/15/94	SA	10
AM	B	9	6/15/94	SP	15
AM	B	9	6/15/94	SM	3
AM	B	9	6/15/94	SE	40
AM	B	9	6/15/94	AP	5
AM	B	9	6/15/94	PV	5
AM	B	9	6/15/94	LN	2
AM	B	9	6/15/94	S	1
AM	B	9	6/15/94	BG	19
AM	C	1	6/15/94	SA	30
AM	C	1	6/15/94	SP	45
AM	C	1	6/15/94	SE	5
AM	C	1	6/15/94	AP	5
AM	C	1	6/15/94	PV	5
AM	C	1	6/15/94	DTR	10
AM	C	2	6/15/94	SA	20
AM	C	2	6/15/94	SP	60
AM	C	2	6/15/94	SE	7
AM	C	2	6/15/94	AP	5
AM	C	2	6/15/94	LN	1
AM	C	2	6/15/94	DTR	7
AM	C	3	6/15/94	SA	10
AM	C	3	6/15/94	SP	70
AM	C	3	6/15/94	SE	3
AM	C	3	6/15/94	AP	7
AM	C	3	6/15/94	DTR	10
AM	C	4	6/15/94	SA	55
AM	C	4	6/15/94	SE	25
AM	C	4	6/15/94	AP	10
AM	C	4	6/15/94	DTR	10
AM	C	5	6/15/94	SA	5
AM	C	5	6/15/94	SP	75
AM	C	5	6/15/94	SE	1

MARSH	ZONE	STATION	DATE	SPECIES	PERCENT
AM	C	5	6/15/94	AP	5
AM	C	5	6/15/94	DTR	14
AM	C	6	6/15/94	SA	20
AM	C	6	6/15/94	SP	60
AM	C	6	6/15/94	SM	1
AM	C	6	6/15/94	SE	2
AM	C	6	6/15/94	AP	5
AM	C	6	6/15/94	DTR	12
AM	D	1	6/15/94	SA	5
AM	D	1	6/15/94	SP	80
AM	D	1	6/15/94	AP	3
AM	D	1	6/15/94	DTR	12
AM	D	2	6/15/94	SA	45
AM	D	2	6/15/94	SP	20
AM	D	2	6/15/94	SE	20
AM	D	2	6/15/94	AP	1
AM	D	2	6/15/94	P	5
AM	D	2	6/15/94	DTR	6
AM	D	2	6/15/94	BG	3
AM	D	3	6/15/94	SA	20
AM	D	3	6/15/94	SP	30
AM	D	3	6/15/94	JG	35
AM	D	3	6/15/94	SE	5
AM	D	3	6/15/94	AP	1
AM	D	3	6/15/94	DTR	9
AM	D	4	6/15/94	SA	75
AM	D	4	6/15/94	AP	5
AM	D	4	6/15/94	Sas	5
AM	D	4	6/15/94	DTR	15
AM	D	5	6/15/94	SP	60
AM	D	5	6/15/94	JG	15
AM	D	5	6/15/94	SM	7
AM	D	5	6/15/94	SE	1
AM	D	5	6/15/94	AP	8
AM	D	5	6/15/94	DTR	9
AM	D	6	6/15/94	SP	80
AM	D	6	6/15/94	SE	5
AM	D	6	6/15/94	AP	1
AM	D	6	6/15/94	DTR	14
AM	F	11	6/15/94	SE	1
AM	F	11	6/15/94	BG	99
AM	F	12	6/15/94	SE	1
AM	F	12	6/15/94	BG	99
AM	E	13	6/15/94	P	15
AM	E	13	6/15/94	DTR	85
AM	E	14	6/15/94	JG	3
AM	E	14	6/15/94	SE	1
AM	E	14	6/15/94	P	15
AM	E	14	6/15/94	DTR	81
AM	D	15	6/15/94	SA	5
AM	D	15	6/15/94	SP	20
AM	D	15	6/15/94	JG	20
AM	D	15	6/15/94	P	5
AM	D	15	6/15/94	WP	10
AM	D	15	6/15/94	Wr	10
AM	D	15	6/15/94	DTR	30
AM	D	16	6/15/94	SA	10
AM	D	16	6/15/94	SP	60
AM	D	16	6/15/94	SE	1

MARSH	ZONE	STATION	DATE	SPECIES	PERCENT
AM	D	16	6/15/94	AP	1
AM	D	16	6/15/94	P	5
AM	D	16	6/15/94	DTR	23
AM	C	17	6/15/94	SA	15
AM	C	17	6/15/94	SP	65
AM	C	17	6/15/94	SE	1
AM	C	17	6/15/94	AP	5
AM	C	17	6/15/94	DTR	14
AM	A	18	6/15/94	SA	15
AM	A	18	6/15/94	SP	50
AM	A	18	6/15/94	PM	2
AM	A	18	6/15/94	TM	10
AM	A	18	6/15/94	SE	1
AM	A	18	6/15/94	AP	1
AM	A	18	6/15/94	DTR	21
AM	A	19	6/15/94	SA	20
AM	A	19	6/15/94	SP	50
AM	A	19	6/15/94	SE	2
AM	A	19	6/15/94	AP	5
AM	A	19	6/15/94	DTR	23
AM	B	20	6/15/94	SA	30
AM	B	20	6/15/94	SP	50
AM	B	20	6/15/94	SE	7
AM	B	20	6/15/94	AP	7
AM	B	20	6/15/94	DTR	6

AWCOMIN MARSH 1992 % HARVEST											
MARSH	ZONE	STATION	DATE	SPECIES	# V. STEM	# V. LEAF	# R. STEM	# R. LEAF	AVE. STEM HT	X LEAF	BIOMASS
AM	A	1	7/16/92	SP	398	.	.	.	16.95	.	13.9
AM	A	2	7/16/92	SP	417	.	.	.	19.08	.	17.2
AM	A	2	7/16/92	SA	1	.	.	.	.	.	.
AM	A	2	7/16/92	Ot	1	.	.	.	.	.	.
AM	A	3	7/16/92	SP	285	.	.	.	25.72	.	14.6
AM	A	4	7/16/92	SP	472	.	.	.	19.47	.	13.2
AM	A	4	7/16/92	SA	9	.	.	.	.	.	2.6
AM	A	4	7/16/92	LN	1	.	.	.	.	.	.
AM	A	5	7/16/92	SP	418	.	.	.	18.78	.	10.2
AM	A	5	7/16/92	SA	7	.	.	.	.	.	4.3
AM	A	5	7/16/92	PLS	45	.	.	.	.	.	.
AM	A	5	7/16/92	Ot	1	.	.	.	.	.	.
AM	A	5	7/16/92	LN	2	.	.	.	.	.	.
AM	A	5	7/16/92	SE	11	.	.	.	.	.	.
AM	A	6	7/16/92	SP	417	.	.	.	24.33	.	17.9
AM	A	7	7/16/92	SP	366	.	.	.	21.05	.	14.1
AM	A	8	7/16/92	SP	604	.	.	.	19.04	.	19.4
AM	A	9	7/16/92	SP	487	.	.	.	22.24	.	20.9
AM	B	1	7/16/92	SA	25	.	.	.	43.25	.	12
AM	B	1	7/16/92	AP	1	.	.	.	18	.	1.1
AM	B	1	7/16/92	SE	19	.	.	.	21.5	.	.
AM	B	2	7/16/92	SP	293	.	.	.	36.59	.	18.5
AM	B	2	7/16/92	SA	21	.	.	.	53.75	.	29.1
AM	B	2	7/16/92	SE	4	.	.	.	10	.	.
AM	B	3	7/16/92	SP	59	.	.	.	34.2	.	3.3
AM	B	3	7/16/92	SA	59	.	.	.	35.4	.	18.7
AM	B	4	7/16/92	SP	235	.	.	.	22.96	.	11.1
AM	B	4	7/16/92	SA	15	.	.	.	33.5	.	5.7
AM	B	5	7/16/92	SP	3	.	.	.	34.5	.	0.1
AM	B	5	7/16/92	SA	54	.	.	.	43.7	.	29.6
AM	B	6	7/16/92	SP	159	.	.	.	32.97	.	12.2
AM	B	6	7/16/92	SA	35	.	.	.	32.84	.	13.9
AM	B	7	7/16/92	SP	233	.	.	.	29.83	.	12.6
AM	B	7	7/16/92	SA	29	.	.	.	38.25	.	5.5
AM	B	7	7/16/92	AP	1	.	.	.	19	.	0.1
AM	B	8	7/16/92	SP	219	.	.	.	36.6	.	20.9
AM	B	8	7/16/92	SA	32	.	.	.	56.67	.	22.6
AM	B	9	7/16/92	SA	45	.	.	.	39.88	.	22.8

MARSH	ZONE	STATION	DATE	SPECIES	# V. STEM	# V. LEAF	# R. STEM	# R. LEAF	AVE. STEM HT	X LEAF	BIOMASS
AM	C	1	7/16/92	SP	28	.	.	.	20.61	.	10.9
AM	C	1	7/16/92	SA	19	.	.	.	37.5	.	4.8
AM	C	2	7/16/92	SP	170	.	.	.	27.33	.	9.6
AM	C	2	7/16/92	SA	13	.	.	.	35.5	.	4.8
AM	C	3	7/16/92	SP	185	.	.	.	24.84	.	13.9
AM	C	3	7/16/92	SA	19	.	.	.	34.5	.	3.7
AM	C	4	7/16/92	SA	35	.	.	.	33.67	.	14.5
AM	C	5	7/16/92	SP	139	.	.	.	24.31	.	8
AM	C	5	7/16/92	SA	9	.	.	.	31.5	.	1.5
AM	C	6	7/16/92	SP	120	.	.	.	25	.	6.8
AM	C	6	7/16/92	SA	20	.	.	.	27.75	.	4.7

AWCOMIN MARSH 1993 % HARVEST												
MARSH	ZONE	STATION	DATE	SPECIES	TYPE	# V. STEM	# V. LEAVES	# R. STEMS	# R. LEAVES	AVE. STEM HT	X LEAF	BIOMASS
AM	A	4	7/29/93	AP	O	9	.	.	.	.	.	0.3
AM	A	5	7/29/93	AP	O	1	.	.	.	.	.	0.8
AM	A	6	7/29/93	AP	O	3	.	.	.	24.17	.	0.4
AM	A	1	7/29/93	DS	O	2	.	.	.	19.95	8	0.1
AM	A	1	7/29/93	SA	SA	6	.	1	.	20.617	3.167	2.4
AM	A	2	7/29/93	SA	SA	2	4	.	.	30.85	.	1.9
AM	A	4	7/29/93	SA	SA	1	1	.	.	.	.	0.8
AM	A	5	7/29/93	SA	SA	2	0	.	.	49.6	.	1.6
AM	A	19	7/29/93	SA	SA	7	3	.	.	39.786	4.286	4.1
AM	A	5	7/29/93	SE	SE	1	.	.	.	17.2	.	0
AM	A	6	7/29/93	SE	SE	1	.	.	.	22.5	.	0
AM	A	9	7/29/93	SE	SE	2	.	.	.	8.7	.	0
AM	A	1	7/29/93	SP	SP	316	.	12	.	19.18	.	13.1
AM	A	2	7/29/93	SP	SP	549	.	.	.	23.4	.	23.8
AM	A	3	7/29/93	SP	SP	381	.	1	.	25.13	.	25.3
AM	A	4	7/29/93	SP	SP	420	.	2	.	31.73	.	22
AM	A	5	7/29/93	SP	SP	314	.	1	.	31.69	.	15.8
AM	A	6	7/29/93	SP	SP	156	.	.	.	29.66	.	10.3
AM	A	7	7/29/93	SP	SP	279	.	16	.	30.42	.	21.9
AM	A	8	7/29/93	SP	SP	401	.	47	.	28.48	.	34.7
AM	A	18	7/29/93	SP	SP	79	.	.	.	25.89	.	9
AM	A	9	7/29/93	SP	SP	299	.	2	.	25.91	.	19.1
AM	A	19	7/29/93	SP	SP	62	.	.	.	25.95	.	2.8
AM	B	10	7/29/93	AP	O	1	.	.	.	18.1	.	0
AM	B	6	7/29/93	AP	O	1	.	.	.	17.4	.	0.1
AM	B	8	7/29/93	AP	O	68	.	.	.	6.94	.	7.2
AM	B	7	7/29/93	LC	O	1	.	.	.	4.2	.	0
AM	B	1	7/29/93	SA	SA	19	35	.	.	38.14	.	13.8
AM	B	10	7/29/93	SA	SA	16	.	.	.	42.76	.	7.2
AM	B	2	7/29/93	SA	SA	10	39	.	.	36.45	.	8.4
AM	B	3	7/29/93	SA	SA	25	11	.	.	33.95	.	8.5
AM	B	4	7/29/93	SA	SA	29	7	.	.	32.8	.	9.2
AM	B	5	7/29/93	SA	SA	37	4	.	.	35.53	.	21.4
AM	B	6	7/29/93	SA	SA	43	18	.	.	29.4	.	11
AM	B	9	7/29/93	SA	SA	7	6	.	.	27.957	4.286	3.9
AM	B	1	7/29/93	SE	SE	72	.	.	.	10.88	.	1.8
AM	B	10	7/29/93	SE	SE	6	.	.	.	13.35	.	0.1
AM	B	5	7/29/93	SE	SE	4	.	.	.	19	.	0.3

MARSH	ZONE	STATION	DATE	SPECIES	TYPE	# V. STEM	# V. LEAVES	# R. STEMS	# R. LEAVES	AVE. STEM HT	X LEAF	BIOMASS
AM	B	6	7/29/93	SE	SE	4	.	.	.	15.6	.	0.1
AM	B	7	7/29/93	SE	SE	1	.	.	.	6.9	.	0
AM	B	8	7/29/93	SE	SE	3	.	.	.	16.63	.	1.7
AM	B	10	7/29/93	SP	SP	149	.	.	.	28.32	.	8.1
AM	B	2	7/29/93	SP	SP	69	.	1	.	28.44	.	6.4
AM	B	3	7/29/93	SP	SP	87	.	6	.	24.69	.	6.8
AM	B	4	7/29/93	SP	SP	108	.	.	.	25.31	.	4.9
AM	B	6	7/29/93	SP	SP	110	.	2	.	21.97	.	5.1
AM	B	7	7/29/93	SP	SP	27	.	.	.	8.7	3	0.4
AM	B	8	7/29/93	SP	SP	5	.	.	.	11.5	2	0.1
AM	C	2	7/29/93	AP	O	11	.	.	.	18.03	.	0.9
AM	C	5	7/29/93	AP	O	3	.	.	.	4.93	.	0.1
AM	C	6	7/29/93	AP	O	2	.	.	.	13.7	.	0
AM	C	1	7/29/93	SA	SA	.	33	.	.	27.18	.	6.4
AM	C	2	7/29/93	SA	SA	9	3	.	.	31.733	4	2.5
AM	C	3	7/29/93	SA	SA	5	5	.	.	32.7	3.8	3.1
AM	C	4	7/29/93	SA	SA	81	12	5	.	20.64	.	8.9
AM	C	5	7/29/93	SA	SA	1	.	.	.	34	5	0.3
AM	C	6	7/29/93	SA	SA	20	4	.	.	28.54	.	6.5
AM	C	17	7/29/93	SA	SA	6	2	.	.	30.9	.	0.9
AM	C	2	7/29/93	SE	SE	2	.	.	.	4.95	.	0
AM	C	3	7/29/93	SE	SE	1	.	.	.	8.4	.	0
AM	C	4	7/29/93	SE	SE	8	.	.	.	18.588	.	1.2
AM	C	6	7/29/93	SE	SE	6	.	.	.	11.75	.	0.2
AM	C	1	7/29/93	SP	SP	122	.	.	.	26.97	.	7.8
AM	C	2	7/29/93	SP	SP	108	.	9	.	24.74	.	7.4
AM	C	3	7/29/93	SP	SP	198	.	10	.	23.65	.	12.5
AM	C	5	7/29/93	SP	SP	161	.	1	.	21.89	.	8.9
AM	C	6	7/29/93	SP	SP	88	.	2	.	21.99	.	5.6
AM	C	17	7/29/93	SP	SP	125	.	.	.	29.46	.	5.1
AM	D	2	7/29/93	AP	O	2	.	.	.	6.65	.	0
AM	D	15	7/29/93	AP	O	2	.	.	.	11.8	.	0.1
AM	D	2	7/29/93	P	P	7	2	.	.	46.143	7.286	5.8
AM	D	3	7/29/93	P	P	6	.	.	.	.	.	18
AM	D	15	7/29/93	P	P	4	.	.	.	79.85	.	8.1
AM	D	16	7/29/93	P	P	2	.	.	.	61.75	.	3.1
AM	D	1	7/29/93	SA	SA	1	2	.	.	35.9	5	0.9
AM	D	2	7/29/93	SA	SA	36	13	3	.	28.62	.	12.5
AM	D	3	7/29/93	SA	SA	.	37	.	.	35.49	.	11.9

MARSH	ZONE	STATION	DATE	SPECIES	TYPE	# V. STEM	# V. LEAVES	# R. STEMS	# R. LEAVES	AVE. STEM HT	X LEAF	BIOMASS
AM	D	15	7/29/93	SA	SA	10	8	.	.	27.43	6.6	1.4
AM	D	16	7/29/93	SA	SA	10	9	.	.	46.17	4.2	7.4
AM	D	2	7/29/93	SE	SE	154	.	.	.	14.79	.	4.9
AM	D	3	7/29/93	SE	SE	17	.	.	.	11.17	.	0.3
AM	D	1	7/29/93	SP	SP	298	.	6	.	22.48	.	19.2
AM	D	2	7/29/93	SP	SP	189	.	30	.	21.62	.	12.1
AM	D	3	7/29/93	SP	SP	41	.	2	.	34.52	.	5.8
AM	D	4	7/29/93	SP	SP	170	.	7	.	26.41	.	11
AM	D	5	7/29/93	SP	SP	102	.	9	.	28.12	.	11.7
AM	D	15	7/29/93	SP	SP	129	.	23	.	26.98	.	12.7
AM	D	16	7/29/93	SP	SP	285	.	24	.	28.85	.	20.1
AM	D	16	7/29/93	SP	SP	281	.	4	.	38.17	.	21.2
AM	D	2	7/29/93	TM	O	1	.	.	.	15.1	2	0
AM	E	13	7/29/93	AP	O	2	.	.	.	19	.	0.6
AM	E	14	7/29/93	AP	O	3	.	.	.	18.467	.	0.1
AM	E	13	7/29/93	P	P	7	.	.	.	101.757	.	33.6
AM	E	14	7/29/93	P	P	2	.	.	.	137.2	.	12.5
AM	E	14	7/29/93	JG	O	6	8	.	.	44.517	3.5	1.6
AM	F	12	7/29/93	AP	O	2	.	.	.	7.75	.	0.1
AM	F	12	7/29/93	P	P	11	.	.	.	92.9	.	23.5
AM	F	11	7/29/93	SPP	SPP	11	6	.	.	50.81	.	9.6
AM	F	12	7/29/93	SPP	SPP	4	1	.	.	12.775	4.5	0.1

MARSH SAMPLING STUART FARMS JUN 3, 1993											
				Temp.	Temp.	Corr	Corr	Soil	Soil	% Soil	%LOI
Site	Transect	Elevation	Rep.	at 1 cm	at 10 cm	Eh 1cm	Eh 10cm	Sal	pH	Moisture	
D	5	HIGH	1	10.8	11.0	405.0	401.0	0	6.8	52.7	13.0
D	5	HIGH	2	10.7	11.0	370.0	409.0	0	6.7	49.2	11.3
D	5	MID	1	10.9	11.3	361.0	268.0	5	6.3	74.6	33.2
D	5	MID	2	11.1	11.3	303.0	3.0	4	6.6	70.0	13.8
D	5	LOW	1	11.9	12.8	-4.0	166.0	7	6.7	62.0	13.8
D	5	LOW	2	12.0	12.8	-119.0	-87.0	8	6.4	63.0	12.3
D	3	HIGH	1	12.3	11.0	37.0	-44.0	0	6.6	88.2	70.6
D	3	HIGH	2	14.4	11.5	178.0	-12.0	0	6.5	87.7	70.8
D	3	MID	1	14.5	13.2	13.0	-89.0	3	6.2	86.8	68.6
D	3	MID	2	14.6	13.4	19.0	1.0	3	6.2	86.3	67.3
D	3	LOW	1	12.5	13.5	316.0	-207.0	8	6.2	68.5	17.1
D	3	LOW	2	14.3	13.2	283.0	291.0	5	6.1	59.2	13.6
D	1	LOW	1	15.1	13.0	143.0	171.0	12	6.7	57.8	9.8
D	1	LOW	2	15.9	12.5	-332.0	111.0	12	6.5	56.0	11.2
D	1	MID	1	14.0	12.9	-12.0	-85.0	10	6.3	83.9	51.9
D	1	MID	2	15.2	13.4	98.0	-7.0	8	6.4	85.7	13.8
D	1	HIGH	1	11.6	11.8	16.0	-54.0	8	6.1	86.2	58.6
D	1	HIGH	2	11.6	11.7	6.0	-154.0	6	6.7	88.1	55.4
U	1	HIGH	1	14.0	10.9	458.0	346.0	0	6.8	60.0	32.5
U	1	HIGH	2	11.8	10.9	417.0	506.0	0	4.4	61.2	32.0
U	1	MID	1	13.4	10.8	132.0	217.0	0	6.9	68.4	38.0
U	1	MID	2	13.0	10.9	384.0	374.0	0	6.7	70.6	49.9
U	1	LOW	1	24.0	18.8	195.0	38.0	0	6.3	46.2	8.5
U	1	LOW	2	21.5	17.2	393.0	138.0	0	5.8	44.1	9.4
U	3	HIGH	1	16.4	12.2	322.0	19.0	0	6.6	39.6	22.3
U	3	HIGH	2	15.4	12.1	398.0	599.0	0	6.9	33.2	20.8
U	3	MID	1	14.7	12.1	331.0	402.0	0	6.9	49.1	17.0
U	3	MID	2	13.3	11.4	151.0	493.0	0	6.6	51.2	22.5
U	3	LOW	1	23.3	17.1	106.0	47.0	0	6.5	62.9	13.2
U	3	LOW	2	20.7	18.3	395.0	268.0	0	6.5	65.7	13.4
U	6	HIGH	1	15.0	12.5	283.0	56.0	0	6.7	66.8	27.6
U	6	HIGH	2	15.9	12.2	263.0	233.0	0	6.8	68.8	30.2
U	6	MID	1	13.8	11.3	336.0	-39.0	0	6.9	65.6	32.1
U	6	MID	2	13.2	10.5	398.0	322.0	0	6.5	67.0	34.9
U	6	LOW	1	16.3	14.6	378.0	416.0	0	7.2	46.4	10.1
U	6	LOW	2	18.8	14.1	418.0	351.0	0	5.8	42.4	10.1

STUART FARMS SAMPLING NOV 2, 1993											
				Temp.	Temp.	Corr.	Corr.	Soil	Soil	% Soil	%LOI
Zone	Transect	Elevation	Rep.	1 cm.	10 cm.	EH 1CM	EH 10 CM	Sal.	pH	Moisture	
U	1	HIGH	1	6.3	6.6	202	77	12	5.2	70.0	25.2
U	1	HIGH	2	6.4	6.7	490	164	15	5.8	72.3	29.8
U	1	MID	1	5.7	6.4	204	179	18	6.1	77.8	42.9
U	1	MID	2	5.3	6.1	309	294	17	6.2	76.1	38.5
U	1	LOW	1	6.4	6.5	430	499	10	5.2	65.7	10.6
U	1	LOW	2	4.2	4.8	349	404	10	6.8	67.6	16.1
U	3	HIGH	1	5.8	5.6	384	494	12	6.7	64.1	21.3
U	3	HIGH	2	5.6	5.6	424	409	14	6.4	62.0	17.1
U	3	MID	1	7.3	5.8	349	344	12	6.6	63.3	15.5
U	3	MID	2	5.4	5.4	414	49	10	6.7	64.7	16.5
U	3	LOW	1	5.3	6.0	374	375	14	6.0	70.5	13.7
U	3	LOW	2	5.3	6.6	329	394	17	6.1	69.2	14.8
U	6	HIGH	1	6.6	6.4	285	164	10	6.8	75.4	35.3
U	6	HIGH	2	6.0	6.5	102	-120	7	6.4	76.7	37.2
U	6	MID	1	5.6	6.0	274	-66	10	6.5	73.8	33.9
U	6	MID	2	5.4	6.0	444	484	9	6.6	74.0	35.1
U	6	LOW	1	5.1	5.7	34	464	7	6.8	69.3	16.9
U	6	LOW	2	5.1	5.5	434	404	8	6.8	69.4	16.5
D	5	HIGH	1	5.2	5.4	33	564	9	6.6	69.8	19.3
D	5	HIGH	2	5.1	5.2	444	164	12	6.0	66.7	13.8
D	5	MID	1	5.5	5.6	374	-16	12	6.5	79.6	34.5
D	5	MID	2	5.6	5.6	214	364	16	6.7	77.6	30.6
D	5	LOW	1	5.9	5.4	264	91	17	6.0	72.7	13.7
D	5	LOW	2	5.1	5.1	319	300	16	6.5	72.2	13.1
D	3	HIGH	1	5.6	5.2	374	79	12	6.1	87.1	74.1
D	3	HIGH	2	6.0	5.2	344	238	13	6.3	87.6	69.0
D	3	MID	1	5.5	5.3	374	269	16	5.5	87.1	66.0
D	3	MID	2	7.4	5.4	-40	194	16	5.8	85.9	63.1
D	3	LOW	1	7.1	5.9	154	-1	19	5.1	75.4	16.7
D	3	LOW	2	7.7	5.9	-172	284	16	6.3	73.3	15.4
D	1	HIGH	1	5.2	5.0	414	50	20	6.4	84.5	60.6
D	1	HIGH	2	5.9	5.1	234	244	19	6.0	85.4	63.3
D	1	MID	1	6.5	5.2	-116	124	17	6.4	84.8	56.4
D	1	MID	2	6.8	5.7	284	-26	18	6.1	88.1	51.1
D	1	LOW	1	8.4	5.5	169	59	25	4.4	73.3	12.3
D	1	LOW	2	7.2	5.6	234	204	21	5.4	66.4	11.5

STUART FARM 1993 % COVER							
MARSH	ZONE	TRANSECT	STATION	DATE	SPECIES	PERCENT	TYPE
SF	U	1	1	7/30/93	POS	10	O
SF	U	1	1	7/30/93	.	50	O
SF	U	1	1	7/30/93	AR	30	O
SF	U	1	1	7/30/93	AgS	5	O
SF	U	1	1	7/30/93	TO	5	O
SF	U	1	2	7/30/93	SPp	7	SPP
SF	U	1	2	7/30/93	AS	45	O
SF	U	1	2	7/30/93	AR	15	O
SF	U	1	2	7/30/93	AgS	30	O
SF	U	1	3	7/30/93	TL	20	O
SF	U	1	3	7/30/93	LS	20	LS
SF	U	1	3	7/30/93	POS	15	O
SF	U	1	3	7/30/93	CA	3	O
SF	U	1	3	7/30/93	Pls	3	O
SF	U	1	3	7/30/93	Prs	3	O
SF	U	1	3	7/30/93	Cys	7	O
SF	U	2	1	7/30/93	AR	30	O
SF	U	2	1	7/30/93	CS	40	O
SF	U	2	1	7/30/93	LS	5	LS
SF	U	2	1	7/30/93	Ags	10	O
SF	U	2	1	7/30/93	AS	10	O
SF	U	2	2	7/30/93	AR	30	O
SF	U	2	2	7/30/93	PS	2	O
SF	U	2	2	7/30/93	Fs	55	O
SF	U	2	2	7/30/93	LS	5	LS
SF	U	2	3	7/30/93	TI	20	O
SF	U	2	3	7/30/93	LS	25	LS
SF	U	2	3	7/30/93	CG	5	O
SF	U	2	3	7/30/93	PhAr	35	O
SF	U	2	3	7/30/93	AS	5	O
SF	U	2	3	7/30/93	Ot	5	O
SF	U	3	1	7/30/93	LS	20	LS
SF	U	3	1	7/30/93	AR	70	O
SF	U	3	1	7/30/93	Ot	10	O
SF	U	3	2	7/30/93	AS	1	O
SF	U	3	2	7/30/93	AR	95	O
SF	U	3	3	7/30/93	LS	90	LS
SF	U	3	3	7/30/93	CG	5	O
SF	U	4	1	7/30/93	PhAr	3	O
SF	U	4	1	7/30/93	AS	50	O
SF	U	4	1	7/30/93	AR	40	O
SF	U	4	2	7/30/93	PhAr	5	O
SF	U	4	2	7/30/93	AS	55	O
SF	U	4	2	7/30/93	LS	30	LS
SF	U	4	3	7/30/93	SPp	5	SPP
SF	U	4	3	7/30/93	PhAr	40	O
SF	U	4	3	7/30/93	Ot	15	O
SF	U	4	3	7/30/93	LS	10	LS
SF	U	4	3	7/30/93	AS	5	O
SF	U	5	1	7/30/93	IC	70	O
SF	U	5	1	7/30/93	AS	20	O
SF	U	5	1	7/30/93	UP	2	O
SF	U	5	2	7/30/93	AS	100	O
SF	U	5	3	7/30/93	LS	65	LS
SF	U	5	3	7/30/93	PS	5	O
SF	U	5	3	7/30/93	POS	10	O
SF	U	5	3	7/30/93	IC	5	O
SF	U	5	3	7/30/93	VH	5	O
SF	U	5	3	7/30/93	CG	5	O
SF	U	5	3	7/30/93	Gr2	5	O

MARSH	ZONE	TRANSECT	STATION	DATE	SPECIES	PERCENT	TYPE
SF	U	6	1	7/30/93	LS	70	LS
SF	U	6	1	7/30/93	TA	10	O
SF	U	6	1	7/30/93	SPp	10	SPP
SF	U	6	1	7/30/93	JE	3	O
SF	U	6	1	7/30/93	IC	3	O
SF	U	6	1	7/30/93	PS	3	O
SF	U	6	2	7/30/93	LS	75	LS
SF	U	6	2	7/30/93	TL	5	O
SF	U	6	2	7/30/93	JE	15	O
SF	U	6	2	7/30/93	AS	2	O
SF	U	6	2	7/30/93	Gs	2	O
SF	U	6	2	7/30/93	IC	2	O
SF	U	6	3	7/30/93	LS	85	LS
SF	U	6	3	7/30/93	CG	1	O
SF	U	6	3	7/30/93	AS	3	O
SF	U	6	3	7/30/93	PS	2	O
SF	U	6	3	7/30/93	Gs	2	O
SF	U	6	3	7/30/93	Ags	2	O
SF	U	6	3	7/30/93	IC	2	O
SF	U	6	3	7/30/93	CaR	2	O
SF	L	1	1	8/4/93	SR	15	O
SF	L	1	1	8/4/93	SP	65	SP
SF	L	1	1	8/4/93	Sas	7	O
SF	L	1	1	8/4/93	SR	8	O
SF	L	1	2	8/4/93	PA	15	O
SF	L	1	2	8/4/93	SP	75	SP
SF	L	1	2	8/4/93	TM	10	O
SF	L	1	3	8/4/93	SA	40	SA
SF	L	1	3	8/4/93	SR	15	O
SF	L	1	3	8/4/93	SP	15	SP
SF	L	1	3	8/4/93	Un5	5	O
SF	L	2	1	8/4/93	SP	95	SP
SF	L	2	2	8/4/93	SCA	10	O
SF	L	2	2	8/4/93	SR	5	O
SF	L	2	2	8/4/93	PA	10	O
SF	L	2	2	8/4/93	Sas	10	O
SF	L	2	2	8/4/93	TM	5	O
SF	L	2	2	8/4/93	SP	60	SP
SF	L	2	3	8/4/93	SA	90	SA
SF	L	3	1	7/30/93	CP	90	CP
SF	L	3	1	7/30/93	SD	5	O
SF	L	3	2	7/30/93	SP	65	SP
SF	L	3	2	7/30/93	S2	25	O
SF	L	3	2	7/30/93	PA	5	O
SF	L	3	2	7/30/93	Ot	5	O
SF	L	3	3	7/30/93	SA	70	SA
SF	L	3	3	7/30/93	Wr	10	O
SF	L	3	3	7/30/93	Un4	10	O
SF	L	4	1	7/30/93	CP	80	CP
SF	L	4	2	7/30/93	CP	90	CP
SF	L	4	3	7/30/93	SA	70	SA
SF	L	4	3	7/30/93	SR	10	O
SF	L	5	1	7/30/93	P	80	P
SF	L	5	1	7/30/93	IC	7	O
SF	L	5	1	7/30/93	RT	5	O
SF	L	5	1	7/30/93	Vs	2	O
SF	L	5	2	7/30/93	P	75	P
SF	L	5	2	7/30/93	RR	15	O
SF	L	5	3	7/30/93	P	75	P
SF	L	5	3	7/30/93	SA	15	SA
SF	L	5	3	7/30/93	CP	5	CP

STUART FARM 1994 % COVER							
MARSH	ZONE	TRANSECT	STATION	DATE	SPECIES	PERCENT	TYPE
SF	U	1	2	6/10/94	Js	90	O
SF	U	1	2	6/10/94	AR	5	O
SF	U	1	3	6/10/94	TL	5	O
SF	U	1	3	6/10/94	LS	10	LS
SF	U	1	3	6/10/94	FGA	80	O
SF	U	1	3	6/10/94	Js	1	O
SF	U	2	1	6/10/94	AR	90	O
SF	U	2	1	6/10/94	Sas	0.5	O
SF	U	2	1	6/10/94	UN	20	O
SF	U	2	2	6/10/94	Sas	15	O
SF	U	2	2	6/10/94	AR	10	O
SF	U	2	2	6/10/94	UN	50	O
SF	U	2	3	6/10/94	AP	0.5	O
SF	U	2	3	6/10/94	CC	5	O
SF	U	2	3	6/10/94	LS	1	LS
SF	U	2	3	6/10/94	FGA	50	O
SF	U	2	3	6/10/94	UN	2	O
SF	U	3	1	6/10/94	AR	40	O
SF	U	3	2	6/10/94	AR	60	O
SF	U	3	2	6/10/94	UN	5	O
SF	U	3	3	6/10/94	LS	0.5	LS
SF	U	3	3	6/10/94	UN	5.5	O
SF	U	4	1	6/10/94	CC	50	O
SF	U	4	1	6/10/94	AR	10	O
SF	U	4	2	6/10/94	AR	30	O
SF	U	4	2	6/10/94	LS	0.5	LS
SF	U	4	2	6/10/94	Sas	1	O
SF	U	4	3	6/10/94	CAS	0.5	O
SF	U	4	3	6/10/94	FGA	50	O
SF	U	4	3	6/10/94	LS	15	LS
SF	U	5	2	6/10/94	TO	1	O
SF	U	5	2	6/10/94	AR	2	O
SF	U	5	2	6/10/94	LS	2	LS
SF	U	5	2	6/10/94	Sas	2	O
SF	U	5	3	6/10/94	AP	0.5	O
SF	U	5	3	6/10/94	LS	20	LS
SF	U	5	3	6/10/94	Sas	10	O
SF	U	5	3	6/10/94	UN	5	O
SF	U	5	3	6/10/94	FGA	40	O
SF	U	6	1	6/10/94	TL	2	O
SF	U	6	1	6/10/94	AR	2	O
SF	U	6	1	6/10/94	Sas	10	O
SF	U	6	1	6/10/94	US	0.5	O
SF	U	6	2	6/10/94	LS	0.5	LS
SF	U	6	2	6/10/94	Sas	5	O
SF	U	6	2	6/10/94	AR	0.5	O
SF	U	6	3	6/10/94	AP	0.5	O
SF	U	6	3	6/10/94	LS	40	LS
SF	L	1	1	6/10/94	AP	0.5	O
SF	L	1	1	6/10/94	SSP	10	O
SF	L	1	1	6/10/94	UN	70	O
SF	L	1	1	6/10/94	Sas	10	O
SF	L	1	2	6/10/94	SP	50	SP
SF	L	1	2	6/10/94	PA	15	O
SF	L	1	3	6/10/94	SA	40	SA
SF	L	1	3	6/10/94	SSP	30	O
SF	L	1	3	6/10/94	PA	0.5	O
SF	L	2	1	6/10/94	SP	50	SP

MARSH	ZONE	TRANSECT	STATION	DATE	SPECIES	PERCENT	TYPE
SF	L	2	1	6/10/94	JG	5	O
SF	L	2	1	6/10/94	Sas	1	O
SF	L	2	2	6/10/94	SP	60	SP
SF	L	2	2	6/10/94	TM	0.5	O
SF	L	2	2	6/10/94	SSP	1	O
SF	L	2	2	6/10/94	PA	10	O
SF	L	2	3	6/10/94	SA	60	SA
SF	L	3	1	6/10/94	CP	80	CP
SF	L	3	2	6/10/94	SP	70	SP
SF	L	3	2	6/10/94	JG	2	O
SF	L	3	2	6/10/94	PA	5	O
SF	L	3	3	6/10/94	SA	60	SA
SF	L	3	3	6/10/94	AP	0.5	O
SF	L	3	3	6/10/94	UN	5	O
SF	L	4	1	6/10/94	CP	80	CP
SF	L	4	2	6/10/94	CP	80	CP
SF	L	4	3	6/10/94	SA	50	SA
SF	L	5	1	6/10/94	RS	30	O
SF	L	5	1	6/10/94	P	40	P
SF	L	5	2	6/10/94	TR	0.5	O
SF	L	5	2	6/10/94	P	40	P
SF	L	5	3	6/10/94	SA	15	SA
SF	L	5	3	6/10/94	P	40	P

MARSH	ZONE	TRANSECT	STATION	DATE	SPECIES	# V. STEM	# V. LEAF	# R. STEM	# R. LEAF	AVE. STEM HT.	X LEAF	BIOMASS
SF	L	1	1	80493	SR	5	.	.	.	62.5	5.6	5.8
SF	L	1	1	80493	SP	62	.	1	.	47.7	.	8.4
SF	L	1	2	80493	SP	263	.	.	.	40.7	.	26.9
SF	L	1	2	80493	PA	46	.	.	.	16.6	.	2
SF	L	1	3	80493	SA	17	11	.	.	60.1	.	15.5
SF	L	2	1	80493	SP	422	.	2	.	47.3	.	36.1
SF	L	2	2	80493	SP	478	.	.	.	33.5	.	42.9
SF	L	2	2	80493	SCIR	3	.	2	.	50.4	3.4	2.3
SF	L	2	2	80493	PP	6	.	.	.	21.4	.	0.6
SF	L	2	2	80493	UN1	4	.	.	.	18.9	4.75	0.3
SF	L	2	2	80493	UN2	3	.	.	.	29.2	.	0.1
SF	L	2	2	80493	UN3	3	.	.	.	13.9	.	0
SF	L	2	2	80493	UN4	5	.	.	.	28.9	2.2	0.7
SF	L	2	3	80493	SA	23	4	.	.	110.4	.	66.4
SF	L	3	1	73093	SR	7		0		109.4		11.3
SF	L	3	1	73093	ES	0		2		1.5		1.5
SF	L	3	2	73093	SP	484		0		32.5		27
SF	L	3	2	73093	Un1	17		0		16.9		0.9
SF	L	3	2	73093	PP	8		0		16.5		0.3
SF	L	3	3	80493	SA	25	1	.	.	93.5	.	46.1
SF	L	4	1	73093	SR	10		0		12.6		21.7
SF	L	4	1	73093	UN2	0		3		79.2		2.2
SF	L	4	2	73093	CP	12		5		98.2		21.2
SF	L	4	3	80493	SA	34	4	3	3	115.4	.	86.7
SF	L	5	2	80493	P	3	.	.	.	150.9	.	31.1
SF	L	5	3	80493	P	5	.	.	.	155.9	.	39.9
SF	L	5	3	80493	AR	4	.	.	.	85.6	.	3.8
SF	U	1	1	73093	UN1	178		0		20.6		2.9
SF	U	1	1	73093	UN2	.		.		.		4.6
SF	U	1	1	73093	UN3	.		.		.		1.2
SF	U	1	1	73093	UN4	.		.		.		2.5
SF	U	1	3	73093	Js	3		84		56.2		24
SF	U	1	3	73093	UN1	1		0		37.0		0
SF	U	1	3	73093	UN2	18		0		18.5		0.6
SF	U	1	3	73093	UN3	9		0		.		0.3
SF	U	1	3	73093	UN4	23		0		.		0.6
SF	U	2	1	73093	AS	2		0		74.3		8
SF	U	2	1	73093	AgS	2		5		73.5		2.8
SF	U	2	1	73093	AR	11		0		68.5		8.8
SF	U	2	1	73093	UN1	18		0		43.6		1.1
SF	U	2	2	73093	AgS	26		60		47.6		15.8
SF	U	2	2	73093	EA	13		0		34.6		0.4
SF	U	2	2	73093	AGR	.		.		.		12.3
SF	U	2	2	73093	UN2	.		.		.		0.2
SF	U	2	2	73093	UN3	.		.		.		2.2

MARSH	ZONE	TRANSECT	STATION	DATE	SPECIES	# V. STEM	# V. LEAF	# R. STEM	# R. LEAF	AVE. STEM HT.	X LEAF	BIOMASS
SF	U	2	3	73093	AS	28	.	.	.	47.8	.	21.1
SF	U	2	3	73093	PhAr	12	.	10	.	115.1	.	48.3
SF	U	2	3	73093	Un	5	.	.	.	90.3	.	0.6
SF	U	3	1	73093	AR	122	.	.	.	44.2	.	.
SF	U	3	2	73093	AR	55	.	8	.	55.5	.	31
SF	U	3	3	82793	LS	.	.	2	.	180.8	265.5	24.6
SF	U	3	3	82793	UN1	22	.	.	.	56.1	.	30.6
SF	U	3	3	73093	LS	0		2		180.8		24.6
SF	U	3	3	73093	UN1	22		0		56.1		30.6
SF	U	4	1	73093	AR	108	.	.	.	53.8	.	23.2
SF	U	4	2	73093	AR	4	.	.	.	74.1	5.25	2.5
SF	U	4	2	73093	SS	20	.	.	.	71.3	.	19.7
SF	U	4	2	73093	ANT	3	.	.	.	88.1	.	9.1
SF	U	4	3	73093	PhAr	18	.	2	.	67.5	.	19.9
SF	U	5	1	73093	P	1	.	.	.	81.8	7	17
SF	U	5	1	73093	SS	4	.	.	.	86.9	.	.
SF	U	5	2	73093	UN1	1	.	.	.	30.0	.	0.1
SF	U	5	2	73093	UN2	5	.	.	.	36.8	3	0.3
SF	U	5	2	73093	UN3	5	.	.	.	35.6	2.8	0.3
SF	U	5	2	73093	AST	13	.	.	.	90.9	.	53
SF	U	5	3	73093	LS	4		1		140.6		78.7
SF	U	5	3	73093	Js	2		3		72.1		1
SF	U	5	3	73093	UN1	2		0		42.3		0.1
SF	U	6	1	73093	LS	.	.	2	.	143.8	223	.
SF	U	6	1	73093	UN	3	.	.	.	.	.	.
SF	U	6	1	73093	TEAR	1	.	.	.	.	.	.
SF	U	6	2	73093	Js	1		4		45.0		0.9
SF	U	6	2	73093	LS	0		4		147.1		57.1
SF	U	6	2	73093	UN1	25		2		66.3		5.2
SF	U	6	2	73093	UN2	1		0		56.1		0.4
SF	U	6	2	73093	UN3	1		0		19.2		0.1
SF	U	6	2	73093	UN4	9		0		33.1		0.3
SF	U	6	2	73093	AS	16		0		46.5		3
SF	U	6	2	73093	LS	0		4		162.6		128.6
SF	U	6	2	73093	UN1	3		5		79.0		2.1
SF	U	6	2	73093	UN2	.		.		.		1.3
SF	U	6	2	73093	UN3	.		.		.		1.3
SF	U	6	2	73093	UN4	.		.		.		2.5

INMP MITIGATION SAMPLING 9/21/93										
			Temp.	Temp.	Corr.	Corr.	Soil	Soil	% Soil	%LOI
Zone	Statior	Rep.	at 1 cm	at 10 cm	EH 1CM	EH 10CM	Sal.	pH	Moisture	
Created	1	A	12.7	12.3	179	354	34	7.7	55.2	2.89
Created	1	B	13.2	12.7	101	192	33	7.0	56.3	1.80
Created	2	A	12.8	12.6	155	401	32	6.8	57.8	1.91
Created	2	B	13.3	12.8	226	361	30	6.6	56.5	3.02
Created	3	A	12.8	12.4	111	326	32	7.1	56.1	1.61
Created	3	B	12.9	12.6	376	299	34	7.4	55.3	1.56
Created	4	A	12.6	12.2	230	316	44	7.2	55.5	1.14
Created	4	B	13.0	12.5	131	233	49	6.8	55.1	3.75
Created	5	A	12.9	12.6	275	235	32	7.1	56.5	3.65
Created	5	B	13.2	12.9	57	165	36	7.3	56.0	3.62
Created	6	A	12.9	12.6	381	296	36	6.8	55.4	3.39
Created	6	B	13.3	12.8	281	330	37	7.3	54.9	3.61
Created	7	A	12.8	12.5	252	313	34	7.1	56.5	1.72
Created	7	B	13.2	12.8	291	249	32	7.2	56.0	1.38
Created	8	A	12.7	12.5	51	-174	34	7.3	57.5	4.11
Created	8	B	13.2	12.6	59	-184	32	7.4	56.9	2.12
Created	9	A	12.7	12.4	-59	343	28	6.9	55.3	3.00
Created	9	B	13.2	12.6	26	305	35	7.4	55.2	2.94
Created	10	A	12.7	12.4	56	323	34	7.3	56.9	3.46
Created	10	B	13.2	12.6	121	186	34	7.3	55.3	2.80
Created	11	A	12.9	12.5	331	13	35	6.4	55.1	3.22
Created	11	B	13.0	12.6	288	355	37	7.1	55.7	3.31
Created	12	A	13.0	12.8	-185	-129	33	6.8	55.2	3.38
Created	12	B	13.0	12.7	398	145	35	7.2	55.4	2.80
Created	13	A	13.0	12.8	-44	405	32	6.8	56.2	3.28
Created	13	B	13.3	12.9	50	379	34	7.1	56.5	3.00
Created	14	A	12.8	12.5	-146	231	34	6.8	55.6	7.02
Created	14	B	13.4	12.8	31	289	34	6.4	55.7	3.09
Created	15	A	13.4	13.1	-176	371	30	6.9	56.0	3.18
Created	15	B	13.7	13.2	128	223	32	6.9	56.1	3.03
Created	16	A	13.4	13.1	-191	219	34	6.8	59.0	4.00
Created	16	B	13.3	13.0	32	211	36	6.7	56.1	3.27
Reference	1	A	13.9	13.5	-179	-39	30	4.8	78.6	15.13
Reference	1	B	14.2	13.7	-71	-179	35	7.2	73.7	11.79
Reference	2	A	14.8	13.8	-84	-143	32	6.6	74.8	15.97
Reference	2	B	14.7	13.6	61	-113	34	6.2	74.8	16.70
Reference	3	A	13.7	13.2	-95	-137	31	5	79.1	15.29
Reference	3	B	14	13.4	-194	-138	32	4.8	81.0	14.10
Reference	4	A	14.7	13.6	29	-150	34	6.4	73.7	11.62
Reference	4	B	14.4	13.6	131	-167	32	6.2	76.7	12.43
Reference	5	A	14.2	13.5	146	-130	35	5.9	71.7	9.93
Reference	5	B	14.4	13.7	-122	-129	34	4.9	74.2	12.11
Reference	6	A	14	13.3	-129	-189	33	5.8	78.9	13.87
Reference	6	B	13.8	13.3	-201	-174	32	6.6	80.0	14.53
Reference	7	A	13.8	13.4	43	-105	34	6.5	77.6	17.27
Reference	7	B	13.5	13.4	116	-212	31	5.3	81.2	18.90
Reference	8	A	14.3	13.2	159	-128	32	6.2	79.7	25.27
Reference	8	B	13.9	13.3	282	-62	26	7.2	78.6	21.77

INMP PLANT DATA PRINT

INNER NORTH MILL P			PERCENT COVER AND HARVEST DATA 9/93														
			RELATIVE PERCENT COVER								%	% COVER	# TOTAL	MEAN LF	MEAN	TOTAL	CANOPY
ZONE	REP	SAM	SA	SAT	SAS	SP	LC	FV	AN	BARE	COVER	VASCULAR	SHOOTS	AREA	HEIGHT	BIOMASS	STRUCTURE
REFERNC	1	A	95	95				3		2	98	95	25	28.6	25.3	67.344	7
REFERNC	1	B	80	55	25			10	10	0	100	80	28	35.5	33.1	41.145	8
REFERNC	2	A	100	100						0	100	100	30	114.9	90.1	88.37	9
REFERNC	2	B	90	90					5	5	95	90	31	98.6	78.9	72.082	9
REFERNC	3	A	95	95						5	95	95	29	124.1	88.9	51.818	9
REFERNC	3	B	85	85				2	1	12	88	85	27	70.3	55.4	74.164	8
REFERNC	4	A	85		85					15	85	85	37	91.1	64.8	49.399	10
REFERNC	4	B	85		85					15	85	85	17	75.9	55.2	31.323	8
REFERNC	5	A	80	80						20	80	80	58	147.3	90	86.48	10
REFERNC	5	B	90	90						10	90	90	64	129	82.9	62.646	10
REFERNC	6	A	95	95						5	95	95	47	55.5	38	95.063	9
REFERNC	6	B	100	100						0	100	100	49	96	57.3	123.62	9
REFERNC	7	A	95	95						5	95	95	50	126.9	89.1	64.685	10
REFERNC	7	B	90	90						10	90	90	49	67.9	68.7	42.089	10
REFERNC	8	A	95	95						5	95	95	39	108.8	76.5	44.899	11
REFERNC	8	B	90	90		5				5	95	95	65	106.6	73.5	38.906	11
CREATED	1	A	15							85	15	15	6	9.7	12.4		4
CREATED	1	B	20							80	20	20	8	6.6	6.6		3
CREATED	2	A	20							80	20	20	5	21.9	18.6		5
CREATED	2	B	15							85	15	15	11	22.2	19.2		6
CREATED	3	A	10							90	10	10	1	9.5	11		2
CREATED	3	B	10							90	10	10	11	22.3	19.2		6
CREATED	4	A	10							90	10	10	0	0	0		0
CREATED	4	B	10							90	10	10	1	6.7	5		1
CREATED	5	A	15							85	15	15	11	17.8	17.9		6
CREATED	5	B	10							90	10	10	8	17.6	12.8		4
CREATED	6	A	10							90	10	10	0	0	0		0
CREATED	6	B	15							85	15	15	0	0	0		0
CREATED	7	A	25							75	25	25	16	24.8	19.6		6
CREATED	7	B	15							85	15	15	11	13.7	14		5
CREATED	8	A	10							90	10	10	3	23.9	20.3		4
CREATED	8	B	10							90	10	10	10	0	0		0
CREATED	9	A	10							90	10	10	1	12.3	16		2
CREATED	9	B	10							90	10	10	1	6.7	5		1
CREATED	10	A	8							92	8	8	3	21.7	18.7		4
CREATED	10	B	10							90	10	10	3	10.1	10		3
CREATED	11	A	20							80	20	20	0	0	0		0
CREATED	11	B	10							90	10	10	1	48.4	48		4
CREATED	12	A	10							90	10	10	8	6.5	9		4
CREATED	12	B	12							88	12	12	2	6.7	5		1
CREATED	13	A	30				2			78	22	32	9	22.9	17.7		7
CREATED	13	B	30							70	30	30	14	19.9	18.4		6
CREATED	14	A	30							70	30	30	16	37.8	30.4		6
CREATED	14	B	8							92	8	8	11	12.6	13.2		5
CREATED	15	A	15							85	15	15	17	30.2	30		7
CREATED	15	B	20							80	20	20	8	13.7	9.6		4
CREATED	16	A	4							96	4	4	3	33.7	22		4
CREATED	16	B	40							60	40	40	8	17.7	12.9		4

Fish Species Identity and Abundance by Site and Date*

Site	Date	Species Present	Number	Density
Awcomin Marsh Reference	7 Oct. '93	*Fundulus heteroclitus*	1	0.041
	21 Oct.'93	*Fundulus heteroclitus*	2	
		Menidia menidia	1	
		Pungitius pungitius	2	
		Total Fish	5	0.205
Awcomin Marsh Restoration	7 Oct. '93	*No fish present*	0	0
	21 Oct.'93	*No fish present*	0	0
Mill Creek Stuart Farm - Downstream	20 Sept. '93	*Fundulus heteroclitus*	7	0.097
	5 Oct. '93	*Fundulus heteroclitus*	32	0.444
Mill Creek Stuart Farm - Upstream	20 Sept. '93	*Fundulus heteroclitus*	31	
		Apeltes quadracus	1	
		Anguilla rostrata	6	
		Lepomis sp.	1	
		Total Fish	39	0.448
	5 Oct. '93	*Fundulus heteroclitus*	5	
		Pungitius pungitius	1	
		Total Fish	6	0.069
Inner North Mill Pond - Reference	10 Sept. '93	*Fundulus heteroclitus*	301	
		Menidia menidia	91	
		Anguilla rostrata	1	
		Total fish	393	1.29
	21 Sept. '93	*Fundulus heteroclitus*	355	1.16
Inner North Mill Pond - Created	10 Sept. '93	*Fundulus heteroclitus*	53	
		Menidia menidia	2	
		Anguilla rostrata	1	
		Total fish	56	0.08
	21 Sept. '93	*Fundulus heteroclitus*	165	
		Menidia menidia	2	
		Total fish	167	0.24

* Fish were sampled after hydrologic restoration at both Awcomin Marsh and Stuart Farm. Densities are expressed per m^2 of low marsh sampled.

APPENDIX II- 28

AWCOMIN MARSH WATER TABLE DATA

	A	B	C	D	E
1	Date	Site	%o T	%o B	Depth
2	921005	A-1	36	35	24.6
3	921005	A-2	35		26.3
4	921005	A-3	34		25.0
5	921005	A-4	36		28.3
6	921005	A-5	36		26.4
7	921005	A-6	36		27.3
8	921005	A-7	36	36	26.9
9	921005	A-8	36	36	26.9
10	921005	A-9	37	37	25.5
11	921005	B-1	32	32	41.8
12	921005	B-2	32		47.3
13	921005	B-3	.		.
14	921005	B-4	32	32	30.2
15	921005	B-5	32	32	18.7
16	921005	B-6	30	30	29.5
17	921005	B-7	28	30	15.7
18	921005	B-8	30	32	12.7
19	921005	B-9	30	30	6.1
20	921005	C-1	34	34	23.9
21	921005	C-2	33	34	11.8
22	921005	C-3	32	38	16.7
23	921005	C-4	35	35	20.8
24	921005	C-5	32	34	21.8
25	921005	C-6	34	34	18.1
26	921005	D-1	25	25	16.1
27	921005	D-2	28	28	18.4
28	921005	D-3	28	28	21.0
29	921005	D-4	20	20	22.4
30	921005	D-5	25	25	22.3
31	921005	D-6	25	28	14.0
32	Date	Site	%o T	%o B	
33	921014	A-1	37	37	19.0
34	921014	A-2	36	36	21.3
35	921014	A-3	34	34	16.2
36	921014	A-4	36	36	18.2
37	921014	A-5	36	36	19.0
38	921014	A-6	36	36	20.9
39	921014	A-7	38	38	15.9
40	921014	A-8	38	38	17.2
41	921014	A-9	37	37	15.9
42	921014	B-1	34	34	23.4
43	921014	B-2	32	32	39.5
44	921014	B-3	34	33	44.3
45	921014	B-4	28	31	24.7
46	921014	B-5	27	30	14.6
47	921014	B-6	28	28	23.5
48	921014	B-7	25	30	11.1
49	921014	B-8	22	30	8.1
50	921014	B-9	21	28	3.3

	A	B	C	D	E
51	921014	C-1	22	28	19.7
52	921014	C-2	24	30	8.6
53	921014	C-3	24	28	13.9
54	921014	C-4	32	30	15.8
55	921014	C-5	26	30	16.8
56	921014	C-6	26	29	13.5
57	921014	D-1	.	20	12.8
58	921014	D-2	20	24	14.3
59	921014	D-3	18	22	17.8
60	921014	D-4	14	16	17.8
61	921014	D-5	15	19	16.3
62	921014	D-6	14	16	20.3
63					
64	Date	Site	%o T	%o B	
65	921020	A-1	35	36	18.1
66	921020	A-2	35	35	20.3
67	921020	A-3	34	34.5	14.9
68	921020	A-4	36	36	17.3
69	921020	A-5	35.5	36	18.1
70	921020	A-6	36	36	20.0
71	921020	A-7	36	36	15.4
72	921020	A-8	36	36.5	16.3
73	921020	A-9	36	36	14.9
74	921020	B-1	32	32	40.8
75	921020	B-2	32		52.4
76	921020	B-3	.	.	.
77	921020	B-4	28	30	24.7
78	921020	B-5	26	29	14.6
79	921020	B-6	25	25	20.8
80	921020	B-7	20	30	7.8
81	921020	B-8	23	30	9.5
82	921020	B-9	25	28	8.4
83	921020	C-1	25	28	21.6
84	921020	C-2	22	30	10.0
85	921020	C-3	22	28	14.4
86	921020	C-4	26	35	18.1
87	921020	C-5	28	31	19.5
88	921020	C-6	29	31	15.8
89	921020	D-1	20	22	12.4
90	921020	D-2	23	27	13.8
91	921020	D-3	20	25	17.8
92	921020	D-4	19	20	17.8
93	921020	D-5	16	21	17.7
94	921020	D-6	20	22	10.3
95					
96	Date	Site	%o T	%o B	
97	930610	A-1	28	29	14.9
98	930610	A-2	30	30	16.2
99	930610	A-3	.		.
100	930610	A-4	.		.

	A	B	C	D	E
101	930610	A-5	.		.
102	930610	A-6	32	30	14.4
103	930610	A-7	28	30	7.6
104	930610	A-8	31	32	7.1
105	930610	A-9	30	32	12.6
106	930610	B-1	26	29	16.0
107	930610	B-2	27	30	21.1
108	930610	B-3	24	26	18.1
109	930610	B-4	28	32	31.6
110	930610	B-5	27	30	14.1
111	930610	B-6	26	27	16.2
112	930610	B-7	32	34	19.2
113	930610	B-8	32	33	9.9
114	930610	B-9	.		.
115	930610	C-1	30	32	26.2
116	930610	C-2	30	33	13.7
117	930610	C-3	27	32	15.3
118	930610	C-4	31	32	21.7
119	930610	C-5	31	32	26.9
120	930610	C-6	30	30	27.3
121	930610	D-1	29	32	22.5
122	930610	D-2	28	31	21.6
123	930610	D-3	29	30	24.7
124	930610	D-4	10	22	25.6
125	930610	D-5	28	32	24.6
126	930610	D-6	25	30	15.4
127					
128	Date	Site	%o T	%o B	
129	930617	A-1	.		.
130	930617	A-2	21	21	0.8
131	930617	A-3	.		.
132	930617	A-4	.		.
133	930617	A-5	.		.
134	930617	A-6	30	30	26.9
135	930617	A-7	.		.
136	930617	A-8	.		.
137	930617	A-9	.		.
138	930617	B-1	28	28	50.5
139	930617	B-2	25	25	51.0
140	930617	B-3	.		.
141	930617	B-4	20	20	50.4
142	930617	B-5	24	24	32.1
143	930617	B-6	18	18	31.3
144	930617	B-7	26	26	32.2
145	930617	B-8	.		.
146	930617	B-9	22	22	15.3
147	930617	C-1	25	25	40.9
148	930617	C-2	25	25	27.5
149	930617	C-3	24	24	24.1
150	930617	C-4	26	26	31.4

	A	B	C	D	E
151	930617	C-5	22	22	34.7
152	930617	C-6	25	25	38.3
153	930617	D-1	22	22	31.7
154	930617	D-2	30	30	39.6
155	930617	D-3	27	27	41.7
156	930617	D-4	17	17	35.8
157	930617	D-5	25	25	33.8
158	930617	D-6	22	22	24.6
159					
160	Date	Site	%o T	%o B	
161	920919	A-1	24	32	14.9
162	920919	A-2	32		20.8
163	920919	A-3	30	32	17.6
164	920919	A-4	28	32	16.4
165	920919	A-5	18	30	14.9
166	920919	A-6	26	32	23.2
167	920919	A-7	20.5	32	10.8
168	920919	A-8	18	32	8.9
169	920919	A-9	20	32	9.9
170	920919	B-1	30	30	52.3
171	920919	B-2	26		51.9
172	920919	B-3	.		.
173	920919	B-4	24	25	32.9
174	920919	B-5	25	25	26.5
175	920919	B-6	22	22	25.4
176	920919	B-7	22	28	14.3
177	920919	B-8	22	27	11.3
178	920919	B-9	26	28	4.3
179	920919	C-1	30	30	23.4
180	920919	C-2	25	30	10.9
181	920919	C-3	25	26	16.7
182	920919	C-4	32	32	22.7
183	920919	C-5	27	30	26.9
184	920919	C-6	28	30	19.0
185	920919	D-1	22	22	16.1
186	920919	D-2	25	25	16.1
187	920919	D-3	25	25	18.7
188	920919	D-4	18	18	20.1
189	920919	D-5	20	22	19.1
190	920919	D-6	25	28	12.6
191					
192	Date	Site	%o T	%o B	
193	920724	A-1	28	28	28.1
194	920724	A-2	30	30	28.6
195	920724	A-3	30	30	28.6
196	920724	A-4	30	30	31.3
197	920724	A-5	30	30	30.8
198	920724	A-6	30	30	32.9
199	920724	A-7	30	29	31.9
200	920724	A-8	30	30	28.1

	A	B	C	D	E
201	920724	A-9	30	30	29.7
202	920724	B-1	20	20	8.6
203	920724	B-2	20	20	17.3
204	920724	B-3	22	22	18.4
205	920724	B-4	16	16	20.5
206	920724	B-5	18	18	10.3
207	920724	B-6	18	18	18.9
208	920724	B-7	16	16	16.7
209	920724	B-8	15	15	14.6
210	920724	B-9	20	20	15.1
211	920724	C-1	20	21	23.8
212	920724	C-2	17	16	13.0
213	920724	C-3	16	16	18.9
214	920724	C-4	26	26	20.0
215	920724	C-5	19	19	21.6
216	920724	C-6	18	18	19.4
217					
218	Date	Site	%o T	%o B	
219	920804	A-1	31	32	14.0
220	920804	A-2	31	31	12.4
221	920804	A-3	32	32	9.7
222	920804	A-4	32	32	11.3
223	920804	A-5	32	32	19.4
224	920804	A-6	32	31	18.4
225	920804	A-7	33	33	8.1
226	920804	A-8	32	32	9.7
227	920804	A-9	31	32	11.3
228	920804	B-1	30	30	4.3
229	920804	B-2	30	30	3.2
230	920804	B-3	31	31	2.2
231	920804	B-4	28	28	22.7
232	920804	B-5	30	30	9.7
233	920804	B-6	30	30	13.5
234	920804	B-7	28	29	8.6
235	920804	B-8	28	29	10.3
236	920804	B-9	28	28	10.8
237	920804	C-1	28	29	21.1
238	920804	C-2	27	28	10.8
239	920804	C-3	25	25	11.3
240	920804	C-4	31	31	14.6
241	920804	C-5	28	28	18.4
242	920804	C-6	29	30	13.5
243					
244	Date	Site	%o T	%o B	
245	930624	A-1	30	33	14.6
246	930624	A-2	32	33	2.9
247	930624	A-3	32	33	15.3
248	930624	ADAVE1	32	.	.
249	930624	A-4	32	32	5.3
250	930624	A-5	34	32	2.5

	A	B	C	D	E
251	930624	A-6	33	32	15.8
252	930624	ADAVE2	31	.	.
253	930624	A-7	32	32	9.4
254	930624	A-8	32	32	10.8
255	930624	A-9	33	34	13.1
256	930624	ADAVE3	34	.	.
257	930624	B-1	29	30	10.0
258	930624	B-2	30	30	10.1
259	930624	B-3	31	32	7.0
260	930624	BDAVE1	30	.	.
261	930624	B-4	32	32	28.3
262	930624	B-5	32	32	12.8
263	930624	B-6	31	31	16.2
264	930624	BDAVE2	32	.	!EVAL
265	930624	B-7	37	38	5.5
266	930624	B-8	39	40	4.4
267	930624	B-9	35	35	-12.7
268	930624	BDAVE3	39	.	!EVAL
269	930624	C-1	30	32	27.1
270	930624	C-2	30	32	13.7
271	930624	C-3	29	31	15.8
272	930624	CDAVE1	29	.	!EVAL
273	930624	C-4	35	35	21.3
274	930624	C-5	32	30	23.7
275	930624	C-6	31	33	22.3
276	930624	CDAVE2	29	.	!EVAL
277	930624	D-1	30	32	23.9
278	930624	D-2	30	31	24.4
279	930624	D-3	30	31	27.0
280	930624	DDAVE1	31	.	!EVAL
281	930624	D-4	18	16	33.0
282	930624	D-5	31	31	28.3
283	930624	D-6	30	31	21.8
284	930624	DDAVE2	25	.	
285					
286	Date	Site	%o T	%o B	
287	930723	A-1	31	.	5
288	930723	A-2	31	.	3.5
289	930723	A-3	31	.	4.5
290	930723	ADAVE-1	36	.	0
291	930723	A-4	32	.	4
292	930723	A-5	31	.	7
293	930723	A-6	31	.	5
294	930723	ADAVE2	35	.	3
295	930723	A-7	35	.	0
296	930723	A-8	33	.	0
297	930723	A-9	32	.	4.5
298	930723	ADAVE3	32	.	5
299	930723	B-1	31	.	5
300	930723	B-2	32	.	3

	A	B	C	D	E
301	930723	B-3	32	.	0
302	930723	BDAVE1	32	.	3
303	930723	B-4	34	.	3
304	930723	B-5	35	.	2
305	930723	B-6	37	.	4
306	930723	BDAVE2	42	.	1
307	930723	B-7	36	.	7
308	930723	B-8	37	.	3.5
309	930723	B-9	34	.	* 2
310	930723	BDAVE3	45	.	1
311	930723	C-1	34	.	6
312	930723	C-2	35	.	3
313	930723	C-3	36	.	7
314	930723	CDAVE1	38	.	2
315	930723	C-4	34	.	1
316	930723	C-5	35	.	7.5
317	930723	C-6	32	.	7
318	930723	CDAVE2	40	.	6
319	930723	D-1	37	.	9
320	930723	D-2	35	.	7
321	930723	D-3	37	.	6
322	930723	DDAVE1	42	.	5
323	930723	D-4	25	.	11
324	930723	D-5	35	.	7.5
325	930723	D-6	34	.	5
326	930723	DDAVE2	32	.	4.5
327					
328	Date	Site	%o T	%o B	
329	930809	A-1	29		19
330	930809	A-2	33		20
331	930809	A-3	.		.
332	930809	ADAVE-1	35		18.5
333	930809	A-4	.		.
334	930809	A-5	34		29
335	930809	A-6	.		25
336	930809	ADAVE2	35		19
337	930809	A-7	35		24
338	930809	A-8	.		25
339	930809	A-9	.		26
340	930809	ADAVE3	37		13
341	930809	B-1	.		46
342	930809	B-2	35		38
343	930809	B-3	.		36
344	930809	BDAVE1	.		.
345	930809	B-4	32		27
346	930809	B-5	32		24
347	930809	B-6	35		24
348	930809	BDAVE2	40		17
349	930809	B-7	40		21
350	930809	B-8	.		23

	A	B	C	D	E
351	930809	B-9	34		24
352	930809	BDAVE3	44		15
353	930809	C-1	33		25
354	930809	C-2	35		23
355	930809	C-3	34		23
356	930809	CDAVE1	38		19
357	930809	C-4	33		20
358	930809	C-5	30		26.5
359	930809	C-6	32		26
360	930809	CDAVE2	42		18
361	930809	D-1	35		28
362	930809	D-2	33		25
363	930809	D-3	36		22.5
364	930809	DDAVE1	.		.
365	930809	D-4	.		.
366	930809	D-5	.		27
367	930809	D-6	33		25
368	930809	DDAVE2	32		15.5
369					
370	Date	Site	%o T	%o B	
371	930813	A-1	32		24.5
372	930813	A-2	28		24.5
373	930813	A-3	.		.
374	930813	ADAVE-1	.		.
375	930813	A-4	33		31
376	930813	A-5	33		33
377	930813	A-6	33		23
378	930813	ADAVE2	.		.
379	930813	A-7	34		22
380	930813	A-8	37		21
381	930813	A-9	37		21
382	930813	ADAVE3	34		20
383	930813	B-1	38		47
384	930813	B-2	35		42
385	930813	B-3	.		.
386	930813	BDAVE1	.		.
387	930813	B-4	31		32
388	930813	B-5	33		29
389	930813	B-6	34		29
390	930813	BDAVE2	38		27
391	930813	B-7	37		29
392	930813	B-8	.		.
393	930813	B-9	34		30
394	930813	BDAVE3	.		.
395	930813	C-1	.		.
396	930813	C-2	34		22.5
397	930813	C-3	33		29
398	930813	CDAVE1	.		.
399	930813	C-4	32		24.5
400	930813	C-5	35		32

	A	B	C	D	E
401	930813	C-6	32		29.5
402	930813	CDAVE2	.		.
403	930813	D-1	30		34.5
404	930813	D-2	33		36
405	930813	D-3	34		29.9
406	930813	DDAVE1	.		.
407	930813	D-4	.		.
408	930813	D-5	.		.
409	930813	D-6	29		23.5
410	930813	DDAVE2	.		.
411					
412	Date	Site	%o T	%o B	
413	930817	A-1	30		3
414	930817	A-2	32		2
415	930817	A-3	32		3.5
416	930817	ADAVE-1	36		0
417	930817	A-4	32		7
418	930817	A-5	32		3
419	930817	A-6	32		7
420	930817	ADAVE2	36		0.5
421	930817	A-7	32		0
422	930817	A-8	32		0
423	930817	A-9	32		3.5
424	930817	ADAVE3	35		0
425	930817	B-1	35		6
426	930817	B-2	35		6.5
427	930817	B-3	36		5
428	930817	BDAVE1	34		4
429	930817	B-4	37		9
430	930817	B-5	38		5
431	930817	B-6	35		5.5
432	930817	BDAVE2	41		5
433	930817	B-7	42		7.5
434	930817	B-8	38		8
435	930817	B-9	38		2
436	930817	BDAVE3	38		6
437	930817	C-1	35		11
438	930817	C-2	37		9.5
439	930817	C-3	36		13.5
440	930817	CDAVE1	38		8
441	930817	C-4	36		5.5
442	930817	C-5	34		14.5
443	930817	C-6	34		15
444	930817	CDAVE2	36		13
445	930817	D-1	28		17.5
446	930817	D-2	38		15
447	930817	D-3	27		36
448	930817	DDAVE1	40		15
449	930817	D-4	.		.
450	930817	D-5	.		.

	A	B	C	D	E
451	930817	D-6	32		30
452	930817	DDAVE2	.		.
453					
454	Date	Site	%o T	%o B	
455	930824	A-1	31		8
456	930824	A-2	32		11
457	930824	A-3	35		13
458	930824	ADAVE-1	35		11
459	930824	A-4	34		16
460	930824	A-5	33		12
461	930824	A-6	32		17.5
462	930824	ADAVE2	37		0
463	930824	A-7	34		5.5
464	930824	A-8	32		6
465	930824	A-9	32		8
466	930824	ADAVE3	35		0
467	930824	B-1	31		5.5
468	930824	B-2	32		7
469	930824	B-3	36		5
470	930824	BDAVE1	32		5.5
471	930824	B-4	32		7
472	930824	B-5	34		4
473	930824	B-6	36		6
474	930824	BDAVE2	35		3
475	930824	B-7	36		6
476	930824	B-8	38		7
477	930824	B-9	34		1.5
478	930824	BDAVE3	38		0
479	930824	C-1	34		12
480	930824	C-2	36		8.5
481	930824	C-3	35		10.5
482	930824	CDAVE1	33		5
483	930824	C-4	32		14.5
484	930824	C-5	34		15.5
485	930824	C-6	35		5
486	930824	CDAVE2	34		11
487	930824	D-1	35		15.5
488	930824	D-2	34		12
489	930824	D-3	38		10
490	930824	DDAVE1	43		9.5
491	930824	D-4	30		16
492	930824	D-5	33		10
493	930824	D-6	32		8.5
494	930824	DDAVE2	33		7
495					
496					
497					
498					
499					
500					

	A	B	C	D	E
501					
502					
503					
504					
505					
506					
507					
508					
509					
510					
511					
512					
513					
514					
515					
516					
517					
518					
519					
520					
521					
522	DATE	Site	%o T	%o B	
523	940603	A-1	22		0
524	940603	A-2	26		21
525	940603	A-3	.		.
526	940603	ADAVE-1	29		20
527	940603	A-4	32		25
528	940603	A-5	24		29
529	940603	A-6	.		.
530	940603	ADAVE2	.		.
531	940603	A-7	.		.
532	940603	A-8	23		22
533	940603	A-9	29		18
534	940603	ADAVE3	.		.
535	940603	B-1	26		32
536	940603	B-2	26		34
537	940603	B-3	25		28
538	940603	BDAVE1	25		20
539	940603	B-4	26		16
540	940603	B-5	26		17
541	940603	B-6	28		15
542	940603	BDAVE2	26		13.5
543	940603	B-7	27		17
544	940603	B-8	26		17
545	940603	B-9	30		16.5
546	940603	BDAVE3	26		14.5
547	940603	C-1	25		19
548	940603	C-2	28		13.5
549	940603	C-3	25		13.5
550	940603	CDAVE1	22		13

	A	B	C	D	E
551	940603	C-4	26		12
552	940603	C-5	28		20
553	940603	C-6	28		20
554	940603	CDAVE2	28		17
555	940603	D-1	25		15
556	940603	D-2	29		13.5
557	940603	D-3	29		11
558	940603	DDAVE1	27		15
559	940603	D-4	24		25.5
560	940603	D-5	23		17
561	940603	D-6	22		9.5
562	940603	DDAVE2	24		13.5
563					
564	DATE	Site	%o T	%o B	
565	940608	A-1	23		11
566	940608	A-2	24		13
567	940608	A-3	30		14
568	940608	ADAVE-1	29		13.5
569	940608	A-4	31		14.5
570	940608	A-5	30		14
571	940608	A-6	31		8.5
572	940608	ADAVE2	30		13.5
573	940608	A-7	32		4
574	940608	A-8	32		5.5
575	940608	A-9	32		9
576	940608	ADAVE3	32		1
577	940608	B-1	27		47
578	940608	B-2	26		47.5
579	940608	B-3	.		.
580	940608	BDAVE1	27		20
581	940608	B-4	25		27.5
582	940608	B-5	25		24.5
583	940608	B-6	28		22
584	940608	BDAVE2	27		22
585	940608	B-7	34		29
586	940608	B-8	.		.
587	940608	B-9	33		22
588	940608	BDAVE3	28		19
589	940608	C-1	29		25.5
590	940608	C-2	26		17.5
591	940608	C-3	25		18
592	940608	CDAVE1	20		16
593	940608	C-4	24		13
594	940608	C-5	25		19
595	940608	C-6	28		25
596	940608	CDAVE2	26		20
597	940608	D-1	26		21.5
598	940608	D-2	29		18
599	940608	D-3	26		16.5
600	940608	DDAVE1	27		19

	A	B	C	D	E
601	940608	D-4	23		24.5
602	940608	D-5	23		22
603	940608	D-6	21		14
604	940608	DDAVE2	22		17
605					
606	DATE	Site	%o T	%o B	
607	940620	A-1	30		12.5
608	940620	A-2	26		12.5
609	940620	A-3	34		14
610	940620	ADAVE-1	31		13
611	940620	A-4	32		15.5
612	940620	A-5	32		14
613	940620	A-6	32		10
614	940620	ADAVE2	32		-13
615	940620	A-7	33		10
616	940620	A-8	32		10
617	940620	A-9	32		10
618	940620	ADAVE3	32		5.5
619	940620	B-1	32		34
620	940620	B-2	.		.
621	940620	B-3	28		40
622	940620	BDAVE1	.		.
623	940620	B-4	26		31
624	940620	B-5	31		35
625	940620	B-6	29		35
626	940620	BDAVE2	29		21.5
627	940620	B-7	36		9.5
628	940620	B-8	38		13
629	940620	B-9	38		10.5
630	940620	BDAVE3	37		10
631	940620	C-1	28		25
632	940620	C-2	.		25
633	940620	C-3	25		28
634	940620	CDAVE1	22		21.5
635	940620	C-4	24		22
636	940620	C-5	25		24
637	940620	C-6	28		30
638	940620	CDAVE2	26		22
639	940620	D-1	26		32
640	940620	D-2	30		28.5
641	940620	D-3	27		20
642	940620	DDAVE1	27		23
643	940620	D-4	23		32
644	940620	D-5	25		27
645	940620	D-6	24		21.5
646	940620	DDAVE2	25		23
647					
648	DATE	Site	%o T	%o B	
649	940623	A-1	32		1
650	940623	A-2	29		6

	A	B	C	D	E
651	940623	A-3	30		10.5
652	940623	ADAVE-1	32		7
653	940623	A-4	30		12
654	940623	A-5	30		8
655	940623	A-6	30		7
656	940623	ADAVE2	29		7
657	940623	A-7	32		2
658	940623	A-8	32		1
659	940623	A-9	31		6.5
660	940623	ADAVE3	32		-4
661	940623	B-1	31		4
662	940623	B-2	31		4
663	940623	B-3	30		0
664	940623	BDAVE1	33		0
665	940623	B-4	32		5
666	940623	B-5	32		3.5
667	940623	B-6	33		4
668	940623	BDAVE2	35		0
669	940623	B-7	35		3.5
670	940623	B-8	37		1
671	940623	B-9	38		6
672	940623	BDAVE3	37		2.5
673	940623	C-1	30		8.5
674	940623	C-2	31		5
675	940623	C-3	30		6
676	940623	CDAVE1	31		2
677	940623	C-4	30		0
678	940623	C-5	31		9
679	940623	C-6	33		9
680	940623	CDAVE2	30		5.5
681	940623	D-1	32		8
682	940623	D-2	30		7
683	940623	D-3	31		5
684	940623	DDAVE1	30		0
685	940623	D-4	31		6
686	940623	D-5	31		0.5
687	940623	D-6	28		-2
688	940623	DDAVE2	31		-4.5
689					
690	DATE	Site	%o T	%o B	
691	920901	A-1	31		12.1
692	920901	A-2	30		12.5
693	920901	A-3	30		9.8
694	920901	A-4	30		9.5
695	920901	A-5	30		14.0
696	920901	A-6	30		14.9
697	920901	A-7	30		8.0
698	920901	A-8	30		7.5
699	920901	A-9	28		10.8
700	920901	B-1	30		9.6

	A	B	C	D	E
701	920901	B-2	30		8.3
702	920901	B-3	29		7.5
703	920901	B-4	25		23.8
704	920901	B-5	26		11.4
705	920901	B-6	30		17.5
706	920901	B-7	31		8.3
707	920901	B-8	30		6.2
708	920901	B-9	28		3.8
709	920901	C-1	31		17.9
710	920901	C-2	31		5.8
711	920901	C-3	34.5		14.4
712	920901	C-4	30		14.8
713	920901	C-5	32		13.7
714	920901	C-6	30		11.6
715					
716	DATE	Site	%o T	%o B	
717	920905	A-1	30		21.8
718	920905	A-2	30		24.0
719	920905	A-3	31		19.5
720	920905	A-4	32		26.9
721	920905	A-5	32		26.4
722	920905	A-6	32		26.4
723	920905	A-7	30		20.9
724	920905	A-8	30		22.7
725	920905	A-9	34		10.8
726	920905	B-1	24		12.3
727	920905	B-2	18		13.8
728	920905	B-3	25		12.1
729	920905	B-4	24		21.0
730	920905	B-5	22		11.8
731	920905	B-6	20		16.6
732	920905	B-7	22		9.7
733	920905	B-8	20		6.7
734	920905	B-9	18		-3.1
735	920905	C-1	25		18.3
736	920905	C-2	24		7.2
737	920905	C-3	24		10.7
738	920905	C-4	28		15.3
739	920905	C-5	26		14.9
740	920905	C-6	28		12.1
741	920905	D-1	22		11.8
742	920905	D-2	24		12.9
743	920905	D-3	25		16.9
744	920905	D-4	16		16.4
745	920905	D-5	20		16.3
746	920905	D-6	20		5.4
747					
748	DATE	Site	%o T	%o B	
749	920821	A-1	25		24.6
750	920821	A-2	30		26.8

	A	B	C	D	E
751	920821	A-3	30		24.1
752	920821	A-4	29		28.3
753	920821	A-5	25		26.9
754	920821	A-6	26		27.3
755	920821	A-7	30		26.4
756	920821	A-8	30		27.3
757	920821	A-9	25		26.9
758	920821	B-1	16		14.6
759	920821	B-2	15		22.0
760	920821	B-3	25		24.1
761	920821	B-4	15		25.1
762	920821	B-5	13		13.7
763	920821	B-6	12		21.7
764	920821	B-7	14		10.7
765	920821	B-8	15		9.0
766	920821	B-9	15		4.7
767	920821	C-1	20		39.0
768	920821	C-2	20		27.0
769	920821	C-3	15		30.5
770	920821	C-4	22		35.5
771	920821	C-5	21		36.5
772	920821	C-6	21		35.5
773					
774					
775					
776					
777					
778					
779					
780					
781					
782					
783					
784					
785					
786					
787					
788					
789					
790					
791					
792					
793					
794					
795					
796					
797					
798					
799					
800	DATE	SITE	%o	DEPTH	

	A	B	C	D	E
801	930624	DAVE1	.	.	
802	930624	DAVE2	.	.	
803	930624	DAVE3	18	19.5	
804	930624	DAVE4	.	.	
805	930624	DAVE5	29	12	
806	930624	DAVE6	32	12.5	
807	930624	DAVE7	28	7	
808	930624	DAVE8	27	0	
809	930624	DAVE9	31	* 2	
810	930624	DAVE10	32	3.5	
811					
812	DATE	SITE	%o	DEPTH	
813	930723	DAVE1	15	24	
814	930723	DAVE2	12	17	
815	930723	DAVE3	28	1	
816	930723	DAVE4	28	10	
817	930723	DAVE5	35	7	
818	930723	DAVE6	45	5.5	
819	930723	DAVE7	40	2	
820	930723	DAVE8	35	* 3	
821	930723	DAVE9	36	* 4	
822	930723	DAVE10	39	0.5	
823					
824	DATE	SITE	%o	DEPTH	
825	930809	DAVE1	10	19	
826	930809	DAVE2	.	.	
827	930809	DAVE3	30	15	
828	930809	DAVE4	28	15.5	
829	930809	DAVE5	.	.	
830	930809	DAVE6	.	14	
831	930809	DAVE7	38	18	
832	930809	DAVE8	35	10	
833	930809	DAVE9	38	15	
834	930809	DAVE10	38	15.5	
835					
836	DATE	SITE	%o	DEPTH	
837	930813	DAVE1	.	.	
838	930813	DAVE2	.	.	
839	930813	DAVE3	26	18	
840	930813	DAVE4	.	.	
841	930813	DAVE5	.	.	
842	930813	DAVE6	48	15	
843	930813	DAVE7	.	.	
844	930813	DAVE8	31	13.5	
845	930813	DAVE9	.	.	
846	930813	DAVE10	.	.	
847					
848	DATE	SITE	%o	DEPTH	
849	930817	DAVE1	.	.	
850	930817	DAVE2	.	.	

	A	B	C	D	E
851	930817	DAVE3	.	.	
852	930817	DAVE4	.	.	
853	930817	DAVE5	35	18	
854	930817	DAVE6	36	16	
855	930817	DAVE7	36	6	
856	930817	DAVE8	35	3	
857	930817	DAVE9	35	0	
858	930817	DAVE10	37	5	
859					
860	DATE	SITE	%o	DEPTH	
861	930824	DAVE1	.	.	
862	930824	DAVE2	.	.	
863	930824	DAVE3	32	5.5	
864	930824	DAVE4	30	11	
865	930824	DAVE5	37	13	
866	930824	DAVE6	42	9	
867	930824	DAVE7	32	5	
868	930824	DAVE8	35	0	
869	930824	DAVE9	32	0	
870	930824	DAVE10	35	4.5	
871					
872	DATE	SITE	%o	DEPTH	
873	940603	DAVE1	.	.	
874	940603	DAVE2	.	.	
875	940603	DAVE3	15	4.5	
876	940603	DAVE4	11	7	
877	940603	DAVE5	12.5	14	
878	940603	DAVE6	.	.	
879	940603	DAVE7	25	12	
880	940603	DAVE8	27	10	
881	940603	DAVE9	28	13.5	
882	940603	DAVE10	30	14	
883					
884	DATE	SITE	%o	DEPTH	
885	940608	DAVE1	.	.	
886	940608	DAVE2	.	.	
887	940608	DAVE3	18	11.5	
888	940608	DAVE4	10	10	
889	940608	DAVE5	24	17.5	
890	940608	DAVE6	25	21	
891	940608	DAVE7	25	20	
892	940608	DAVE8	25	17	
893	940608	DAVE9	38	20	
894	940608	DAVE10	28	20	
895					
896	DATE	SITE	%o	DEPTH	
897	940620	DAVE1	.	.	
898	940620	DAVE2	.	.	
899	940620	DAVE3	20	16	
900	940620	DAVE4	14	23	

	A	B	C	D	E
901	940620	DAVE5	25	23	
902	940620	DAVE6	26	17.5	
903	940620	DAVE7	24	24	
904	940620	DAVE8	30	21	
905	940620	DAVE9	36	2	
906	940620	DAVE10	29	20	
907					
908	940623	DAVE1	.	.	
909	940623	DAVE2	.	.	
910	940623	DAVE3	25	-4.5	
911	940623	DAVE4	18	-2	
912	940623	DAVE5	30	3	
913	940623	DAVE6	32	3	
914	940623	DAVE7	33	0	
915	940623	DAVE8	30	-2	
916	940623	DAVE9	38	-3	
917	940623	DAVE10	34	2.5	

APPENDIX II- 29

MILL CREEK STUART FARM

WATER TABLE DATA

	A	B	C	D	E
1	DATE	SITE	%o	DEPTH	TIDE S/N
2	930610	SFL1A	6	-0.488479	N
3	930610	SFL1B	6	4.1198157	N
4	930610	SFL1C	14	11.953917	N
5	930610	SFL2A	4	2.2764977	N
6	930610	SFL2B	5	2.7373272	N
7	930610	SFL2C	12	9.1889401	N
8	930610	SFL3A	1	2.2764977	N
9	930610	SFL3B	3	5.5023041	N
10	930610	SFL3C	15	8.2672811	N
11	930610	SFL4A	0	4.5806452	N
12	930610	SFL4B	4	6.4239631	N
13	930610	SFL4C	1	-15.69585	N
14	930610	SFL5A	.	.	N
15	930610	SFL5B	.	.	N
16	930610	SFL5C	.	.	N
17	930610	SFU1A	0	17.9447	N
18	930610	SFU1B	0	18.40553	N
19	930610	SFU1C	0	10.110599	N
20	930610	SFU2A	0	21.170507	N
21	930610	SFU2B	0	21.170507	N
22	930610	SFU2C	0	11.032258	N
23	930610	SFU3A	0	20.248848	N
24	930610	SFU3B	0	16.562212	N
25	930610	SFU3C	0	7.3456221	N
26	930610	SFU4A	0	21.170507	N
27	930610	SFU4B	0	21.170507	N
28	930610	SFU4C	0	9.1889401	N
29	930610	SFU5A	0	18.866359	N
30	930610	SFU5B	0	21.170507	N
31	930610	SFU5C	0	8.7281106	N
32	930610	SFU6A	0	8.7281106	N
33	930610	SFU6B	0	20.248848	N
34	930610	SFU6C	0	21.170507	N
35				2.7373272	
36	DATE	SITE	%o	!VALUE	TIDE S/N
37	930617	SFL1A	5	12.875576	N
38	930617	SFL1B	6	19.327189	N
39	930617	SFL1C	13	4.5806452	N
40	930617	SFL2A	4	14.718894	N
41	930617	SFL2B	5	19.327189	N
42	930617	SFL2C	11	6.8847926	N
43	930617	SFL3A	1	14.718894	N
44	930617	SFL3B	3	18.40553	N
45	930617	SFL3C	11	4.5806452	N
46	930617	SFL4A	2	12.414747	N
47	930617	SFL4B	3	17.023041	N
48	930617	SFL4C	0	-20.30415	N
49	930617	SFL5A	.	.	N
50	930617	SFL5B	.	.	N

	A	B	C	D	E
51	930617	SFL5C	.	.	N
52	930617	SFU1A	0	16.562212	N
53	930617	SFU1B	0	17.023041	N
54	930617	SFU1C	0	6.8847926	N
55	930617	SFU2A	.	.	N
56	930617	SFU2B	.	.	N
57	930617	SFU2C	0	6.8847926	N
58	930617	SFU3A	0	2.7373272	N
59	930617	SFU3B	0	18.866359	N
60	930617	SFU3C	0	7.3456221	N
61	930617	SFU4A	.	.	N
62	930617	SFU4B	.	.	N
63	930617	SFU4C	0	8.2672811	N
64	930617	SFU5A	0	18.40553	N
65	930617	SFU5B	0	18.40553	N
66	930617	SFU5C	0	8.7281106	N
67	930617	SFU6A	0	17.483871	N
68	930617	SFU6B	0	20.248848	N
69	930617	SFU6C	0	19.327189	N
70				2.7373272	
71	DATE	SITE	%o	IVALUE	TIDE S/N
72	930624	SFL1A	10	0.4331797	S
73	930624	SFL1B	11	2.7373272	S
74	930624	SFL1C	16	8.2672811	S
75	930624	SFL2A	16	1.8156682	S
76	930624	SFL2B	10	1.3548387	S
77	930624	SFL2C	13	8.2672811	S
78	930624	SFL3A	3	5.0414747	S
79	930624	SFL3B	5	2.7373272	S
80	930624	SFL3C	17	4.5806452	S
81	930624	SFL4A	5	1.3548387	S
82	930624	SFL4B	3	3.6589862	S
83	930624	SFL4C	2	-26.75576	S
84	930624	SFL5A	.	.	S
85	930624	SFL5B	.	.	S
86	930624	SFL5C	.	.	S
87	930624	SFU1A	0	17.483871	S
88	930624	SFU1B	0	18.40553	S
89	930624	SFU1C	0	11.953917	S
90	930624	SFU2A	.	.	S
91	930624	SFU2B	.	.	S
92	930624	SFU2C	5	12.875576	S
93	930624	SFU3A	.	.	S
94	930624	SFU3B	.	.	S
95	930624	SFU3C	0	12.875576	S
96	930624	SFU4A	.	.	S
97	930624	SFU4B	.	.	S
98	930624	SFU4C	0	7.8064516	S
99	930624	SFU5A	0	17.483871	S
100	930624	SFU5B	0	18.40553	S

	A	B	C	D	E
101	930624	SFU5C	0	17.023041	S
102	930624	SFU6A	.	.	S
103	930624	SFU6B	.	.	S
104	930624	SFU6C	.	.	S
105				2.7373272	
106	DATE	SITE	%o	.	TIDE S/N
107	930714	SFL5A	20	7.8064516	N
108	930714	SFL5B	27	20.248848	N
109	930714	SFL5C	15	18.40553	N
110				2.7373272	
111	DATE	SITE	%o	.	TIDE S/N
112	930723	SFL1A	20	-0.02765	S
113	930723	SFL1B	18	0.8940092	S
114	930723	SFL1C	27	8.2672811	S
115	930723	SFL2A	15	2.7373272	S
116	930723	SFL2B	18	0.8940092	S
117	930723	SFL2C	20	7.3456221	S
118	930723	SFL3A	9	1.8156682	S
119	930723	SFL3B	12	1.8156682	S
120	930723	SFL3C	24	6.4239631	S
121	930723	SFL4A	12	-1.870968	S
122	930723	SFL4B	6	-0.488479	S
123	930723	SFL4C	5	-10.1659	S
124	930723	SFL5A	14	12.875576	S
125	930723	SFL5B	10	8.2672811	S
126	930723	SFL5C	21	7.3456221	S
127	930723	SFU1A	0	12.875576	S
128	930723	SFU1B	.	.	S
129	930723	SFU1C	0	21.170507	S
130	930723	SFU2A	0	19.788018	S
131	930723	SFU2B	0	21.170507	S
132	930723	SFU2C	2	17.9447	S
133	930723	SFU3A	0	25.778802	S
134	930723	SFU3B	0	17.9447	S
135	930723	SFU3C	.	.	S
136	930723	SFU4A	0	28.082949	S
137	930723	SFU4B	0	21.170507	S
138	930723	SFU4C	0	21.170507	S
139	930723	SFU5A	2	21.170507	S
140	930723	SFU5B	0	23.935484	S
141	930723	SFU5C	.	.	S
142	930723	SFU6A	0	20.248848	S
143	930723	SFU6B	0	24.857143	S
144	930723	SFU6C	.	.	S
145				2.7373272	
146	DATE	SITE	%o	.	TIDE S/N
147	930726	SFL5A	.	.	S
148	930726	SFL5B	12	21.170507	S
149	930726	SFL5C	.	.	S
150				2.7373272	

	A	B	C	D	E
151	DATE	SITE	%o	.	TIDE S/N
152	930809	SFL1A	21	12.414747	N
153	930809	SFL1B	21	17.9447	N
154	930809	SFL1C	25	8.7281106	N
155	930809	SFL2A	18	16.562212	N
156	930809	SFL2B	18	19.327189	N
157	930809	SFL2C	20	7.8064516	N
158	930809	SFL3A	8	17.483871	N
159	930809	SFL3B	12	18.40553	N
160	930809	SFL3C	22	7.3456221	N
161	930809	SFL4A	13	16.101382	N
162	930809	SFL4B	10	17.483871	N
163	930809	SFL4C	6	-16.61751	N
164	930809	SFL5A	15	18.40553	N
165	930809	SFL5B	.	.	N
166	930809	SFL5C	21	7.3456221	N
167	930809	SFU1A	.	.	N
168	930809	SFU1B	.	.	N
169	930809	SFU1C	.	.	N
170	930809	SFU2A	.	.	N
171	930809	SFU2B	0	20.248848	N
172	930809	SFU2C	0	13.336406	N
173	930809	SFU3A	.	.	N
174	930809	SFU3B	.	.	N
175	930809	SFU3C	.	.	N
176	930809	SFU4A	.	.	N
177	930809	SFU4B	.	.	N
178	930809	SFU4C	0	18.40553	N
179	930809	SFU5A	2	14.718894	N
180	930809	SFU5B	.	.	N
181	930809	SFU5C	.	.	N
182	930809	SFU6A	.	.	N
183	930809	SFU6B	0	20.248848	N
184	930809	SFU6C	0	18.40553	N
185				2.7373272	
186	DATE	SITE	%o	.	TIDE S/N
187	930813	SFL1A	15	18.40553	N
188	930813	SFL1B	.	.	N
189	930813	SFL1C	.	.	N
190	930813	SFL2A	.	.	N
191	930813	SFL2B	14	18.40553	N
192	930813	SFL2C	.	.	N
193	930813	SFL3A	4	18.40553	N
194	930813	SFL3B	.	.	N
195	930813	SFL3C	14	2.7373272	N
196	930813	SFL4A	6	18.866359	N
197	930813	SFL4B	5	19.327189	N
198	930813	SFL4C	4	-12.00922	N
199	930813	SFL5A	10	17.9447	N
200	930813	SFL5B	.	.	N

	A	B	C	D	E
201	930813	SFL5C	.	.	N
202	930813	SFU1A	.	.	N
203	930813	SFU1B	.	.	N
204	930813	SFU1C	.	.	N
205	930813	SFU2A	.	.	N
206	930813	SFU2B	0	19.788018	N
207	930813	SFU2C	0	15.179724	N
208	930813	SFU3A	.	.	N
209	930813	SFU3B	.	.	N
210	930813	SFU3C	.	.	N
211	930813	SFU4A	.	.	N
212	930813	SFU4B	.	.	N
213	930813	SFU4C	.	.	N
214	930813	SFU5A	.	.	N
215	930813	SFU5B	.	.	N
216	930813	SFU5C	.	.	N
217	930813	SFU6A	.	.	N
218	930813	SFU6B	.	.	N
219	930813	SFU6C	0	9.1889401	N
220				2.7373272	
221	DATE	SITE	%o	!VALUE	TIDE S/N
222	930817	SFL1A	20	-1.870968	S
223	930817	SFL1B	25	-0.02765	S
224	930817	SFL1C	25	0.4331797	S
225	930817	SFL2A	18	0.8940092	S
226	930817	SFL2B	18	-0.949309	S
227	930817	SFL2C	25	-0.488479	S
228	930817	SFL3A	14	-0.02765	S
229	930817	SFL3B	15	1.8156682	S
230	930817	SFL3C	20	2.7373272	S
231	930817	SFL4A	18	2.7373272	S
232	930817	SFL4B	10	-0.949309	S
233	930817	SFL4C	12	-4.635945	S
234	930817	SFL5A	20	12.875576	S
235	930817	SFL5B	15	6.4239631	S
236	930817	SFL5C	22	6.4239631	S
237	930817	SFU1A	.	.	S
238	930817	SFU1B	.	.	S
239	930817	SFU1C	.	.	S
240	930817	SFU2A	.	.	S
241	930817	SFU2B	.	.	S
242	930817	SFU2C	0	17.483871	S
243	930817	SFU3A	.	.	S
244	930817	SFU3B	.	.	S
245	930817	SFU3C	.	.	S
246	930817	SFU4A	.	.	S
247	930817	SFU4B	0	20.248848	S
248	930817	SFU4C	.	.	S
249	930817	SFU5A	2	17.023041	S
250	930817	SFU5B	0	19.788018	S

	A	B	C	D	E
251	930817	SFU5C	.	.	S
252	930817	SFU6A	.	.	S
253	930817	SFU6B	.	.	S
254	930817	SFU6C	0	17.023041	S
255				2.7373272	
256	DATE	SITE	%o	!VALUE	TIDE S/N
257	930823	SFL1A	20	4.5806452	S
258	930823	SFL1B	26	5.0414747	S
259	930823	SFL1C	26	11.493088	S
260	930823	SFL2A	20	3.6589862	S
261	930823	SFL2B	18	5.5023041	S
262	930823	SFL2C	26	8.7281106	S
263	930823	SFL3A	12	2.7373272	S
264	930823	SFL3B	15	4.1198157	S
265	930823	SFL3C	25	7.3456221	S
266	930823	SFL4A	14	3.0138249	S
267	930823	SFL4B	12	3.0138249	S
268	930823	SFL4C	12	8.2672811	S
269	930823	SFL5A	20	11.953917	S
270	930823	SFL5B	16	13.336406	S
271	930823	SFL5C	24	8.2672811	S
272	930823	SFU1A	0	14.718894	S
273	930823	SFU1B	.	20.248848	S
274	930823	SFU1C	.	.	S
275	930823	SFU2A	0	19.788018	S
276	930823	SFU2B	.	.	S
277	930823	SFU2C	0	17.023041	S
278	930823	SFU3A	.	.	S
279	930823	SFU3B	.	.	S
280	930823	SFU3C	.	.	S
281	930823	SFU4A	.	.	S
282	930823	SFU4B	0	20.248848	S
283	930823	SFU4C	0	17.483871	S
284	930823	SFU5A	1	16.562212	S
285	930823	SFU5B	0	19.788018	S
286	930823	SFU5C	.	.	S
287	930823	SFU6A	.	.	S
288	930823	SFU6B	0	18.40553	S
289	930823	SFU6C	0	16.101382	S
290				2.7373272	
291	DATE	SITE	%o	!VALUE	TIDE S/N
292	940603	SFL1A	5	13.797235	N
293	940603	SFL1B	15	16.562212	N
294	940603	SFL1C	17	6.8847926	N
295	940603	SFL2A	11	12.875576	N
296	940603	SFL2B	17	19.327189	N
297	940603	SFL2C	10	5.0414747	N
298	940603	SFL3A	11	16.562212	N
299	940603	SFL3B	9	17.023041	N
300	940603	SFL3C	9	13.797235	N

	A	B	C	D	E
301	940603	SFL4A	5	19.327189	N
302	940603	SFL4B	9	19.327189	N
303	940603	SFL4C	9	18.40553	N
304	940603	SFL5A	14	19.327189	N
305	940603	SFL5B	.	.	N
306	940603	SFL5C	14	11.493088	N
307	940603	SFU1A	5	8.2672811	N
308	940603	SFU1B	7	9.1889401	N
309	940603	SFU1C	7	6.8847926	N
310	940603	SFU2A	11	7.3456221	N
311	940603	SFU2B	10	2.7373272	N
312	940603	SFU2C	12	8.7281106	N
313	940603	SFU3A	.	.	N
314	940603	SFU3B	.	.	N
315	940603	SFU3C	9	-11.08756	N
316	940603	SFU4A	9	8.7281106	N
317	940603	SFU4B	.	.	N
318	940603	SFU4C	9	6.8847926	N
319	940603	SFU5A	10	19.788018	N
320	940603	SFU5B	10	11.953917	N
321	940603	SFU5C	10	16.562212	N
322	940603	SFU6A	4	11.953917	N
323	940603	SFU6B	5	13.797235	N
324	940603	SFU6C	.	.	N
325				2.7373272	
326	DATE	SITE	%o	!VALUE	TIDE S/N
327	940608	SFL1A	6	8.2672811	N
328	940608	SFL1B	15	20.248848	N
329	940608	SFL1C	19	7.3456221	N
330	940608	SFL2A	12	16.101382	N
331	940608	SFL2B	16	18.866359	N
332	940608	SFL2C	13	6.4239631	N
333	940608	SFL3A	14	7.3456221	N
334	940608	SFL3B	7	23.013825	N
335	940608	SFL3C	10	19.327189	N
336	940608	SFL4A	4	21.170507	N
337	940608	SFL4B	10	19.327189	N
338	940608	SFL4C	10	15.640553	N
339	940608	SFL5A	15	23.013825	N
340	940608	SFL5B	9	22.092166	N
341	940608	SFL5C	17	11.032258	N
342	940608	SFU1A	8	3.6589862	N
343	940608	SFU1B	12	8.2672811	N
344	940608	SFU1C	14	7.3456221	N
345	940608	SFU2A	12	4.5806452	N
346	940608	SFU2B	7	2.7373272	N
347	940608	SFU2C	16	9.1889401	N
348	940608	SFU3A	13	16.562212	N
349	940608	SFU3B	16	23.013825	N
350	940608	SFU3C	12	11.493088	N

	A	B	C	D	E
351	940608	SFU4A	11	11.493088	N
352	940608	SFU4B	15	22.092166	N
353	940608	SFU4C	15	9.1889401	N
354	940608	SFU5A	12	14.718894	N
355	940608	SFU5B	15	11.953917	N
356	940608	SFU5C	10	16.562212	N
357	940608	SFU6A	5	8.2672811	N
358	940608	SFU6B	8	11.032258	N
359	940608	SFU6C	15	21.170507	N
360					
361	DATE	SITE	%o	IVALUE	TIDE S/N
362	940620	SFL1A	18	5.5023041	S
363	940620	SFL1B	21	8.2672811	S
364	940620	SFL1C	20	5.9631336	S
365	940620	SFL2A	12	21.170507	S
366	940620	SFL2B	19	11.493088	S
367	940620	SFL2C	19	5.5023041	S
368	940620	SFL3A	10	18.866359	S
369	940620	SFL3B	20	11.953917	S
370	940620	SFL3C	18	-13.85253	S
371	940620	SFL4A	18	11.953917	S
372	940620	SFL4B	13	11.032258	S
373	940620	SFL4C	15	20.248848	S
374	940620	SFL5A	14	21.170507	S
375	940620	SFL5B	18	16.562212	S
376	940620	SFL5C	20	10.571429	S
377	940620	SFU1A	15	2.7373272	S
378	940620	SFU1B	19	6.4239631	S
379	940620	SFU1C	19	6.4239631	S
380	940620	SFU2A	17	2.7373272	S
381	940620	SFU2B	15	-1.870968	S
382	940620	SFU2C	21	9.1889401	S
383	940620	SFU3A	20	21.170507	S
384	940620	SFU3B	22	21.170507	S
385	940620	SFU3C	22	11.953917	S
386	940620	SFU4A	20	9.6497696	S
387	940620	SFU4B	15	18.866359	S
388	940620	SFU4C	20	11.032258	S
389	940620	SFU5A	20	19.327189	S
390	940620	SFU5B	21	11.953917	S
391	940620	SFU5C	20	13.797235	S
392	940620	SFU6A	10	5.5023041	S
393	940620	SFU6B	18	8.2672811	S
394	940620	SFU6C	20	21.170507	S
395					
396	DATE	SITE	%o		TIDE S/N
397	940623	SFL1A	21	0.8940092	S
398	940623	SFL1B	24	0.8940092	S
399	940623	SFL1C	25	10.110599	S
400	940623	SFL2A	22	-0.02765	S

	A	B	C	D	E
401	940623	SFL2B	22	0.4331797	S
402	940623	SFL2C	23	5.0414747	S
403	940623	SFL3A	24	0.4331797	S
404	940623	SFL3B	18	0.8940092	S
405	940623	SFL3C	20	7.3456221	S
406	940623	SFL4A	22	2.7373272	S
407	940623	SFL4B	24	0.4331797	S
408	940623	SFL4C	21	24.857143	S
409	940623	SFL5A	22	16.562212	S
410	940623	SFL5B	22	-15.69585	S
411	940623	SFL5C	25	11.953917	S
412	940623	SFU1A	15	2.7373272	S
413	940623	SFU1B	16	3.6589862	S
414	940623	SFU1C	24	7.3456221	S
415	940623	SFU2A	21	-2.792627	S
416	940623	SFU2B	10	-3.714286	S
417	940623	SFU2C	25	8.2672811	S
418	940623	SFU3A	23	21.170507	S
419	940623	SFU3B	25	22.092166	S
420	940623	SFU3C	25	10.571429	S
421	940623	SFU4A	23	9.6497696	S
422	940623	SFU4B	22	17.483871	S
423	940623	SFU4C	24	7.3456221	S
424	940623	SFU5A	25	18.40553	S
425	940623	SFU5B	24	11.493088	S
426	940623	SFU5C	25	9.1889401	S
427	940623	SFU6A	13	4.5806452	S
428	940623	SFU6B	21	7.3456221	S
429	940623	SFU6C	25	14.718894	S

APPENDIX III

An assessment of: "A Manual for monitoring mitigation and restoration projects on New Hampshire's Salt Marshes", by Normandeau Associates, Inc., with appropriate management recommendations and suggestions for improvement of the document.

The Manual not only provides a good plan to organize data for assessment of individual projects, it provides an important step to establish and standardize a database and help organize monitoring data for assessment of mitigation and restoration projects throughout New Hampshire and perhaps northern New England. It is intended for use by professionals concerned with salt marsh resources and functions. The goal of the Manual is to provide a framework within which professionals may develop and implement a long-term monitoring program to assess the success (or failure) of mitigation and restoration projects. By suppling such a framework, the authors hope to: 1) focus the development of the monitoring plan on assessing functions critical to the goals of the specific project, 2) simplify determination of the level of effort required to monitor such projects, and 3) provide standardization of the types and frequency of data collection, so a large database will be available in the future from which to judge mitigation and restoration projects. The Manual decomposes monitoring programs into two efforts: Routine and Comprehensive. Routine monitoring includes observations and measurements necessary to assess the establishment of appropriate vegetation at a site, whereas Comprehensive monitoring is invoked to address specific goals of a project or if the basic vegetation goal is not being approached in a satisfactory manner.

Overall, the Manual is well-written and comprehensive. Most sections of the Manual appear to be well-researched. However, some sections still contain data gaps. These are not crucial points, but should be included. For example: improvement of water quality by removal of suspended sediments in marshes, herbivory and use of salt marshes by deer, and function of salt marsh vegetation in maintaining intertidal habitat as sea level rises, are all important points that have been omitted.

Much of the Manual's utility derives from its generality, so the principles may be applied to different projects. However, the procedures for setting up transects (Appendix A) and the data forms (Appendix B) are specific and may be inappropriate for many if not most projects. Therefore, the forms should indicate that these are merely general examples and modified transect designs and data forms may have to be developed for many projects. In fact, the assessor is directed to set up transects from a reference site to the project, but there is no space on the forms for the reference data. Thus, two examples applied to actual projects (one hydrologic restoration, the other a mitigation-creation project) using real data should be included in the Manual to aid the user.

Although it is clear that the monitoring design should be established prior to the beginning of the restoration or mitigation project and that many projects require baseline monitoring, there is no specific sampling period designated as a baseline period and there are no baseline forms for monitoring. The collection of baseline data should be included in the overall design of many projects, and it should be included as a separate sampling period.

The routine monitoring may require too much data collection for some project budgets. The focus on elevations and slopes requires much detailed information, some of which may not be available for a site (i.e., NGVD). Additionally, efforts spent on measuring surface water salinity may best be used placing simple wells at permanent sampling transects for measuring salinity of the pore water. The well data collected for the bulk of this report provided excellent information to assess the effectiveness of the hydrologic restoration efforts at Awcomin Marsh, Rye and at Mill Creek in Stuart Farm.

Unfortunately, there are no criteria for measuring success of the different parameters, not to mention whole projects. What are the criteria that cause a component of a project to be judged satisfactory or unsatisfactory? For example what is good vegetative cover and how much is needed for a project to be considered a success or a failure requiring remediation? How is productivity estimated from cover, density and height measurements? And, if 18% of the *Spartina alterniflora* shoots are flowering, what can we infer? It appears that such criteria were supposed to be included as part of the Manual (Page 3, sentence #1), but the concept was only alluded to in the text by offering data on natural marshes in New England and New Hampshire. Falling short of providing such criteria, the aim of the Manual could be interpreted as setting up the framework for comparisons, with the actual criteria established separately for each project. The establishment of a statewide or regional database (for example the Acadian Province) with success criteria for several of the measures in this manual would be welcomed. For example, since plant height and density are inversely correlated, these data could be an important criteria for assessing success of the vegetation. Measures of height and density of plants could be placed on two axes of a graph to construct an envelope of height-density values in natural marshes for each species. The restored or created marsh data then could be plotted over time to show how and if the plant stands in the created marsh are approaching the envelope of natural marsh plant stands.

The methods for assessment of sediment budgets were inadequate. In section 2.4 of the Manual, it is suggested that the sources, frequency and quality of sediment be examined. The meaning of frequency is not explained. Also, observations assessing sediment accretion are called for on the data forms, but no practical methods of how these observations might be made are in the sampling protocols (Appendix A). In addition, no methods for the design or establishment of permanent photographic sites were discussed.

In Appendix D, Diagnostics, the smothering of salt marsh vegetation by algae is included in the section on wrack. If the algae is dead, this and the corrective suggestions made are appropriate. If the algae is alive, the addition of fertilizer will only exacerbate the problem and should be avoided.

Although we realize that some may have been inappropriate, many of the suggestions made in 1992 by Burdick were not incorporated into the report. For example, he requested that the section on animals (4.2.4) be made specific for New Hampshire and suggested that the section on fiddler crabs be removed, since there are no fiddler crabs in New Hampshire. In the new version, the section remained general for New England, but the fiddler crab paragraph was deleted, resulting in the section being too general and now with an information gap about the activities of fiddler crabs.

The Manual needs to be revised and expanded to include 1) the above suggestions, 2) examples of assessments from two projects, and 3) assessment criteria. A set of as-built data forms and a set of as-built assessment forms should be filled out for the two most common types of projects: a hydrologic restoration project and a mitigation-creation project. The suggested revisions should be made to increase the value and utility of the Manual for those that assess marsh projects and resource and managers.