Nitrogen Pollution and Adverse Impacts on Resilient Tidal Marshlands

NYS DEC Technical Briefing Summary

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I. Introduction

Salt marshes, or tidal marshes, are highly productive coastal wetlands that provide a wide array of important ecosystem services, including storm surge protection for coastal communities, nutrient removal, carbon sequestration, and habitat for numerous fish and wildlife species (Mitsch and Gosselink, 1993). There has been an accelerated loss of salt marshes in recent decades all around Long Island, but most notably along the south shore and within Jamaica Bay.

By way of example, within nitrogen impaired Jamaica Bay between 1974 and 1994, 526 acres of marsh islands were lost – at an average rate of 26 acres per year. Between 1994 and 1999, the rate of loss accelerated with 220 acres of marsh islands lost at an average rate of 44 acres per year (NYS DEC, 2014a). At significant cost, the New York State Department of Environmental Conservation (NYS DEC) and the Army Corps have rebuilt 146 acres of Jamaica Bay marsh islands to date, with other projects planned. Due to various factors (including wetland fills and coastal development), there was an estimated 18-36% loss in tidal wetlands within the Great South Bay from 1974 to 2001 (NYS DEC, 2014b). Photographs illustrating marsh loss are included in Figures 1 to 6 of this technical summary.

In general, what was once vegetated intertidal marsh is being converted to non-vegetated underwater lands/mud flats. Moreover, high marsh vegetation is being converted to low marsh vegetation. As will be discussed, this process is reducing coastal resiliency from "natural infrastructure." Marshland loss along the south shore of Long Island and Jamaica Bay is occurring in an eco-system that, in many areas, already has experienced significant adverse impacts.

II. Causes of Salt Marsh Loss

There are multiple causes of marsh loss: sea level rise, sediment regime alteration, wave action, coastal development and nutrient enrichment. The most-well documented causes of loss have resulted from coastal development and other types of dredge and/or fill activities. Due to regulations, the potential for future physical destruction of coastal marshlands is limited.

Recent scientific studies have focused on excess nutrient nitrogen loadings (commonly associated with coastal algae blooms and eutrophication) from septic/cesspool systems, waste water treatment plants that do not treat for nitrogen, atmospheric deposition and fertilizer as a significant driver of marsh loss. According to a study conducted within the Great South Bay of Long Island, wastewater-derived nitrogen was the dominant source to watershed surfaces (55%) and that 68% of total nitrogen that entered the Great South Bay was of wastewater origin (Kinney et al., 2011). This includes wastewater from septic systems and sewage effluent discharged within the watershed. Only 16% was contributed by atmospheric deposition on land, 26% by direct atmospheric deposition on Great South Bay, and 7% by use of fertilizer on land.

Other more focused studies undertaken by Suffolk County, as part of a Clean Water Act required analyses of impaired waters, also indicate that septic and cesspool systems are the source of 68% of nitrogen pollution in certain Suffolk County embayments. Based on a review of available data, NYS DEC estimates waste water treatment plant effluent contributes in excess of 80% of the nitrogen to Nassau County south shore embayments.

III. Latest Research on the Affects of Increased Levels of Nitrogen on Salt Marshes

It was once thought that salt marshes had an unlimited capacity to remove nitrogen and were, therefore, not susceptible to damage due to nitrogen overloading. Recent peer-reviewed studies, however, have provided an improved understanding of the mechanism by which nutrient nitrogen enrichment adversely affects salt marsh structure and function. Nutrient enrichment commonly associated with coastal eutrophication (algae blooms, low oxygen, etc.) increases above ground marsh plant leaf biomass yet decreases the dense below-ground biomass of bank-stabilizing plant roots. There is also an increase in microbial decomposition of organic matter within the soils that underlie the marsh biomass that can cause marshes to subside (Deegan et al., 2007 and 2012).

Excessive eutrophication due to nitrogen loadings causes marsh grass along tidal creeks and bay coasts to initially become greener and grow taller in a manner similar to the effects of fertilizing a lawn. The tall marsh grasses, however, produce fewer roots and rhizomes – plant attributes that are critical to stabilizing the edges and soils of marshlands. The poorly rooted grasses eventually grow too tall and then fall over, thereby destabilizing the creek-edge and bay-edge marsh, causing it to slump and exposing soils to erosive forces. The destabilization of creek-edge and bay-edge marshes makes these areas much more susceptible to the constant tugging and pulling of waves, accelerating erosion and the ultimate loss of stabilizing vegetation.

This process results in the loss of the naturally resilient coastal barrier marshes – a barrier that protects shoreline communities from major storm surges and wave action along coastal areas. Tidal wetlands can protect coastal communities from storm damage by dissipating wave energy and amplitude, reducing erosion from waves by slowing water velocity, and by stabilizing shorelines through sediment deposition. Some studies estimate that more than half of normal wave energy is dissipated within the first three meters of marsh vegetation, such as cord grass, while other studies concluded that wave height is reduced by 80% over fairly short distances as waves travel through marsh vegetation (Anderson et al. 2013, Jadhav and Chen 2012, and Ysebaert et al. 2011). Thus, the loss of tidal marshlands results in a direct reduction in coastal resiliency and the ability of these natural features to help protect coastal communities along the south shore of Long Island from future storm surges.

Given sufficient sediment deposition, healthy marshes are able to build elevation in response to sea-level rise, providing a buffer against climate change and coastal submergence. However, excessive nitrogen concentrations accelerates microbial decomposition of leaves, stems, and other organic biomass in marshes and prevent the deposition of sediment and ability of these marsh communities to keep up with sea level rise (Turner et al., 2009). Longer term exposure to enhanced nutrient levels caused impacts at higher marsh elevations and a 2.5 times increased probably of stream channel destabilization (Deegan et al., 2012).

IV. Nitrogen Reductions to Enhance Marshland Health and Resiliency

Given the nexus between nitrogen enrichment, the long-term sustainability of salt marshes along the south shore of Long Island, and the ability of the marshes to provide protection against coastal flooding, New York State should consider supporting an array of programs to reduce nitrogen loadings into Long Island's south shore embayments, including Jamaica Bay. Actions to restore marshes so as to increase coastal resiliency may be unsuccessful unless accompanied by actions to reduce overall nitrogen loadings. Projects that have the potential to remove significant concentrations of nitrogen (e.g., upgrading of the Bay Park Wastewater Treatment Plant with an ocean outfall, expanded use of the Bergen Point wastewater treatment plant with a repaired ocean outfall, the extension of sewers to cover densely populated areas of southern Suffolk County, etc.) could be an appropriate focus of disaster recovery and coastal resiliency efforts.

Figure 1 – 1974 photograph of Black Wall Marsh (41 acres) within Jamaica Bay.

Figure 2 – 1999 Photograph of Black Wall Marsh (21 acres) within Jamaica Bay. Approximately 20 acres of salt marsh were lost between 1974 and 1999.

Figure 3 – 1974 Photograph of Duck Point Marsh (103 acres) within Jamaica

Figure 4 – 1999 Photograph of Duck Point Marsh (38 acres) within Jamaica Bay. Approximately 65 acres of tidal wetlands were lost on Duck Point Marsh in Jamaica Bay between 1974 and 1999.

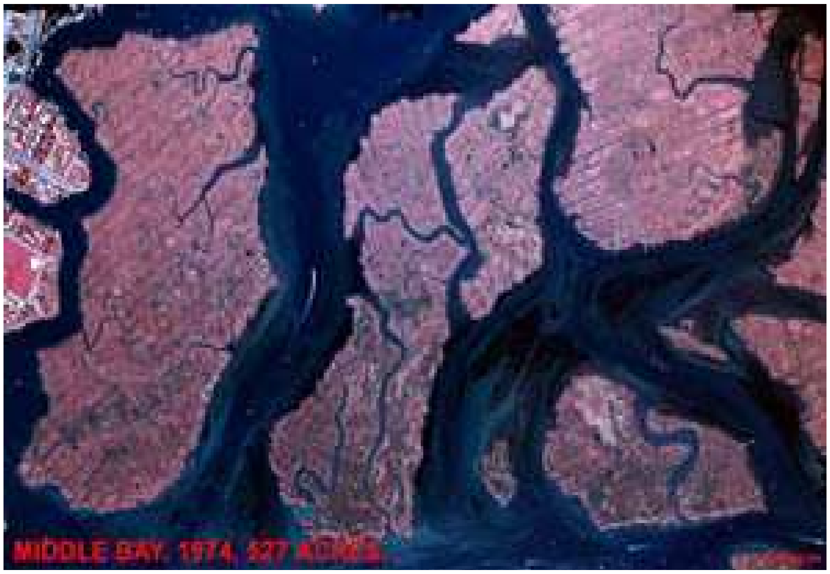

Figure 5 – 1974 Photograph of Middle Bay salt marsh complex (527 acres) located within the South Shore Estuary Reserve.

Figure 6 – 2001 Photograph of Middle Bay salt marsh complex (404 acres) illustrating a 123 acre loss over a 27 year period.

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