Collaborative opportunities between Mass Audubon & Municipality Vulnerability Preparedness plans along the Merrimack River

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The Municipal Vulnerability Preparedness (MVP) grant program is a Massachusetts (MA) state resiliency fund that provides support for local municipalities to plan for climate change resiliency and implement priority projects[1]. Communities that join the MVP program participate in a planning workshop to characterize key climate hazards for their municipality and prioritize potential community actions. We have identified potential avenues for future complementarity and/or collaboration between Mass Audubon and the MVP grant program.

During their MVP planning workshops, many communities and towns along the Merrimack River, such as Newburyport[2], Salisbury[3], Haverhill[4], Lawrence[5] and Lowell[6], shared similar concerns. These riverside municipalities identified issues such as flooding, severe storms, and sea level rise among key hazards likely to be exacerbated by a changing climate, and they expressed concerns about flood-proofing wastewater treatment facilities and town municipal buildings, as well as improving coastal infrastructure. Relevant, ongoing research at Mass Audubon will be able to support local municipalities as they address these and other key issues identified through the MVP process.

Leveraging coastal marsh research to inform wastewater management

Efforts to address flooding and wastewater resiliency could be complemented by Mass Audubon's work examining the sources and effects of excess nutrient loading on salt marshes in the Merrimack River. Salt marshes exist at the intersection of land and sea and provide crucial ecosystem services, such as storm protection and flood mitigation. Excess nutrient loading in the Merrimack River may be acting as a driver of salt marsh habitat degradation and loss[7], and this could have serious negative consequences for coastal areas near the mouth of the Merrimack that depend on salt marshes for climate resiliency.

Ongoing research at Mass Audubon investigates potential downstream effects of nutrient loading and combined sewer overflow (CSO) events on coastal marsh resiliency, particularly near the Joppa Flats Education Center. Wastewater treatment plants and other pollutant discharge sites may contribute to critical nutrient loading in the Merrimack River, which could lead to eutrophication and marsh loss.[7] CSO events, or instances where the capacity of a combined sewer system is exceeded and untreated storm and wastewater are discharged directly into the river, occur during high intensity storm events and contribute to the nutrient loading associated with wastewater treatment centers.[8] CSOs are likely to increase in frequency due to increases in precipitation and storm water runoff from climate change.[9–11]

For municipalities such as Newburyport[2] and Lowell[6], MVP high priority actions focus on enhancing wastewater treatment plant resiliency, including improving flood protections, preventing future CSOs and even relocating wastewater treatment facilities. The results of ongoing nutrient enrichment research at the mouth of the Merrimack River will be critical in

determining the long-term costs of management choices regarding nutrient efflux on the surrounding land area, such as marsh degradation and eutrophication. We suggest that municipalities along the Merrimack leverage nutrient loading research to inform best management practices for wastewater treatment nutrient effluent and flood mitigation strategies. Nutrient enrichment due to wastewater efflux could degrade the surrounding salt marsh, and this natural habitat serves as an important flood control measure for the treatment facility. Proper management of the nutrient effluent could help prevent marsh degradation, creating a positive feedback loop.

Increasing accountability and data sharing from wastewater treatment facilities

To further climate change resiliency efforts, we suggest that municipalities attempting to improve flood protection and mitigate nutrient discharge for local utilities[2,3,6] seek annual accountability reports. We recommend that such reports include a comprehensive record of nutrient discharge values, particularly for locations with permits from the EPA National Pollutant Discharge Elimination System (NPDES). NPDES is a program that regulates point source pollutant discharge into US waters[12]. These data could provide crucial insights on the role of nutrient influxes on marsh and other habitat degradation in the Merrimack River Valley. This data stream could be complemented by decades of vegetation surveys from the Mass Audubon Salt Marsh Science Program to help determine the relationship between nutrients and vegetation over time.

Hybrid and nature-based improvements to coastal infrastructure

MVP planning workshops for coastal municipalities such as Newburyport[2] and Salisbury[3] highlighted the protection of the waterfront and the creation of coastal infrastructure as key priorities; they describe enhancing coastal resiliency using dunes as well as built, or grey, infrastructure (*e.g.,* sea walls, bulk heads). Workshop reports also prioritize improving road drainage[3] and even "raising roadways and modifying culverts" to deal with potential inundation risks[2]. Mass Audubon has similarly conducted analyses of infrastructure resiliency against sea level rise and examined the impact of infrastructure types on flood mitigation efforts, presenting a further opportunity for collaboration. Grey infrastructure is expensive to build, tends to weaken with time, and can cause habitat loss and even erosion[13]. Therefore, we encourage municipalities to pursue green (natural) and/or hybrid green/grey infrastructure. Living shorelines, an example of green resiliency infrastructure, use plants and other natural materials to stabilize coastlines by buffering floods and reducing erosion. Living shorelines could be used to provide flood protection during major storm events for critical utilities, and they additionally offer many co-benefits, such as protecting salt marsh habitats, improving water quality and increasing recreational access[13–15]. Hybrid infrastructure also provides critical coastal risk reduction and can complement nature-based flood mitigation solutions, such as salt marshes and living shorelines, by capitalizing on the best elements of both built and natural infrastructure[13]. Hybrid infrastructure offers competitive and cost-effective coastal protection, and coastal resiliency infrastructure is more likely to be effective when it is informed by a scientific understanding of the surrounding ecological and hydrological system[16].

This further highlights the critical opportunity for collaboration between towns participating in the MVP program and Mass Audubon, an organization well-positioned to provide valuable insights on nature-based solutions crucial for local municipalities preparing for climate change and seeking to improve resiliency along the Merrimack River.

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