## "Tier 2" Eelgrass and Sub-Tidal Seaweed – Supporting Variable

**Question:**
How does total eelgrass biomass (above and belowground) and seaweed biomass vary at 25 sites throughout the Great Bay Estuary?

**Short Answer**
Biomass (the dry weight of above and belowground eelgrass plant material per unit area) assessments are based on sampling within randomly chosen eelgrass meadows, throughout the Great Bay Estuary. In 2021 and 2022, the eelgrass meadows in Portsmouth Harbor tended to have more biomass than those in other locations. However, there may still be more biomass total in Great Bay due to the abundance of shallow habitat where eelgrass can grow.

Seaweed biomass (dry weight per unit area; seaweed grows only aboveground) is slightly higher in Portsmouth Harbor than in Great Bay and Little Bay/Piscataqua River sites, though the differences are small in the context of the variability.

**Why We Track Eelgrass and Seaweed Biomass**
Eelgrass, *Zostera marina*, is an aquatic vascular flowering plant. It is considered critical estuarine habitat and an excellent indicator of overall ecosystem health, due to its sensitivity to light, which is strongly influenced by loadings of nutrients and sediments. Although many eelgrass metrics are possible (e.g., percent cover, density), biomass (the mass of eelgrass above and below the sediment) per unit area is considered one of the most accurate and direct indicators of habitat health (Krause-Jensen et al. 2004).

Some seaweeds (e.g., *Fucus vesiculosis* and *Ascophyllum nodosum*, both often referred to as "rockweed") also provide excellent habitat for juvenile shellfish and other organisms. Rockweed are generally associated with rocky substrates, to which they attach, while eelgrass is generally found on sandy or silty substrates. Some green seaweeds (such as *Ulva lactuca* or sea lettuce) and red seaweeds (such as *Gracilaria vermiculo*phylum) can be anywhere because they can be attached or free-floating. (In the analysis below, the brown seaweeds have been taken out since most brown seaweeds are not indicative of poor ecosystem health.) However, proliferation of other species of seaweeds in the sub-tidal estuarine zone is often an indication of an ecosystem out of balance, frequently because of excessive nutrient and sediment loading and exacerbated by warming water temperatures. (Warming water is also a concern because it impacts eelgrass health regardless of seaweed abundance.)

Therefore, the Tier 2 Monitoring protocol was introduced in 2021 to better track the condition of subtidal eelgrass and the green and red seaweeds, which are often indicative of ecosystem problems, at 25 sites in the Estuary (Figure T-1). There are now three tiers to eelgrass/seaweed monitoring: Tier 1 assesses the distribution of habitat throughout the Estuary; Tier 2 assesses the abundance of eelgrass and seaweed by sub-sampling throughout the Estuary; and Tier 3 examines a host of detailed health metrics at the exact same location at two sites: one in Portsmouth Harbor and the other in Great Bay. More details on Tiers 1, 2, and 3 can be found at: https://scholars.unh.edu/prep/

**Explanation**

Data Results

The median eelgrass biomass within identified beds (Figure T-2) was highest overall in Portsmouth Harbor, but variation in the dataset is quite high. Median biomass of eelgrass was the least in Great Bay. Seaweed biomass (Figure T-3) between Great Bay and Little Bay/Piscataqua River was similar, and seaweed was more abundant at Portsmouth Harbor. The differences in seaweed abundance are small and given the variability across sites, not significant.

Median eelgrass biomass in Great Bay doubled from 2021 to 2022 but decreased by approximately 50% in the other two areas. Meanwhile, median seaweed biomass increased at all three sites from 2021 to 2022.

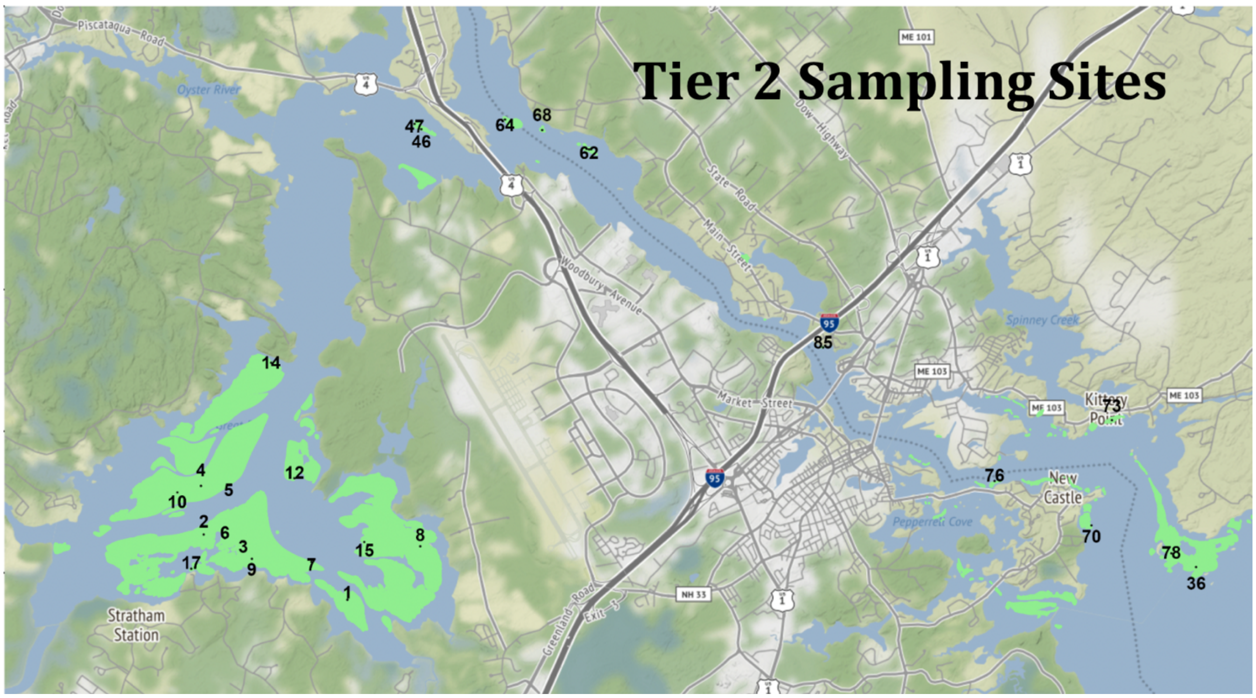


**Figure T-1. A map of Tier 2 sampling sites in the Great Bay Estuary. Numbers indicate the locations of the 25 sites and were chosen from a random sample of 100 sites based on locations that had eelgrass in 2019. Great Bay is located south of site 14; the Little Bay/Piscataqua River group is at the top of the map, and Portsmouth Harbor sites are bottom right. (Map credit: Anna Mikulis)**

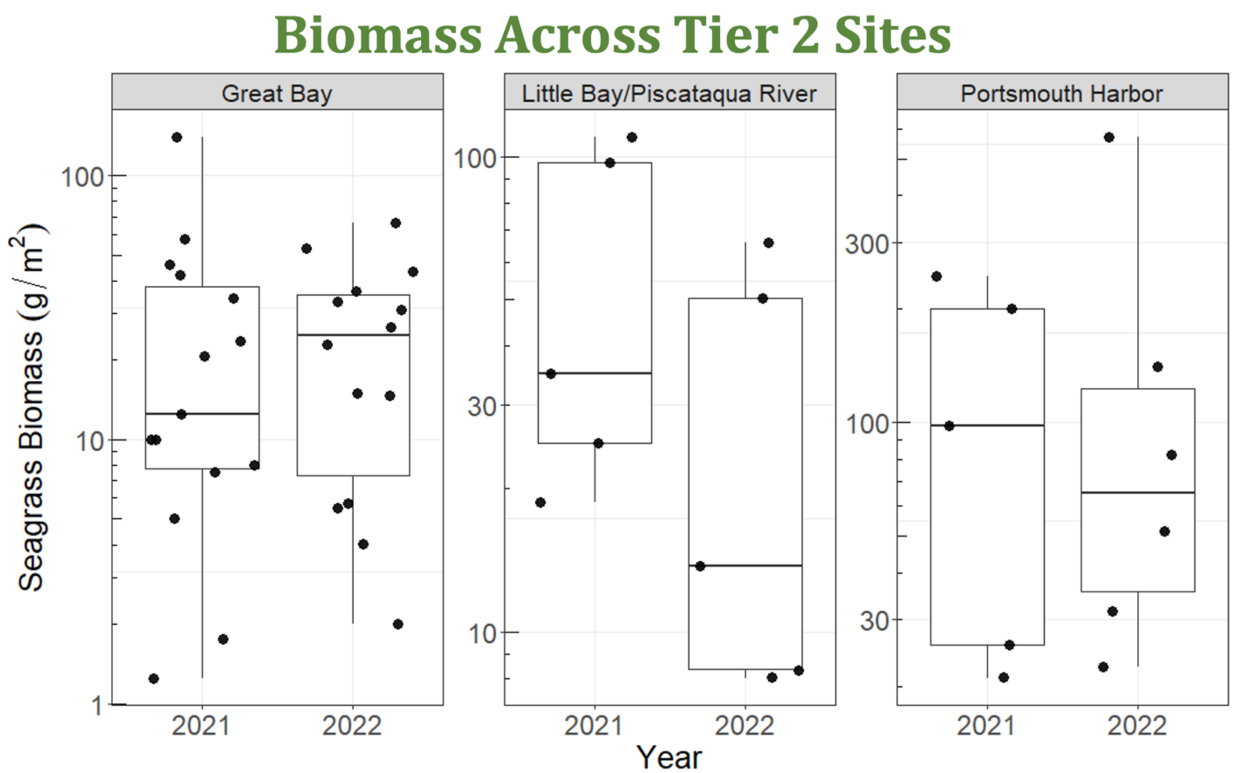


**Figure T-2. Seagrass biomass from 25 sites, partitioned into three main areas in the Estuary for years 2021 and 2022. The vertical axis is on a logarithmic scale to prevent the low and high ends of the data range from being overly condensed on the graph. Use the tick marks on the vertical axis to estimate the biomass. Notice that the Portsmouth Harbor axis maximum is 300 g/m$^2$ versus 100 g/m$^2$ for the other two areas.**
***Data Source: UNH Jackson Estuarine Laboratory.***

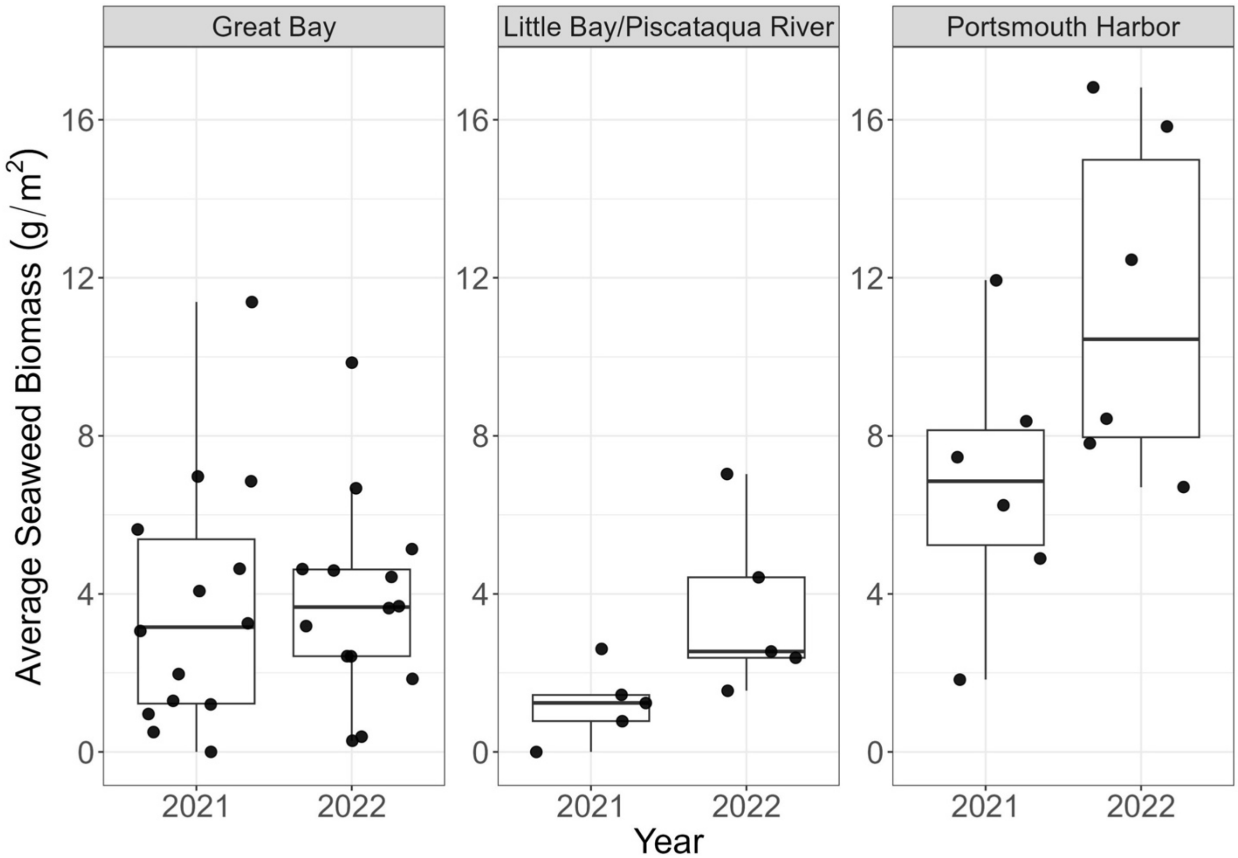


**Figure T-3. Seaweed biomass from three main areas in the Estuary for years 2021 and 2022. The vertical axis is on a logarithmic scale to prevent the low and high ends of the data range from being overly condensed on the graph. Use the tick marks on the vertical axis to estimate the biomass.**
***Data Source: UNH Jackson Estuarine Laboratory.***

## Discussion

Overall, the increase in median eelgrass biomass may emphasize the more stressful conditions affecting Great Bay eelgrass versus locations in and near Portsmouth Harbor. Great Bay experiences greater fluctuations in light, temperature, and salinity than experienced at the Portsmouth Harbor locations. Although eelgrass can tolerate a range of conditions, the range experienced in Great Bay is most likely stressful relative to Portsmouth Harbor.

It is unexpected that red and green seaweed biomass is greater in Portsmouth Harbor than in Great Bay. The species making up the red/green contingent are different across the two locations and the Portsmouth Harbor consortia may weigh more than the species in Great Bay; this has yet to be verified. Also, the seaweed in Great Bay, especially the species *Gracilaria vermiculophyla,* has a tendency to accumulate in large clumps that are variable in time and space and do not always appear in the random quadrats being sampled.

Comparisons of eelgrass and seaweed health between zones and between years are complicated by many confounding factors. Over time, after more years of collecting data, the signal versus noise should become easier to detect.

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**References**

Krause-Jensen D, Queresma, AL, Cunha AH and TM Greve. 2004. How are seagrass distribution and abundance monitored? In, "European seagrasses: an introduction to monitoring and management," eds. Borum, Duarte, Krause-Jensen, and Greve. A publication by the EU project Monitoring and Managing of European Seagrasses (M&MS) EVK3-CT-2000-00044.