Managing Delaware’s Coastal Wetlands for Biodiversity

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At first glance, Delaware’s coastal wetlands seem to have low diversity of flora or fauna, especially in regard to salt marsh vegetation cover. However, upon further examination one sees an interesting, well-adapted mixture of marsh plants and animals critical to the ecological health of our coastline. This mixture can be adversely affected by human-induced habitat alterations, such as by dewatering marsh surfaces with drainage ditches, or by obstructing tidal flow with levees, or by not allowing coastal inlets to naturally close. Biodiversity in coastal wetlands can also be affected by invasion or eruption of undesirable species, which might come to dominate an area at expense of other organisms. Fortunately, there are management activities to restore degraded tide marsh habitats, or to compensate for habitat conversions or losses, which in turn help to maintain the biodiversity and ecological functions of our coastal wetlands. For many years now, the Delaware Division of Fish and Wildlife has used several of these management practices to help to restore or maintain biodiversity.

Northern Delaware Wetlands Rehabilitation Program (NDWRP)

Maintaining or increasing biodiversity is one of the major goals of the Northern Delaware Wetlands Rehabilitation Program (NDWRP). The NDWRP, initiated by DNREC in 1992, is designed to restore approximately 10,000 acres of degraded tidal wetlands at 32 sites in New Castle County along the Christina and Delaware Rivers. The program – housed within the Division’s Mosquito Control Section and supported by the Division’s Wildlife and Fisheries Sections and other programs in DNREC – is a regional, non-regulatory restoration program, which focuses on addressing tidal wetland areas degraded prior to enactment in the 1970’s of federal and state wetland protection laws. Currently, 12 sites (2855 acres) have been restored or are currently undergoing restoration implementation. Many of these sites are wetlands that were impounded decades or even centuries ago for flood prevention, to allow agriculture or protect development and infrastructure near marsh borders, and as such today lack or have severely restricted tidal exchanges with the open estuary. It is anticipated that by ecologically improving numerous individual wetland sites, which together will eventually form a chain of restored areas, a corridor within an urban landscape will be reestablished that provides much needed fish and wildlife habitat, as well as other wetland values and functions. Although these individual wetlands are being restored on a site-by-site basis, the NDWRP’s rehabilitation plans and management practices address regional objectives as well as site-specific needs. The NDWRP seeks to achieve several goals, including: improve water quality, increase fish and wildlife populations and enhance their habitats, increase biological diversity, provide source reduction for mosquito control, protect threatened and endangered species, reduce shoreline erosion, and improve recreational and educational opportunities.
A 6-feet tall staff member is dwarfed by a 15-feet stand of *Phragmites* in Army Creek Marsh, located south of the City of New Castle, along the Delaware River. This illustrates the impenetrable barrier these stands pose to wildlife, fish, and water movement in wetland systems.

**Phragmites Control**

One of the major causes of tidal wetland degradation, especially in fresh or brackish water areas of northern Delaware, has been the disruption of natural wetland hydrology and topography that has allowed *Phragmites* (common reed) invasions to take over. It has been recently confirmed that inadvertent introductions from Europe over the past 100+ years of a more aggressive strain of *Phragmites* has been the primary contributory factor to this species’ rapid spread, particularly since only a few of the numerous European insect herbivores that feed upon *Phragmites* have made the trans-Atlantic trip. This aggressively-growing European strain of *Phragmites* has most-likely displaced the less aggressive native variety, and has come to dominate natural wetland vegetation communities by creating monotypic stands that are largely impenetrable to most fish and wildlife, and therefore of little value to many marsh species. Besides out-competing beneficial plant species and reducing habitat heterogeneity, this grass also usurps open-water habitats while providing little nutritive value to fish and wildlife in live or detritus forms. It is estimated that about 10-15% of Delaware’s coastal wetlands are now infested with tall, dense stands of *Phragmites*, and that about 1/3 of the State’s coastal marsh acreage has *Phragmites* occurrence of some description, in contrast to only a few percent 50 years ago.
View of Riveredge Marsh, located just south of the Delaware Memorial Bridge, showing established monotypic stands of *Phragmites* (light purplish green vegetation) on the marsh plain, being particularly dense near the Delaware River shoreline. These stands, if left untreated, would eventually spread and envelop the entire wetland complex.

The Division of Fish and Wildlife has been contending since the 1950’s with problems caused by *Phragmites* incursions, and has successfully implemented since 1982 a now nationally-recognized Integrated Pest Management (IPM) strategy to control *Phragmites*, involving treatment efforts on State Wildlife Areas and other public lands, plus a cost-share control program for private landowners. This control program involves the periodic aerial applications of the herbicide glyphosate with surfactant, followed by prescribed burning of the dead canes, performed primarily by the Wildlife Section, and to lesser extent by the Mosquito Control Section in association with NDWRP projects. The Division’s ability to treat public lands was significantly enhanced in 1995 by a settlement agreement with New Jersey’s Public Service Energy Group (PSEG), as partial compensation for fisheries losses associated with PSEG’s operation of the Salem (NJ) nuclear power station.

View of a restored tidal freshwater marsh located along the Delaware River shoreline just north of Red Lion Creek. An untreated *Phragmites* dominated impoundment, in the lower left-hand portion of the picture, provides a good contrast.
For the treatment of some *Phragmites*-dominated marshes, vegetation surveys were conducted before herbicide spraying was initiated, and then again in the years following the prescribed burns. Data from vegetation surveys conducted in the late 1980’s at Broad Dyke Marsh just north of New Castle show that upwards of 53% (105 acres) of the marsh surface was dominated by *Phragmites* cover. Initial herbicide spraying and subsequent burning removed some 64% of the *Phragmites* cover, with another herbicide application and burn in 1993 removing an additional 38 acres of persistent or regenerating stands. In 1995, *Phragmites* cover in Broad Dyke Marsh was only 4.3% of the marsh plain. A vegetation survey conducted in 2000 documented *Phragmites* cover at about 9%, which prompted spot-treatments of reinfested areas in 2001.

It is believed that suppression of *Phragmites* reinvasions in Broad Dyke Marsh in part has been aided by restoration in 1995 of limited tidal exchanges to the marsh. One of the first objectives at a NDWRP site is to restore, to the extent practicable, the natural hydrology of these systems, typically accomplishing this objective by installation of water control structures that manage tidal flow between marsh and river. Before this is done for NDWRP projects, vegetation surveys are conducted to determine wetland plant occurrences and distributions. The same type of survey is then conducted several years after tidal exchange has been restored to determine any vegetation community changes. It is hoped that by returning marsh hydrology as close as possible to its natural state, vegetation diversity will increase and be maintained, although a large number of early successional species (such as those that first appear after a major disturbance like fire) can sometimes skew these numbers. Indeed, this desired increase in vegetation diversity has been true at Broad Dyke Marsh, which was one of the first sites in northern Delaware to undergo the NDWRP rehabilitation process. Data collected before tidal exchange was restored in 1995, but after most of the *Phragmites* control was completed, show that there
were 16 dominant species of plants (those occupying >1% of marsh cover) comprising 43% of the marsh’s species richness (total number of species). Data collected in 2000 show that there are now only 12 dominant species making up 32% of the marsh’s species richness, about a 25% decrease in the number of dominant species. However, there were still exactly the same number of total plant species (37) in the 1995 and 2000 studies. Ironically, while it might appear that diversity as measured by the number of dominant species has decreased, the more telling parameter of species equitability (as measured by areal cover) within the present 12 dominant species has significantly increased in areas that were formerly dominated by *Phragmites*, with the dominant species now more evenly distributed, indicative of improvement for the marsh’s ecological health.

**Estuarine Fish Use and NDWRP Impoundments**

Of northern Delaware’s original 16,000 acres of tidal marshes from Augustine Creek northward, 6000 acres have been permanently lost to development, while half of the remaining 10,000 acres are diked and cut-off from normal tidal exchanges, greatly lowering the diversity of fish species that utilize these marshes critical as spawning, nursery or feeding habitats. An important objective of the NDWRP is to restore tidal flow to the greatest extent practicable within these degraded wetlands, reconnecting once biologically-productive systems to the Delaware Estuary, and thus expand suitable habitat for many estuarine fishes and invertebrates.

Two marsh systems that have been recently restored as a result of the NDWRP initiative are Broad Dyke Marsh mentioned above and Augustine Creek Marsh, located just south of Port Penn. An automated tidegate was installed at Broad Dyke Marsh in 1995, and two automated gates were installed at Augustine Creek Marsh in 1999. These tidegates permit daily two-way tidal exchanges to areas that formerly only had one-way discharges to the Delaware River. Prior to installation of the new tidegate at Broad Dyke, only 10 species of fish were collected in the marsh, but since the tidegate went into operation, a total of 40 fish species have been documented to utilize the marsh, a four-fold increase in species richness of the fish community alone, not to mention increased use by other important estuarine species such as blue crabs. Augustine Creek Marsh has experienced a 64% increase in the fish species richness since the new tidegates came into service, and this number will undoubtedly increase by the time this year’s sampling effort is completed. All of these increases are attributable to the reintroduction of estuarine waters to marsh systems that have been excluded from tidal integration with the open estuary. The cumulative effects of restoring more normal aquatic fauna within a corridor of small- to medium-sized coastal marshes in turn enhances the ability of the Delaware Estuary to support and sustain a diverse community of organisms.
Mosquito Control and Open Marsh Water Management

Old parallel-grid-ditches traverse over 2/3’s of Delaware’s 90,000 acres of salt marshes, which were first installed in the 1930’s to try to drain marsh surfaces for mosquito control. While the relatively indiscriminate use of such ditches was only partial successful for controlling mosquitoes, the parallel-grid-ditches eliminated many surface ponds that were valuable fish and wildlife habitats, important components for marsh biodiversity. For example, from a study done by the Division’s Mosquito Control Section, it was found that in the 2300-acre Great Marsh near Lewes, parallel-grid-ditching installed in the 1930’s drained 87 of 97 ponds that were larger than 1/10-acre in size, decreasing the Great Marsh’s acreage of permanent water habitat by 74%.

Wherever practicable, it is still preferable to use source reduction methods instead of insecticides to control mosquitoes, and today the technique of Open Marsh Water Management (OMWM) is being superimposed over the old parallel-grid-ditch network for more effective control of saltmarsh mosquito breeding, reducing the need for insecticide use, while avoiding or minimizing any dewatering impacts on marsh surfaces.

OMWM alterations involve selective excavation of small ponds and primarily non-tidal ditches dug only in the high marsh areas where mosquitoes breed, and often include plugging old parallel-grid-ditches with marsh soils. About 10% of an OMWM-
treated marsh is converted from a marsh surface that in many areas was uniformly and unnaturally covered with a solid blanket of emergent grasses (a result of drainage effects by the old parallel-grid-ditches) into new shallow-water habitats, restoring a more natural mosaic of shallow water and mud surfaces interspersed among grass cover. These ponds and non-tidal ditches provide permanent water habitats for native killifishes that prey upon mosquito larvae. Thus, the OMWM alterations (OMWM ponds in particular), in addition to helping control mosquitoes without relying on insecticides, help to restore surface water habitats in the high, infrequently-flooded tidal marsh where most saltmarsh mosquito breeding occurs.

Submerged aquatic vegetation (e.g. widgeongrass) and edaphic algae mats grow in the permanent water of OMWM ponds, which with colonization by blue crabs, grass shrimp, amphipods, isopods, snails and other invertebrates, plus resident and transient estuarine fishes, then form aquatic communities restoring important functions and biodiversity to the high marsh. As such, OMWM ponds and ditches serve as nursery, feeding or refuge areas for a variety of estuarine fishes and aquatic invertebrates; as foraging sites for wading birds; and as resting and feeding areas for waterfowl. Old parallel-grid-ditches that are not incorporated into OMWM systems are no longer routinely recleaned, but are instead allowed to naturally fill with tidally-borne sediments, to help restore marsh hydrology and biodiversity. Since the early 1980’s, the Division’s Mosquito Control Section has installed OMWM systems over about 6000 acres of previously parallel-grid-ditched marsh, and statewide has about another 3000 acres of problem-breeding marsh targeted for eventual OMWM treatment.

**Downstate Coastal Impoundments**

![Aerial view of Little Creek Impoundment in Kent County, looking toward the west.](image)

The Division of Fish and Wildlife maintains and manages about 2400 acres of impounded coastal wetlands, occurring in 14 downstate impoundments situated from the Port Mahon/Little Creek area to Little Assawoman Bay. Impoundments are constructed to partially exclude and manage the coming-and-going of tides and to control wetland water levels, with such management or control accomplished in part by levees or dikes that separate tidal waters from impounded waters. The U.S. Fish and Wildlife Service
manages another 1100 acres of coastal impoundments at Bombay Hook National Wildlife Refuge, and has about 4200 acres of impounded marshes at Prime Hook National Wildlife Refuge, with federal management interests focused primarily upon creating and maintaining quality habitats for migratory waterfowl.

Many State-owned impoundments were originally constructed in the 1950’s and early 1960’s primarily for waterfowl production and hunting, as well as for saltmarsh mosquito control. From the mid-1980’s through the early 1990’s, many State-owned impoundments were retrofitted with flapgated, adjustable water control structures that now help us better manage these units for tidal exchanges and good water quality, for use by estuarine fishes and invertebrates, and for wading bird and shorebird habitats, in addition to maintaining their traditional values for waterfowl habitats, hunting and mosquito control. The water control structures allow seasonal manipulations of impoundment water levels, which in adherence with multiple-objective water management schedules enables better meeting habitat needs for a wide range of organisms. The Division’s Wildlife and Mosquito Control Sections, with input from our Fisheries Section, now all take a multiple-use approach to stewardship of these valuable impounded areas.

From a bird’s-eye view of Delaware’s downstate coastline, the impoundments maintain fresh or brackish water pools and marshes along the coast in manner that enriches biodiversity. In part, these impounded wetlands help to compensate throughout the region for losses of such low-salinity habitats caused by human intervention to keep coastal inlets open through dredging or construction of jetties, or by other types of impacts detrimental to such habitat types. The extent that a wide variety of wildlife uses these impoundments can be truly impressive. For example, while many people know how Delaware Bay’s downstate beaches are used by shorebirds to feast upon horseshoe crab eggs during spring migration, it is probably not very well known that during high tides along the beachfront, many semipalmed sandpipers and red knots will fly but a short distance to feed in food-laden mudflats of nearby impoundments, joining thousands of dunlins, dowitchers, plovers, yellowlegs and other migratory shorebirds in acquiring energy critical for further northward flight and reproduction. Waterbirds that are scarce elsewhere along our coastline, such as American avocets or black-necked stilts, can frequently be observed in downstate impoundments. Black skimmers feeding low over shallow waters, or belted kingfishers plunging into pools, are telling of an impoundment’s value as good waterbird habitat, joining at times dozens or even hundreds of wading egrets and herons in preying upon small fishes. Testimonial to public interest in the biodiversity of the Division’s managed tidal wetlands is readily observed when truly rare species such as white-winged or whiskered terns are spotted, drawing birders from all over the country.

Managing for Biodiversity

As evident by the types of projects and activities reviewed above, the Division of Fish and Wildlife manages Delaware’s coastal wetlands for a variety of goals and objectives, and in everything we do we always have a accompanying focus on restoring,
maintaining or enhancing biodiversity. This commitment might be seen within one of our NDWRP marsh restoration sites by our performing *Phragmites* control to diversify marsh vegetation cover, or by our restoring tidal exchanges to improve fish habitats; or by our use of OMWM to reduce the need for insecticides to control saltmarsh mosquitoes, while simultaneously restoring shallow-water habitats to marsh surfaces; or by our managing downstate impounded wetlands for multiple environmental objectives, including the provision of quality habitats for waterfowl, shorebirds and wading birds.