Executive Summary

Salt marshes provide a range of key ecosystem services including mitigating storm surge, filtering nutrients, and providing essential habitat for fish and birds. Yet as a borderland between terrestrial and marine ecosystems they are exposed to numerous anthropogenic impacts that degrade their ability to perform these activities. Rapid increases in relative sea level rise (RSLR) are one of the primary ways human activities have altered salt marshes. While historically salt marshes have been capable of maintaining their elevation in relation to sea level rise, the acceleration of sea level in recent years has put them at a greater risk of drowning (Valiela et al. 2015). The goal of this research was twofold. The first goal was to quantify recent rates of salt marsh accretion at sites throughout Long Island Sound (LIS) and compare them to recent (>2000) sea level rise in the area. The second goal was to better understand how fast the salt marshes in LIS were respiring organic matter to understand whether organic matter loss is influencing accretion rates. To do this, seasonal rates of salt marsh respiration (and photosynthesis for vegetated sites via CO_2 fluxes) as well as rates of litterbag decomposition were quantified. Six sites were chosen for this study, three on the north and three on the south side of LIS with two in Connecticut (CT) and four in New York (NY) (Figure 2). Importantly, accretion rates at these sites had previously been measured, which allowed for the comparison of recent rates with historic rates. These six sites spanned a nutrient gradient, west (high) to east (low), allowing for the indirect examination of the role of increased nutrients in salt marsh decomposition.

Five gauges in LIS were used to determine sea level rise rates since 2000. Sea level was found to be rising 0.69 to 0.75 cm yr^{-1} in this region, which is 3 to 4X higher than regional historic rates and the current global average, but consistent with recent studies in the area. Historic LIS salt marsh accretion rates ranged between 0.08 and 0.68 cm yr^{-1} with a mean of 0.2 cm yr^{-1}. The accretion rates (range: 0.21 to 0.48 cm yr^{-1}) measured in this study with radionuclides (^{210}Pb and ^{137}Cs) were 2 to 3X slower than rates of current RSLR These results indicate that at the time of these measurements, these salt marshes were not increasing fast enough to keep pace with RSLR. Barn Island followed by Hunter Island appear to have the lowest accretion rates with Wading River and Udalls Cove the highest rates. There was no significant different between current and past rates collected and in the literature, though accretion rates increased in CRS model data of individual accretion rates over time. The general trends between the two measurements were also consistent.

Decomposition rates indicate how quickly marshes lose organic matter that otherwise would contribute to accretion rates. Rates in the six study sites ranged from 0.08 to 0.36 $month^{-1}$ with an average rate of 0.16 $month^{-1}$. Barn Island and Jarvis Creek had the highest and lowest rates respectively and the remaining marshes all had relatively similar rates.

Mean CO_2 fluxes between sites were only different at Udalls Cove, where significantly higher emission of CO_2 were measured in unvegetated areas. As expected they were also different between vegetated or unvegetated areas and by season. The range of CO_2 fluxes in

vegetated areas was from -25.66 to 22.34 mmol m^{-2} hr^{-1} and from -8.29 to 22.29 mmol m^{-2} hr^{-1} in unvegetated areas with averages of -5.76 and 2.54 mmol m^{-2} hr^{-1} respectively. The overlap in ranges was caused by a higher emission of CO_2 measured in Udalls Cove from a vegetated site in the summer. Seasonal trends of the largest emission in winter and largest uptake in summer were found. Udalls Cove proved an exception to this trend as it had particularly high rates of CO_2 emission throughout the year. CO_2 uptake in vegetated stands significantly increased with air and soil temperature as well as soil moisture, which is not surprising since plants grow fastest during warmer seasons such as summer and wetter seasons such as spring. In contrast, CO_2 emissions from un-vegetated plots significantly increased with air and soil temperature and had no relationship with soil moisture. Litterbag decomposition rates and CO_2 fluxes from vegetated plots were significantly related in spring and fall although the relationship is most linear in fall.

Overall, this study shows that salt marshes do not appear to be keeping pace with current rates of sea level rise in LIS although recent rates of accretion may be increasing. Additionally, CO_2 fluxes varied seasonally by site and Udalls Cove had significantly higher emission than the rest of the sites, which could indicate an enhanced loss of organic matter. No patterns were found between accretion rates, decomposition, CO_2 fluxes and distance from the east river – the proxy for nutrient concentrations. However, site specific nutrient concentrations are likely a more important measurement and such additional information may add clarity to the patterns observed.