Patterns of snail herbivory and phenolics in restored and natural *Spartina alterniflora* populations in Long Island Sound

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Introduction

Salt marshes are crucial in preventing coastal flooding, conserving biodiversity, and improving the quality of coastal waters, but these environments are under threat of degradation (Billah et al. 2022). Thus, restoration efforts to reestablish resilient salt marshes are key in preserving this landscape. The effect of herbivory on marsh restoration is understudied, though understanding interactions between salt marsh plants and herbivores could be key in seeing more successful outcomes (Wasson et al. 2021). Interactions between herbivores and plant chemistry can alter feeding rates on *Spartina alterniflora* (Sieg et al. 2013), but it is unknown how such interactions may affect marsh restoration. To better understand the potential impacts of grazing by snails on marsh restoration success, **this study explored patterns of snail grazing and *Spartina alterniflora* (smooth cordgrass) phenolic production across two natural marshes and two restored populations in Connecticut**.

Objectives

- Determine if snail grazing and phenolics differ among *S. alterniflora* leaves of different age
- Determine if snail grazing and phenolics differ among *S. alterniflora* leaves from natural and restored populations
- Measure periwinkle snail (*Littorina littorea*) densities within 2 natural and 2 restored *S. alterniflora* populations

Methods

- Collected 20 *S. alterniflora* stems per location from two natural marshes and two restored populations:
  - Milford Point (natural)
  - Guilford (natural)
  - Stratford Point planted in 2015 and Stratford Point planted in 2017 (restored)
- Photographed all leaves from each stem and measured area grazed by periwinkle snails on each leaf with ImageJ (Fig. 1A)
- Froze each leaf at -80°C, freeze-dried, and ground in liquid nitrogen
- Conducted Folin-Denis assay on each leaf to determine total phenolic content
- Counted periwinkle snails (*Littorina littorea*) within ten 25cm by 25cm quadrats spaced every 10m along a 50m transect at each location (Fig. 1B)

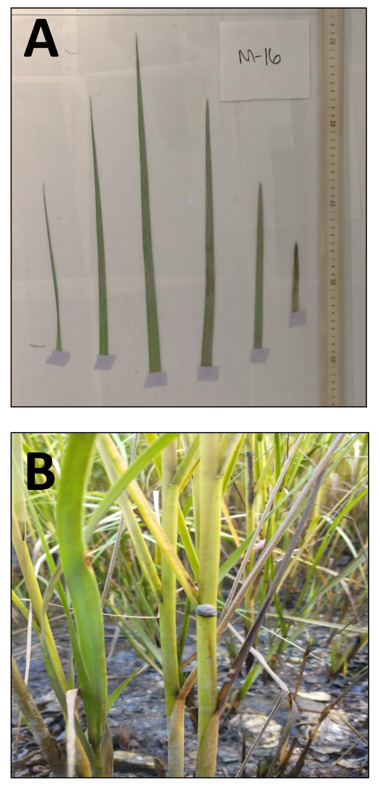

Figure 1. (A) *Spartina alterniflora* leaves from Milford and (B) snails (*Littorina littorea*) grazing on a *Spartina* stem at Stratford Point, CT.

Discussion & Conclusions

- **Neither grazing nor phenolics varied among leaves of different ages** (Figs. 2A, 3A), but **both grazing and phenolics varied among leaves collected from different locations** (Figs. 2B, 3B)
- Contrary to our predictions, **the highest grazing did not occur at the site with highest snail densities or in leaves with the lowest phenolic content**. Instead, grazing was highest in leaves from the Stratford population planted in 2015 (Fig. 2B), although the Stratford population planted in 2017 had the highest snail densities (Table 1)
- Highest phenolic content was seen in leaves from Guilford (Fig. 3B), where grazing (Fig. 2B) and snail densities (Table 1) were also low
- Phenolic levels were lower in leaves from Milford than in leaves from Guilford and Stratford 2017 (Fig. 3B)

Future Directions

- Construct generalized linear models including leaf size, leaf rank, grazing, and site as predictors of phenolic content to better understand if grazing and phenolic production are linked
- Include additional restored and natural marsh sites to explore general patterns of grazing in restored vs. natural marshes

Results

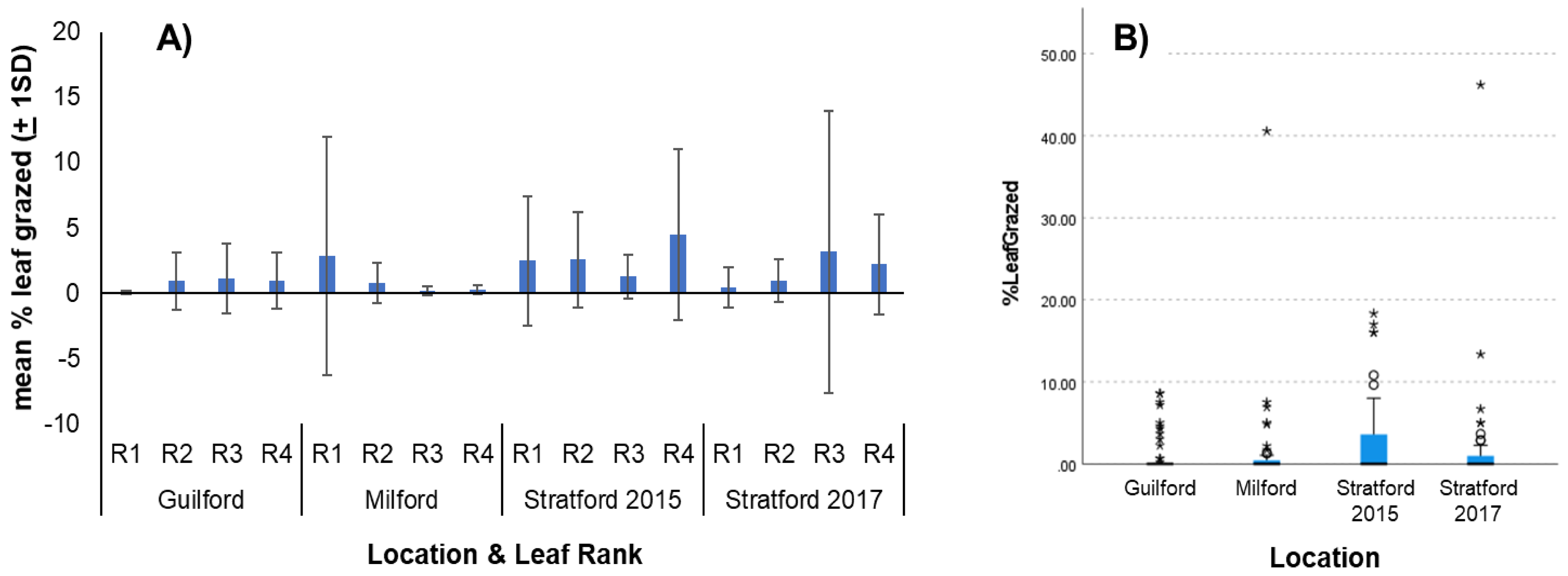

Figure 2. A) Mean % grazed (± 1SD) of *S. alterniflora* leaf ranks 1-4 collected across four locations in Connecticut. R1 is the youngest leaf and R4 is the oldest. Kruskal-Wallis tests showed no difference in grazing among leaf ranks at each site, so ranks were combined and rank was ignored as a factor in a subsequent Kruskal-Wallis test. **B**) Boxplot of % leaf grazed at each site, with the highest grazing seen at the Stratford 2015 site (H = 17.6, p < 0.001). Black bars are median, boxes show first and third quartiles, whiskers show maximum and minimum values, and circles and * show outliers.

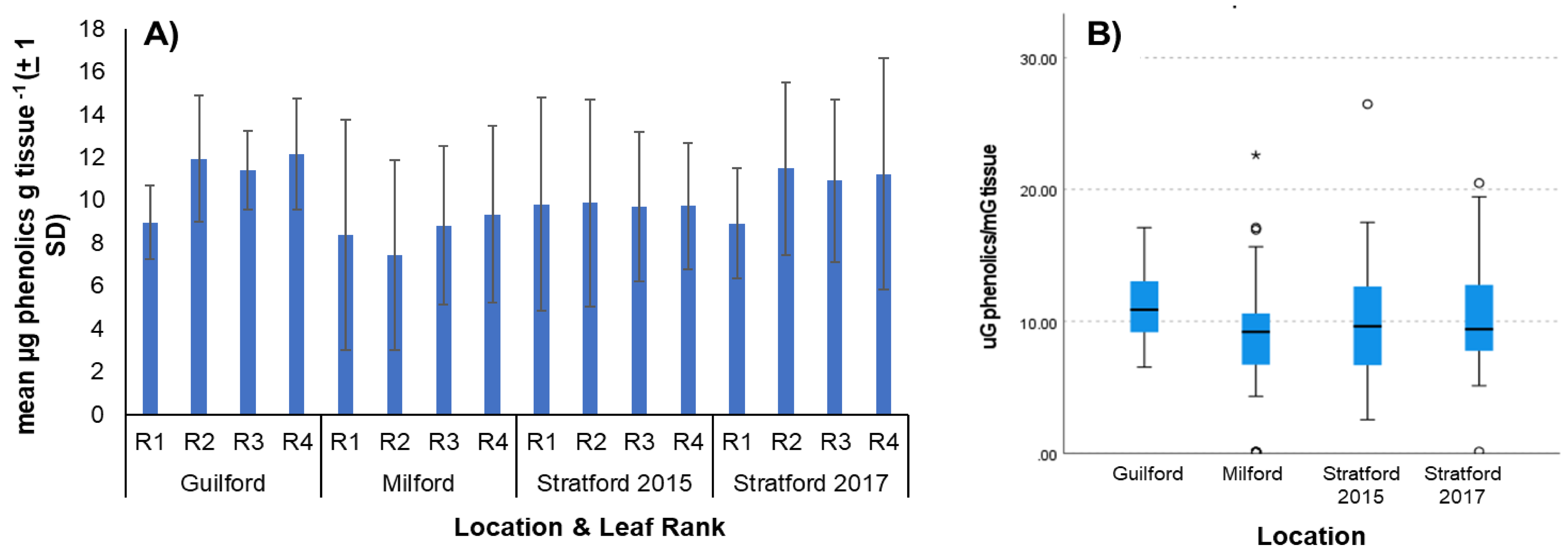

Figure 3. **A**) Mean µg phenolics g dry mass^{-1} in *S. alterniflora* leaf ranks 1-4 collected at four sites in Connecticut. R1 is the youngest leaf and R4 is the oldest. Krsukal-Wallis tests showed no evidence of differences in phenolics among leaf ranks at each site, so all leaf ranks were combined and rank was ignored as a factor in a subsequent Kruskal-Wallis test. **B**) Boxplot of µg phenolics g dry mass-1 in *S. alterniflora* leaves at each site. Kruskal-Wallis with post-hoc pairwise comparisons showed significantly higher phenolics in leaves from Guilford than any other site and lower phenolics in leaves from Milford than leaves from Stratford 2017 (H = 18.2, p < 0.001). Black bars are median, boxes show first and third quartiles, whiskers show maximum and minimum values, and circles and * show outliers.

Table 1. Mean number of periwinkle snails (*Littorina littorea*) per m^2 ± SD at four sites. The highest snail density occurred at Stratford 2017 with the lowest density at Milford.

Location	Mean # Periwinkles per m^2 ± 1 SD
Milford	7.2 ± 12.2
Guilford	8.8 ± 12.8
Stratford 2015	12 ± 15.2
Stratford 2017	25.6 ± 33.9

Literature Cited

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