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Technical Memorandum

To: Steve Rafferty, Chair, Town of Falmouth Water Quality Management Committee
Amy Lowell, Wastewater Superintendent, Town of Falmouth

From: Ed Eichner, Principal, TMDL Solutions/Adjunct Professor, SMAST, UMassD
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Date: October 25, 2023

RE: Response to Buzzards Bay Coalition August 23 Comment Letter on CSP/SMAST
Herring Brook Marsh assessment

I. Introduction and Background

In June 2023, the Coastal Systems Program from the School for Marine Science and Technology at UMass-Dartmouth (CSP/SMAST) in partnership with the rest of the Massachusetts Estuaries Project (MEP) Technical Team completed an assessment of the Herring Brook Marsh estuary system for the Town of Falmouth.¹ This assessment included the detailed data collection and review regularly associated with MEP assessments, including water quality data (both snapshots and continuous data), sediment and benthic infauna characterization, tidal measurements, watershed delineation and assessment, and the development of a validated water quality model that linked watershed nitrogen loading and tidal hydrodynamics. The synthesis of all the collected data showed that the Herring Brook system is a healthy salt marsh system with relatively low nitrogen concentrations. Based on the characteristics of Herring Brook and more than 20 other salt marshes reviewed during the course of the MEP, the project team determined that a threshold concentration of 1.0 mg/L total nitrogen at the boundary between the upper and lower reaches of the marsh would be protective of the Herring Brook system. As with previous MEP assessments, the project team used the validated water quality model to predict a number of different future watershed scenarios, including a) buildout of available land and b) addition of 0.76 million gallons of treated wastewater discharge from the municipal treatment facility. The current total nitrogen concentrations and the projected future concentrations for both potential scenarios were well below the recommended 1.0 mg/L TN threshold.

On August 23, the Town received a comment letter on the Herring Brook Marsh assessment from the Buzzards Bay Coalition (BBC). The comment letter included a review of the assessment report

¹ Eichner, E., S. Kelley, R. Samimy, and D. Schlezinger. 2023. Linked Watershed Marsh Assessment and Modeling to Determine Critical Nitrogen Thresholds and Loading for the Herring Brook Estuarine System, Falmouth MA. Coastal Systems Program, School for Marine Science and Technology, University of Massachusetts Dartmouth. New Bedford, MA. 112 pp.

from Craig Tobias, a professor at the University of Connecticut. Dr. Tobias contends that Herring Brook Marsh is not healthy in large part because 1) it has the highest loss of vegetated area of any Buzzards Bay marshes based on a BBC review² and 2) the assessment “ignores close to two decades of work on marsh sustainability and potential linkages to nutrient loading.”³ At the request of the Town, we have reviewed the Tobias review and offer the following response to each of the major points:

1) Inaccurate assessment of vegetated marsh loss in BBC review

The BBC review of the Herring Brook Marsh is based on three transects within a 0.9 acre area of a 27.5 acre marsh. The three transects extend from the parking area just to the east of the inlet to the main inlet stem of Herring Brook under the Quaker Road bridge (**Figure 1**). We noted that the transect area includes an area of degraded marsh where people appear to have regularly walked across the top of the marsh from the parking area to the water, as well as a 130 ft long revetment that armors the embankment that extends east from the bridge (**Figure 2**). The regular degradation in this 0.9 ac area by foot traffic would appear to make it a poor choice to be representative of the rest of the 27.5 acre marsh.

Our review of available Google Earth aerials at the time of Herring Brook Assessment report preparation noted the degraded area where BBC had their transects had exposed sand since at least 1995 with a path leading to the degraded area from the eastern edge of the revetment. In addition, we noted sand that has been carried into the system near this area, which suggests higher tidal velocities than is seen in the rest of the marsh system. Higher velocities, especially as sea level rises, would tend to preferentially erode the edges of nearby marsh (*i.e.*, the areas where BBC noted most of the marsh area loss since 2001; see Figure 1). Figure V-13 in our report shows that tidal velocities near the revetment and along the edge of the selected marsh area are among the highest in the system outside of the main inlet channel between the groins/jetties. A closer review of the BBC review shows much of the loss of marsh in the area is along this high velocity section of the marsh study area. In contrast to these changes, our review of available aerial photos shows that the bulk of the marsh area of the system appears to be relatively stable since 1995.

In addition, a recent visit to BBC assessment area shows that the landward side of the marsh edge is increasing by migrating into the parking area under the influence of sea level rise (**Figure 3**). Dr. Tobias relied on the BBC assessment results, but site visit show that if BBC researchers had extended the original transects landward, the results would illustrate the gradual landward migration of salt marsh into the low-lying area of the eastern portion of the parking lot. Based on this landward migration of the marsh, it is likely that there actually has been an increase in salt marsh acreage in in the area BBC shows there has been marsh loss.

In summary, the selected BBC area for assessing marsh changes in the Herring Brook Marsh system appears to be unrepresentative of the rest of the system and the BBC marsh study transects missed key marsh expansion. Part of the BBC study area is degraded marsh because of its exposure to regular foot traffic on the marsh surface and tidal velocities along the marsh edges that are much

² Jakuba, R. W., Besterman, A., Hoffart, L., Costa, J. E., Ganju, N., Deegan, L. 2023. Buzzards Bay Salt Marshes: Vulnerability and Adaptation Potential. 32 pp.

³ Tobias, C.R. August 23, 2023. Review of the Final Draft for Linked Watershed Marsh Assessment and Modeling to Determine Critical Nitrogen Thresholds and Loading for the Herring Brook Estuarine System (Eichner et al. 2023). 3 pp.

higher than anywhere in the rest of the marsh. Additionally, the BBC study design had marsh transects that did not incorporate the directly adjacent eastern portion of the parking lot, which has observed landward migration/expansion of the salt marsh. The combined impact of a) selecting an area unrepresentative of the rest of the marsh and b) study design and measurement/observation deficiencies led to incorrect conclusions regarding salt marsh loss in Herring Brook and, which, in turn, led to incorrect conclusions about the health of the Herring Brook marsh.

2) Misleading assessment of nutrient impacts on marshes

Dr. Tobias' global statement that our review of Herring Brook "ignores close to two decades of work on marsh sustainability and potential linkages to nutrient loading" is unconsidered and inconsistent with MassDEP and USEPA decisions. As noted in the Herring Brook assessment, the MEP team has reviewed water quality and ecosystem conditions in more than 20 regional salt marshes and at least 20 additional salt marsh portions within MEP estuaries. These reviews have looked at key factors related to responses to nitrogen loading, including benthic community composition, macroalgal mat formation, tidal hydrodynamics, and dissolved oxygen dynamics. Based on the experience gained from assessing all of these previous marshes and the specific conditions in Herring Brook, we selected the nitrogen threshold included in the Herring Brook assessment. Dr. Tobias does not address any of these factors or their discussion in the Herring Brook assessment.

The Herring Brook nitrogen threshold has been used for other MEP salt marshes in the region and has been judged to be appropriately conservative and protective of salt marsh health during the review of MEP reports by both the Massachusetts Department of Environmental Protection (MassDEP) and the United States Environmental Protection Agency (USEPA). This total nitrogen concentration has also been codified into TMDLs for approval through the Clean Water Act. All of this is part of a public record and regulatory decisions for many of the Towns throughout southeastern Massachusetts. This salt marsh nutrient threshold is also presently being utilized by several communities in southeastern Massachusetts as part of their wastewater planning efforts, including planned increased nutrient loading from wastewater treatment plants within salt marsh watersheds in Chatham, Barnstable, and Orleans. Dr. Tobias does not address any of the findings of previous MEP assessments or MassDEP/USEPA approvals in his unconsidered global statement.

Dr. Tobias has created a definitional conundrum when talking about marsh health and sustainability. His letter seems to say that no marsh can be healthy if it cannot move inland as sea levels rise. While marsh response to sea level rise was not specifically an area to be addressed by our assessment, this global statement does not seem to be a primary concern for the Herring Brook system, especially given the evidence discussed above that the marsh is moving inland.

Dr. Tobias' focus on marsh migration sidelines the issue of nutrient-related health of Herring Brook, which as discussed in the assessment and reaffirmed here, is excellent. As determined through the vetted and accepted MEP approach and its application to determine nitrogen thresholds in numerous salt marshes across southeastern Massachusetts, Herring Brook does not exhibit signs of impairment due to elevated nitrogen loading. The marsh, as a whole, shows signs of being a healthy salt marsh with the exception of the very constrained areas which are discussed above. As such, the concern about the long-term state of the marsh under increased nitrogen loads is not about

marsh health (as the marsh is currently healthy and based on numerous past threshold analyses will remain healthy even with increased nitrogen loads), but rather sustainability.

Dr. Tobias states the marsh is on an unsustainable trajectory due to loss of vegetated surface and inability to migrate landward in response to sea level rise; however, that loss of vegetated surface is not related to present or future nitrogen loading, as the current system nitrogen concentrations, as well as future projected concentrations, are supportive of a healthy marsh system. As noted above and in Figure 3, it is not clear at all that the marsh cannot migrate landward. This finding itself seems to confirm that Dr. Tobias' global statement does not match the particulars of Herring Brook. All of this subsequent review confirms our original observations and overall assessment that Herring Brook Marsh is healthy and further shows that the marsh is currently moving inland and any losses near the bridge are mostly due to physical, not nutrient-related, processes.

II. Response Summary

The BBC comment letter does not provide any basis for change to the Herring Brook assessment or the associated nitrogen threshold. As the key members of the MEP assessment team, we conducted the Herring Brook assessment based on the same MEP procedures utilized to evaluate the overwhelming majority of estuaries and salt marshes in southeastern Massachusetts and incorporated our experiences and insights from looking at all of the MEP salt marsh systems. The selected nitrogen threshold for Herring Brook is based on review of more than 20 regional salt marshes and at least 20 more salt marsh portions with estuaries assessed under the MEP. The selected nitrogen threshold has been approved by MassDEP and USEPA, as appropriately conservative and protective of salt marsh ecosystems. This salt marsh nutrient threshold is also presently being utilized by several communities in southeastern Massachusetts as part of their CWMP wastewater planning efforts, including planned increased nutrient loading from wastewater treatment plants within salt marsh watersheds in Chatham, Barnstable, and Orleans.

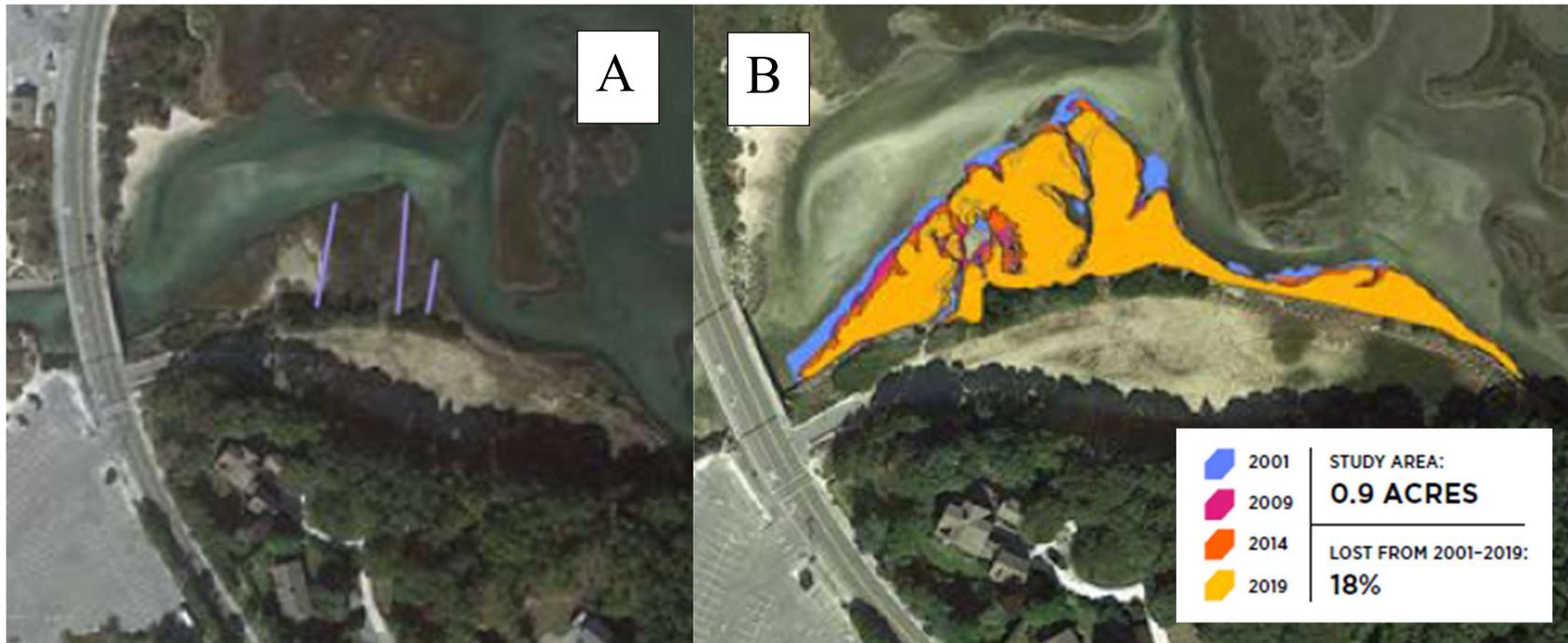


Figure 1. BBC Herring Brook Marsh Assessment Area (from Jakuba and others, 2023). BBC delineated transects in a number of salt marsh systems and the interpretation of historical aerial photographs determined that Herring Brook has lost the most salt marsh of any of the systems reviewed. Closer examination of the area in Herring Brook selected for this assessment shows that it is unrepresentative of the rest of Herring Brook and subject to regular foot traffic impacts that would degrade the marsh and be unrelated to watershed nutrient loading. The left aerial map (A) shows the transects (purple lines) used by BBC for the assessment of salt marsh loss between 2001 and 2019. As noted in the text, this area is regularly stressed by people walking across the surface of the marsh to reach the main channel of Herring Brook. The extent of foot traffic has worn away any salt marsh vegetation and created a large area of sand. Review of Google Earth aerial photographs show that this sand area has been present since at least 1995. In addition, the interpretation of aerial photos by BBC that indicates that most of the salt marsh loss has been along the northern edge of the transect area (B), does not consider that this marsh is exposed to higher tidal velocities than the rest of the Herring Brook Marsh. These higher velocities would create physical, rather than nutrient, stress on the marsh edge and they would also make this area unrepresentative of the rest of Herring Brook Marsh. Overall, review of the details of this study area suggests extrapolation to the rest of the marsh system is not supported and the characterization of Herring Brook Marsh as the most impaired by salt marsh loss is inaccurate.



Figure 2. Google Earth Road View of Area of BBC Herring Brook Transects (October 2019 image). The photo shows the parking area on the right, the area of the salt marsh that has been degraded by people regularly walking across the surface of the marsh in the center, and a portion of the revetment that extends along the edge of parking lot ~130 ft from the edge of the bridge. The area of the BBC salt marsh transects includes a portion of the degraded area and the area assessed for salt marsh loss includes the area from the bridge along the parking lot, including the degraded area. The extensive physical manipulations and impacts within this area are unrepresentative of the rest of Herring Brook Marsh.



Figure 3. Herring Brook Parking Lot: Marsh Expansion (September 2023). Photograph showing the low-lying eastern portion of the Herring Brook parking lot that is inundated at high spring tides and contains extensive areas of salt marsh. This 'new' salt marsh expansion area is a direct result of ongoing sea level rise and indicates that the marsh is migrating due to rising sea levels and expanding into new areas not included in the BBC or Tobias review.