RESTORATION OF MIGRATORY AND
WINTERING WATERFOWL HABITAT
IN COASTAL IMPOUNDMENTS OF
DELAWARE

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Attachment C

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INTRODUCTION

Delaware is the smallest of the Mid-Atlantic States and is situated upon the Delmarva Peninsula which separates the Chesapeake Bay to the west from the Delaware Bay to the east. The eastern boundary of the State is formed by the Delaware River in the north and the Delaware Bay and Atlantic Ocean along the central and southern portions. There are an estimated 83,420 acres of estuarine wetlands within the State which form an important link in the Atlantic Flyway followed by waterfowl on their seasonal migrations from the Canadian north to major wintering areas in the southeastern United States. Several hundred thousand ducks and geese pass through the Delaware Estuary during the fall and spring with significant numbers of some species remaining throughout the winter months. Black duck, mallard, brant, canada geese and greater snow geese are among the most important wintering species in Delaware with numbers varying with the severity of the weather.

Delaware is located in the most densely populated section of the country and human actions have had a significant impact upon its wetlands. Most activities have been detrimental and have resulted in the loss and/or degradation of valuable wetland

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habitat. Since 1938 nearly 10 percent of the State's tidal wetlands has been lost to filling and draining activities for housing, industry and highways (Tiner, R. W. et. al., 1985). Fortunately during this same period, key areas of waterfowl habitat were acquired by state and federal wildlife agencies and waterfowl management intensified on both public and private land in an attempt to halt or reverse declining populations of some waterfowl species.

Impoundment of tidal wetlands was viewed as one effective means of improving and maintaining waterfowl habitat. Although that practice is no longer acceptable to agencies responsible for wetland protection and management, many of the early coastal impoundments currently exist and are being maintained in Delaware. Those impoundments vary in size from a few acres to over 1000 acres and may represent a total area of 10,000 acres of the State's coastal wetlands. Many of the larger impoundments were originally constructed for mosquito control but have also functioned effectively as waterfowl management areas. Early management practices were designed to create breeding habitat and provide concentration areas for migrating and wintering waterfowl. Initially good food and cover were provided and waterfowl responded positively; however, as time progressed, emergent vegetation died out leaving openwater impoundments with a scarcity of plant and invertebrate foods. They continue to be used as resting areas for migrants and function as areas of high harvest but production has been almost eliminated in some while very little food and virtually no cover are provided for migrating and wintering birds.

In late 1985, studies were initiated by the Delaware Division of Fish and Wildlife to identify limiting factors for waterfowl habitat within high level coastal impoundments and recommend methods for improving conditions. The studies are being supported by the Coastal Management Program through a federal grant from the Office of Ocean and Coastal Resource Management and are intended to continue over a five year period. Initial emphasis has been placed on soil and water characteristics as major influences determining the quantity, quality and distribution of aquatic vegetation. Vegetation recovery is considered to be the first requirement for the restoration of plant and invertebrate foods and cover essential to waterfowl populations.

DESCRIPTION OF STUDY AREA

A 640 acre impoundment on the Little Creek Wildlife Area near Little Creek, Delaware was selected for research and treatment. This impoundment was created in 1959 by constructing low earthern dikes to connect an area of low and high tide marsh to the upland. During the early years, the impoundment was dominated by dense stands of salt hay (*Spartina patens*); saltmarsh cordgrass (*Spartina alterniflora*); and salt grass (*Distichlis spicata*) and water levels were maintained by pumping tide water into the impoundment to supplement freshwater runoff. By 1985, conditions had deteriorated to the point that only reminant stands of saltmarsh cordgrass, salt hay and salt grass remained. Most of the area was dominated by mud flats devoid of vegetation with fringes of reed grass (Phragmites australis); rose mallow (Hibiscus moschesutos); high tide bush (Iva frutescens); groundsel bush (Baccharis halimifolia) and various trees and shrubs near the upland. Important waterfowl food plants were absent over most of the area and waterfowl use was greatly reduced particularly during the breeding season. Brood surveys conducted in the early 1960's estimated duck production to be 2.3 birds per acre of habitat (Lesser, 1965) which compared favorably to some of the best waterfowl marshes in the country (Beard 1953; Evans and Black 1956; Keith 1961; and Whitman 1973). In 1986, surveys of the same area estimated production at 0.13 birds per acre which is 90% lower than in the 1960's. Wintering and migrating waterfowl continue to use the area for resting but derive very little protection or feeding opportunity. Canada geese (Branta canadensis); snow geese (Chen hyperborea); black duck (Anas rubripes); mallard (Anas platychynchos); shoveler (Spatula clypeata); blue-winged teal (Anas discors); green-winged teal (Anas carolinensis); pintail (Anas acuta); gadwall (Anas strepera); American wigeon (Marcea americana) and scaup (Aythya spp.) are the major species observed as migrants and wintering adults.

Recent surveys of conditions within the impoundment identified salinity in the soil and water as the most obvious limiting factor to waterfowl habitat. Water level management since the construction of the impoundment has consisted of pumping tidal water into the area prior to the opening of the hunting season each year. Throughout the remainder of the year, water levels were allowed to fluctuate with rainfall and runoff. This resulted in extremely low levels during periods of low rainfall and high evaporation in mid-summer. Over an annual cycle, water salinities were found to vary from near zero in the spring to over 90 ppt in the mid-summer. Soil salinities reflected even higher levels with concentrations commonly exceeding 150 ppt. Saltmarsh cordgrass has been found to die back at water salinities above 45 ppt and to be completely eliminated at levels over 55 ppt (Shiflet 1963). Salt hay and salt grass are even less tolerant of high salinities and, thus, the average salinity levels within the impoundment obviously limited the growth of all emergent vegetation.

Past water management has also prevented nutrient exchange with the estuary, raised the impoundment level by silt deposition and reduced the diversity of invertebrate foods available to waterfowl. The lack of flushing action retained nutrients within the impoundment resulting in high concentrations of nitrates and associated dense algal blooms. Silt in the tidal water pumped into the impoundment was allowed to settle annually causing deposits to accumulate to depths up to 12 inches. This buried the original root mat and seed sources which further inhibited vegetation maintenance. Marco-invertebrates important to wintering waterfowl such as air breathing snails were eliminated with only a few families such as backswimmers, water boatmen, chironomids, amphipods and aquatic beetles surviving as food items. Long periods of flooding will continue to eliminate most snails, but other invertebrates will undoubtedly become more abundant and available to waterfowl as emergent vegetation is restored.

APPLIED MANAGEMENT

While the need for water level management within waterfowl impoundments has long been recognized and practiced intensively in some areas, management to restore severly deteriorated habitats is relatively new especially in the Mid-Atlantic Region. Several large impoundments in Delaware require intensive waterlevel management to restore habitat and maximize waterfowl use; thus, the techniques that have been applied to the Little Creek impoundment are being carefully evaluated and will eventually be extended to all areas with similar needs.

The approach at Little Creek has included the application of a flushing schedule to reduce soil and water salinities and maintain levels conducive to the growth of aquatic vegetation. To develop the desired water level management capability, two water control structures were installed on the Little Creek impoundment. The structures were patterned after the wooden trunk used extensively in South Carolina, but were constructed from a four foot diameter, corrugated aluminum pipe fitted with an adjustable flap gate on the impoundment end.

On the tidal end, a concave door was attached that can be manually opened and closed to exclude tidal influence. This design which also includes a splash board riser permits the manipulation of water levels and circulation with a precision similar to that provided by the Carolina truck.

Installation of the structures was completed in early April, 1987 and a schedule of drawdowns was initiated. A total of six drawdowns were conducted between April and November, 1987. Periods of drawdown varied from less than one week to slightly more than six weeks. Salinities in surface water and interstitial soil water were measured at ten permanent sample sites throughout the impoundment periodically throughout the drawdown schedule to determine average values for each period.

In addition to salinity in soil and surface water, several other chemical variables were regularly monitored including pH, dissolved oxygen, specific conductance, carbon dioxide, ammonia, hardness, chloride, sodium and nitrates. An indepth consideration of these variables is not given in this paper except to note the relatively high levels of nitrates which are conducive to algal blooms. As the ability to manipulate water levels to control salinity increases, it may become important to modify or control other chemical variables; however, immediate emphasis is limited to management of salinity levels.

Permanent vegetation transects were established within the impoundment in 1986 prior to any water level management. The transects were examined in August of 1986 and 1987 to document changes in dominant emergent vegetation types resulting from water level management. Together with photographic records, vegetation response has been determined and refinements in water management are being developed.

RESULTS

Soil and Water Salinity

The first drawdown was accomplished on April 6 and continued for a period of 36 days. This drawdown followed a long period of maximum flood conditions during the winter months which was characterized by lower soil and water salinities. Minimum evaporation and abundant rainfall during the initial drawdown helped to maintain relatively low salinities throughout the period with only minimal increases over predrawdown conditions. The impoundment was reflooded on May 11, 1987 with tidewater having a salinity of 13-15 ppt. Although the tidal water used for flooding was low in salinity, salt levels within the impoundment increased noticeably, probably as a result of salts being dissolved from the substrate, low rainfall and higher evaporation. As soil and water salinities reached levels considered maximum for optimum waterfowl habitat management (32 ppt in soil and 17 ppt in water), a second drawdown was initiated on May 26, 1987. The second drawdown was maintained for a period of 46 days during which both soil and water salinities reached levels well above those necessary for maintenance of emergent vegetation (78 ppt in soil and 42 ppt in water). It was obvious that a drawdown of this duration was too lengthy to maintain optimum salinity levels.

Reflooding of the impoundment gradually reduced salt levels to 48 ppt in the top cm of soil and 27 ppt in the water. Succeeding drawdowns ranged in duration from 3 to 24 days and were successful in maintaining salinity levels in the water below 30 ppt and only slightly above adjacent salt marsh levels which averaged 22-27 ppt. Soil salinities, however, continued to be excessive during drawdown and probably reflect an accumulated salt concentration in the substrate. Both soil and water salinities during the intervening flood periods remained comparable to adjacent saltmarsh levels. Figure 1 shows the response of soil and water salinities to waterlevel manipulation in 1987.

Our initial attempts to flush excess salts from the impoundment appears to have had some success. Extreme salt concentrations that occurred prior to water level management were prevented in 1987, and although levels continued to be higher than desired, there is reason to be optimistic that a schedule of drawdown can be perfected to eventually stabilize salinities and permit management of the impoundment as a brackish saline wetland.

Emergent Vegetation

The response of important vegetation types to water management and salinity reduction has been encouraging. The most significant gains have been recorded in reminant stands of saltmarsh cordgrass. Both the permament vegetation transects and photographic records show significant expansion of that species during 1987. Figure 2 demonstrates the expansion of saltmarsh cordgrass along vegetation transects even though density decreased in some segments. This expansion was associated with a parallel but temporary increase in salt tolerant species such as

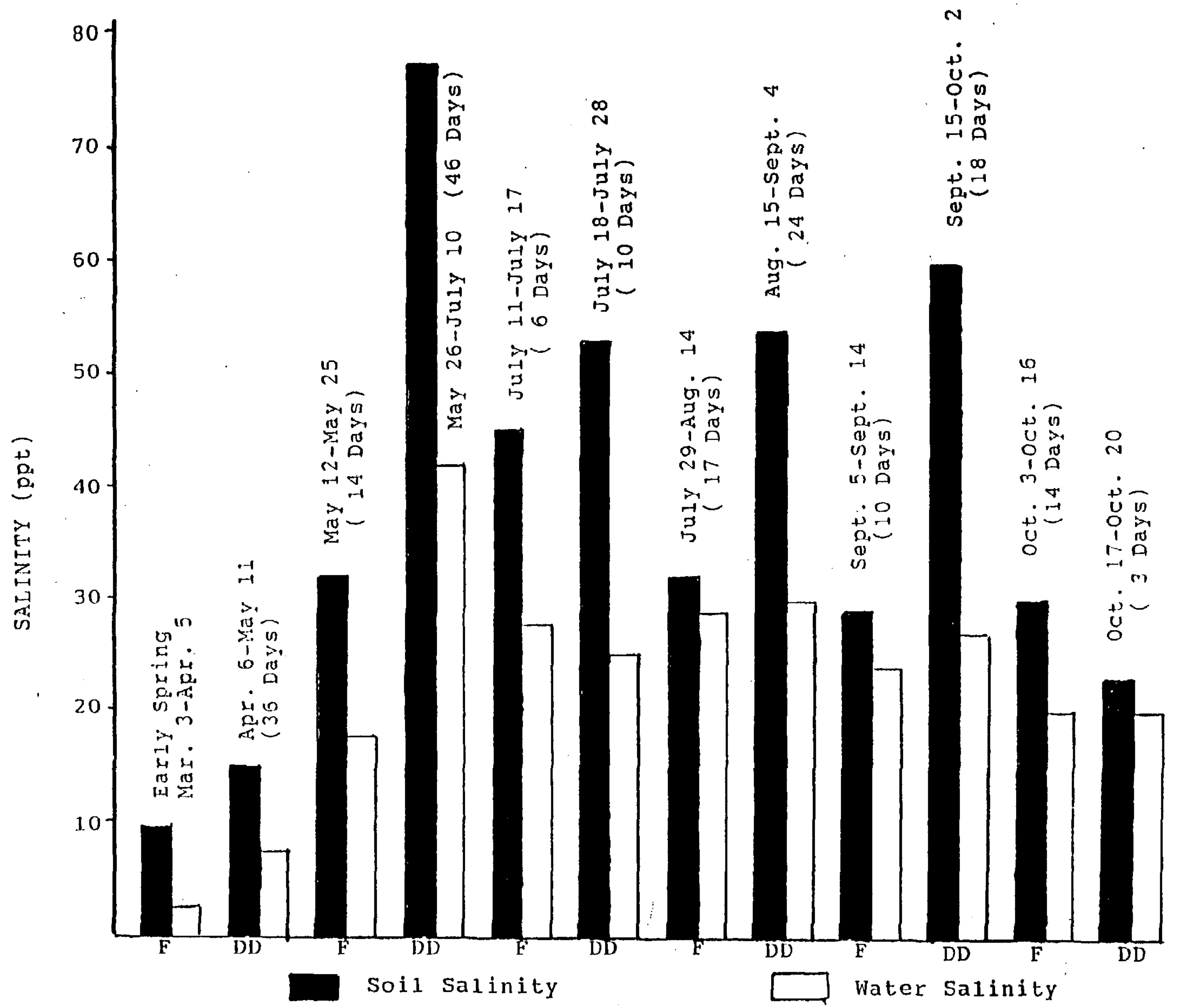

FIGURE 1:THE EFFECT OF DRAWDOWN ON SOIL AND WATER SALINITY

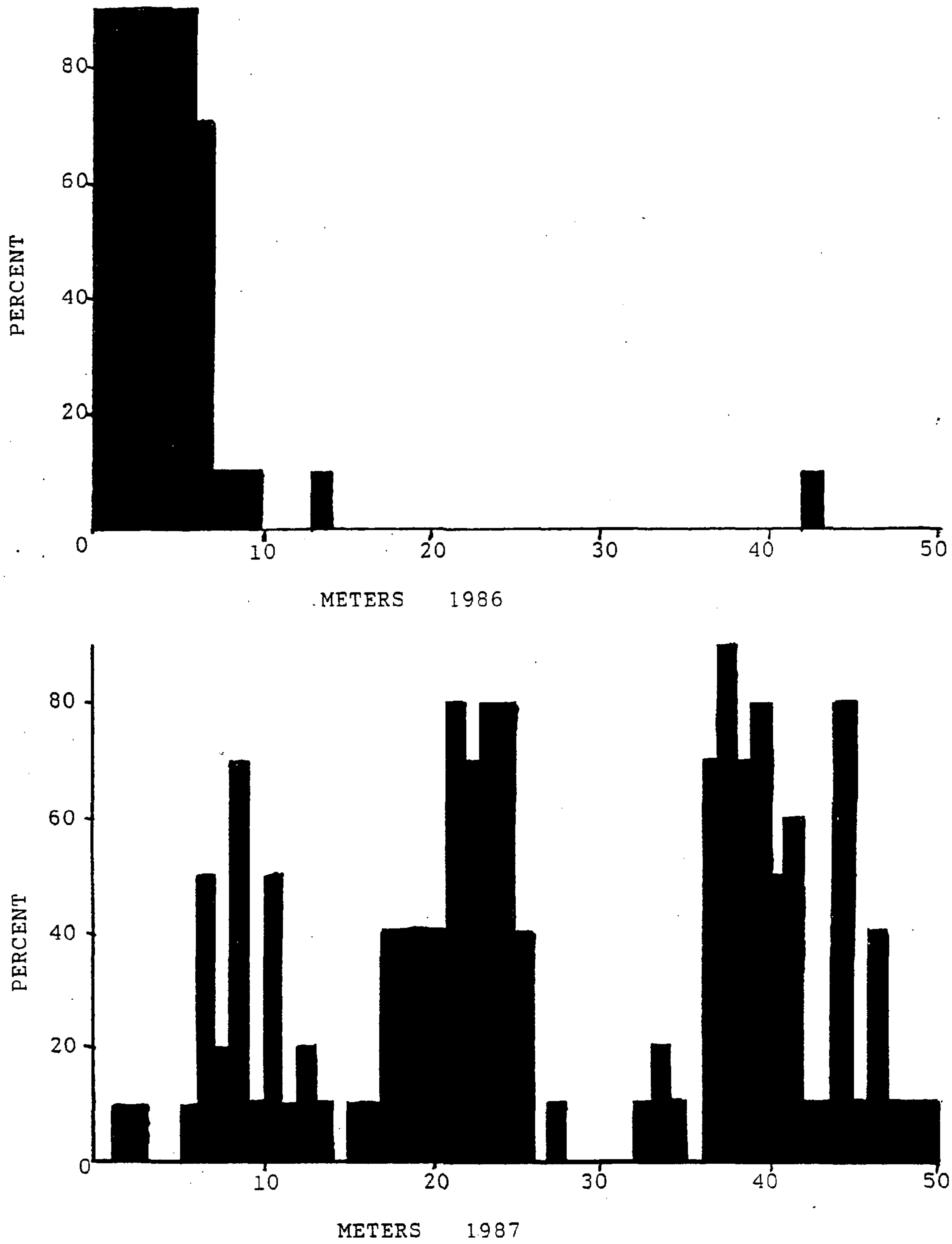

FIGURE 2:

Distribution of <u>Spartina alterniflora</u> Along Vegetation Transect in 1986 and 1987

Bassia sp and Salicornia sp (Figure 3). Early in the season the latter species dominated the vegetative recovery in the impoundment but by late August significant die backs occurred and cordgrass appeared to flourish in segments initially dominated by Bassia. It can be speculated that as salinities, particularly in the soil, were reduced, the salt tolerant species found optimum conditions for growth. With continued salinity reduction and improved water circulation, conditions favored saltmarsh cordgrass which allowed that species to out compete Bassia and Salicornia. Areas of salt hay did not respond to management in 1987. Reminant stands of salt hay neither expanded or became reduced in area as a result of salinity moderation.

An extensive survey of soil salinities in the remaining healthy stands of salt hay, saltmarsh cordgrass and Bassia sp within the impounded area appeared to present a clear explanation of the pattern of vegetation recovery (Table 1). Soil salinity levels within stands of salt hay were less than 30 ppt both at the surface and at a depth of 16-20 cm. Salinities throughout the impoundment almost always exceeded those levels thus preventing any expansion in that vegetative type. Levels recorded in Bassia sp. and Salicornia sp. ranged from a high of 144 ppt at the surface to a low of 15 ppt at a depth of 16-20 cm. Average values were 83 ppt and 39 ppt, respectively. Obviously those levels were reached early in the water level management program permitting growth and expansion of those salt tolerant species. As salinities became further reduced, saltmarsh

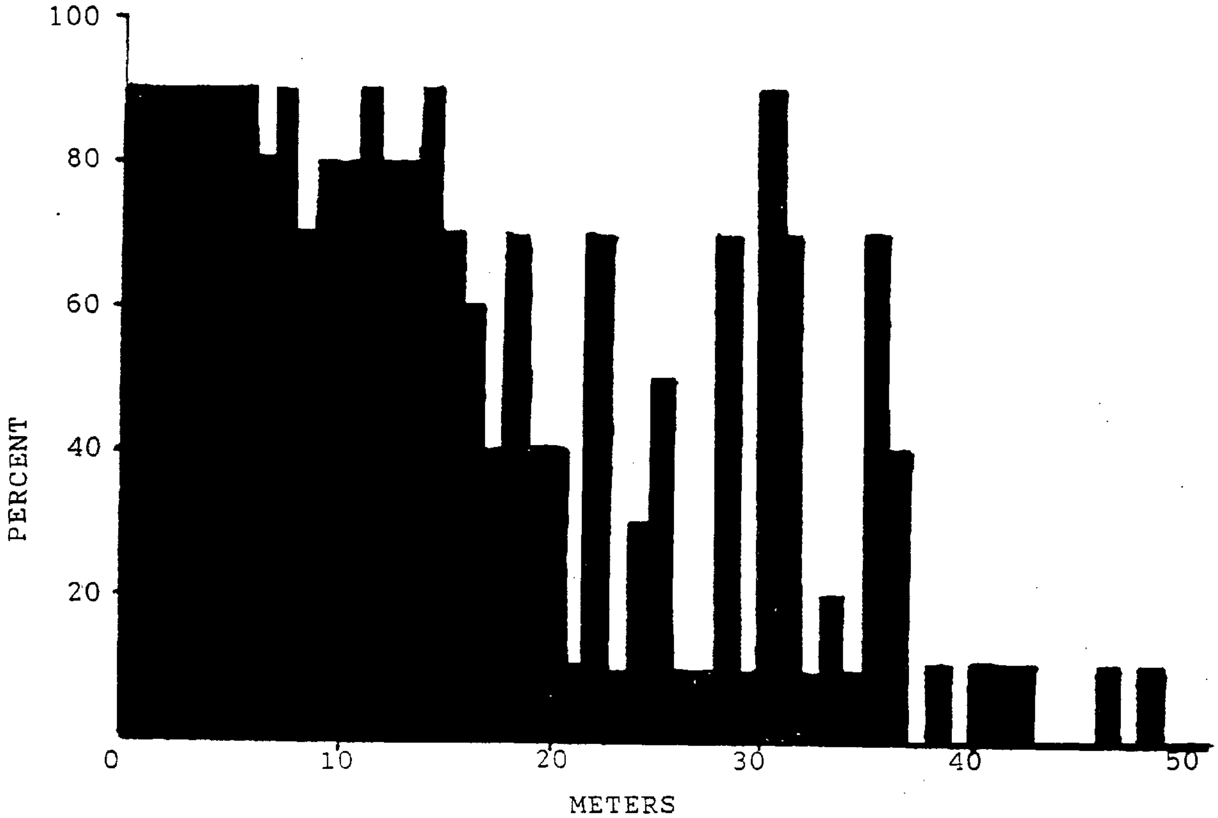

FIGURE 3:

Distribution of Bassia spp. Along Vegetation Transect in 1987 cordgrass responded. At levels of 67 ppt at the surface and 34 ppt at a depth of 16-20 cm, saltmarsh cordgrass began to dominate in areas previously occupied by Bassia sp. and Salicornia sp. As levels are maintained at or below maximum limits for the growth of saltmarsh cordgrass, it is expected that the species will continue to expand and dominate the impoundment.

Table 1. Average Soil Salinities Within Dominant Vegetation Types in the Little Creek Impoundment

Species	0-1 cm	16-20 cm
Spartina patens	28.7	22.3
Spartina alterniflora	67.4	34.1
Bassia sp.	82.6	38.7
Mud flat	55.4	19.4

Algal Blooms

Dense Algal blooms are commonly associated with high concentrations of inorganic nitrogen. Mather (1979) found that nitrogen concentrations as low as 0.30 ppm at the start of the active growing season was sufficient to cause nuisance algal blooms in pond water. Nitrate levels within the Little Creek impoundment always exceeded minimum levels for algal growth and at most times was found to be significantly higher than 0.30 ppm.

In the past, those nitrate levels were correlated with dense algal blooms within the impoundment. Together with high salinities, the algal blooms were believed to adversely affect submerged aquatic vegetation, particularly widgeon grass (Ruppia maritima) which was important to migrating and wintering waterfowl. The shading and oxygen reduction effects of the dense mats when coupled with other stress factors has been sufficient to eliminate all submerged aquatics; however, minimum benefits were provided to breeding waterfowl and broods by the dense populations of invertebrates such as amphipods and corixids associated with the mats.

Nitrate levels remained high even after the initiation of water level manipulation but density and continuity of the mats were reduced. Because of the total drawdown program, the mats that developed were regularly flushed from the impoundment or were broken into small masses which were killed by drying. Obviously, many of the nutrients formerly retained within the impoundment are now able to return to the estuary and nuisance algal growths can be controlled.

Water Circulation

Silt laden tide water has been pumped annually into the impoundment for nearly 30 years. The silt load was continually deposited upon the substrate increasing the level of the impoundment. Today all natural and man-made drainage ditches within the impoundment have filled in and up to 12 inches of silt has been deposited on the marsh surface. The only standing water that remains during total drawdowns is in the borrow pits along the dikes. Those open water areas are the only habitats for fish, submerged aquatic vegetation, and many invertebrates during maximum drawdown. This condition not only limits waterfowl use and submerged aquatics but reduces the effectiveness of mosquito control by predaceous fish. A system of drainage ditches will be installed within the impoundment which will permit more effective flushing through drawdown and will provide access to the interior of the impoundment for mosquito predaceous fish and better water-vegetation interspersion for waterfowl, submerged aquatic vegetation and invertebrates.

Phragmites Control

The common reed (*Phragmites australis*) has spread dramatically throughout Delaware's Coastal marshes and impoundments during the last 40 years. This species provide little value to wildlife in general and its aggressive pattern has allowed it to outcomplete desirable waterfowl food and cover plants and form a monotype within many impounded areas (Jones and Lehman, 1986). The dikes and some of the upland edges of the Little Creek impoundment are dominated by Phragmites; however, high salinity levels may have prevented its expansion into the interior of the impoundment. Control of this species has become the focus of attention in less saline impoundments and it is expected that it will present major problems in the Little Creek impoundment as salinities are reduced.

Fortunately, methods have been developed to effectively control that species. Application of the herbicide, Rodeo®, is being used successfully to control Phragmites. Concentrations of 2-4 pints per acre applied by helicopter has proven effective in killing dense stands of Phragmites. After burning of dead stems, establishment of desired emergents has been accomplished.

SUMMARY

1. Little Creek is characteristic of several impoundments in Delaware although it is probably the most extreme example of habitat deterioration. Impoundments in other mid-Atlantic States (Maryland, New Jersey, North Carolina) are being affected by salinity build-ups which can undoubtedly be corrected or mitigated by proper waterlevel management.
2. More than one season is required to refine drawdown schedules; however, within the next couple of years, we hope to arrive at a permanent management schedule that will maximize habitat quality.
3. Other factors of water chemistry must be considered and evaluated as limiting factors including Nitrate concentrations, pH, and dissolved oxygen throughout the management cycle.
4. Improved water circulation will be achieved and submerged aquatic vegetation and other waterfowl food plants will be re-established and maintained. Invertebrate and fish populations will also benefit and mosquito control can be maintained.
5. <u>S. alterniflora</u> will continue to be encouraged but water-vegetation interspersion will be maintained. That species is highly attractive to snow geese, provides cover and supports important invertebrate populations.

6. Depending upon the level of salinities that can eventually be reached and maintained, other plant species may be encouraged such as salt marsh bulrush, sago pond weed and other valuable food plants.

LITERATURE CITED

Beard, E.B. 1953. The importance of beaver in waterfowl management at the Seney National Wildlife Refuge. J. Wildl. Manage. 17(4):398-436.

Evans, C.D. and K.E. Black. 1956. Duck production studies on the prairie potholes of South Dakota. U.S. Fish and Wildlife Ser., Spec. Sci. Report-Wildl. No. 32, 56 pp.

Jones, W.L. and W. Lehman. 1986. Phragmites control and revegetation following aerial applications of glyphosate in Delaware. In: Proc. of Waterfowl and Wetlands Mgmt. Symp. DNREC, Dover, Delaware. 184-200.

Keith, L.B. 1961. A study of waterfowl ecology on small impoundments in southeastern Alberta. Wildlife Monograph No. 6 88pp.

Lesser, F. H. 1965. Some environmental considerations of impounded tidal marshes on mosquito and waterbird prevalance, Little Creek Wildlife Area, Delaware. Master's Thesis (unpubl.) Univ. of Delaware, Newark. 121 pp.

Mather, T.N. 1979. Nitrogen and phosphorous analysis of Raymond and Shearness impoundments, Bombay Hook NWR, Summer 1979. Unpubl. Report, Dept. of Entomology and Applied Ecology, Univ. of Delaware, Newark. 3 pp.

Shiflet, T.N. 1963. Major ecological factors controlling plant communities in Louisiana marshes. Jour. Range Manage. 16:231-235.

Tiner, R.W. and D. L. Hardin. 11985. Wetlands of Delaware. U.S. Fish and Wildlife Ser., National Wetlands Inventory, Newton Corner, MA and DNRE, Wetlands Section, Dover, DE. Cooperative Publication, 77 pp.

Whitman, W.R. 1973. Waterfowl production on National Wildlife Areas and associated marshes in the N.B.-W.S. Border Area. CWS Report, Sackville, N.B. 7 pp.