How changes in vegetation patterns on the salt marshes caused by tidal inundation and climate change may be affecting reproduction of the salt marsh snail, *Melampus bidentatus*

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Figure 1. *Melampus bidentatus*

Figure 2. Cluster of egg cases

Introduction:

Melampus bidentatus (Fig.1) is a hermaphroditic, pulmonate snail species found in salt marshes along the East coast (Hausman, 1932, 1948). Their preferred habit is high marsh zone dominated by the plant *Spartina patens*. The annual reproductive season last about six weeks between late May, June, and early July. Based on lab studies, each individual deposits about 40 gelatinous egg masses about 1-2 mm in length (Fig. 2) and each mass contains an average of a 850 eggs (Apley 1970). These eggs produce free-swimming veliger larvae. The larvae spend about 4-6 weeks as planktonic larvae before returning to the salt marshes during high tide where they metamorphose and transform into juvenile snails (Apley 1970).

Salt marshes have been changing globally due to climate change, especially due to sea level rise and increased tidal inundation and. One of the major questions is how resident species are handling the various changes within the salt marsh. Many marshes along the CT coast hare exhibiting shifts in vegetation patterns due to tidal inundation. Many *Spartina patens* patches have been replaced by short *Spartina alterniflora*. Since *Spartina patens* is the natural habitat of the species, *Melamapus* populations may be impacted affected by such changes. In this study, I researched how *Melampus* reproduction may be affected by changes occurring on the salt marsh.

Methods and Materials:

The study was conducted at the Banca Marsh in Branford, CT. Five locations on the marsh were sampled (Fig. 3), representing different types of marsh habitats. Areas A, D and C are comprised of large patches *Spartina patens* bordered by either *S. patens* hummocks and/or short *Spartina alterniflora*. Area B is a small, remnant *S. patens* patch, and Area E is located is an extensive short *S. alterniflora* patch.

In each area, five replicate samples were obtained in a 10 cm by 10 cm quadrat (Fig. 4). Vegetation within the quadrats was cut down to the base of the stems and checked for snails. Snails found on the surface and on stems were counted and recorded. Two different sampling methods were used during this study in order to determine which worked best for these types of field study. At first, after the vegetation was cut, the eggs cases within the quadrat were counted. Egg cases were found on the marsh surface and on the stems of the vegetation. A sample of the peat was taken back to the lab in order to closely examine the egg cases. Another method was developed to improve accuracy when counting egg cases. After the vegetation was removed, a blade was used to cut underneath the surface of the soil in order to remove it from the ground such that the area within the quadrat remained completely intact. This was placed in a plastic container, and returned to the lab where the samples could be more closely examined with the aid of a dissecting microscope to identify and count the egg cases. If egg cases were found, five egg cases from each sample were dissected under a microscope and the number of eggs within the egg cases was determined.

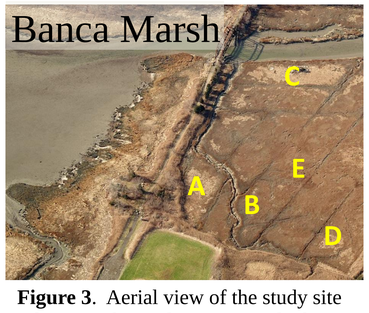

Figure 3. Aerial view of the study site Indicating the six locations studied.

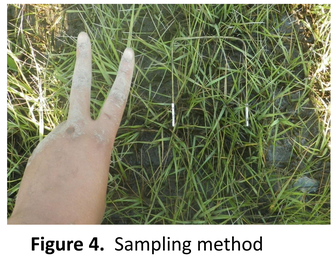

Figure 4. Sampling method

Results:

Note: all values on graphs are per 100 cm^2

- Similar abundances of *Melampus* were found among most vegetation types, however abundance in remnant *Spartina patens* patches was significantly lower (Fig. 5).

- Higher numbers of egg cases were were mostly found in *Spartina patens* and Short *S. alterniflora* patches (Fig. 6).

- However, statistical tests indicated no significant differences in egg deposition among habitats. This may be due to the high variability among locations within patches. A statistical test of dispersion (variance to mean ratio) indicated that the egg cases exhibit a significantly clumped distribution.

- The highest number of eggs per egg case was found in short *Spatina alterniflora* and *S. patens* patches; signifcantky lower numbers were found in hummocked *S. patens* patches (Fig. 7)

- A significant drop in in the mean number of egg cases found overall in early versus late summer, is consistent with previous reports of *Melampus* reproductive periodicity (Fig. 8).

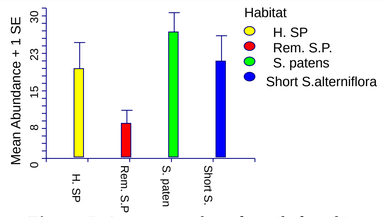

Figure 5. Average number of snails found in particular habitat. The habitats are; H.SP - hummock *Spartina patens*; Rem. S.P. Remnant *Spartina patens*, S. patens: Spartina *patens*, and Short S.Short*:* short *Spartina alterniflora.*

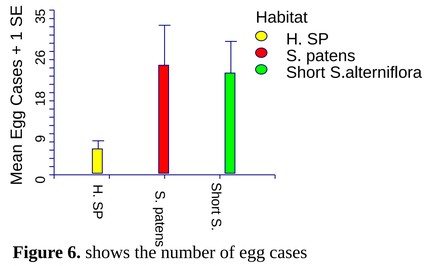

Figure 6. shows the number of egg cases found in each particular habitat.

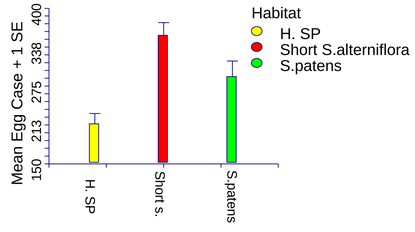

Figure 7. Average number of eggs per egg case in the various habitats.

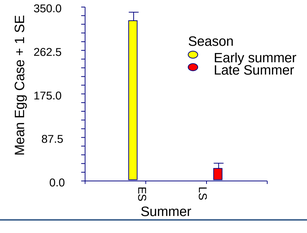

Figure 8. Number of egg cases found in the early summer, June 16th-June 17th verses late summer, July 17th –July 30th.

References:

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Hausman, Sibyl A. (1932). A contribution to the Ecology of the Salt Marsh Snail, *Melampus bidentatus* Say. *The American Naturalist*. 66(707). 541-545.

Russell-Hunter, W.D., Apley, Martyn L., Hunter, Douglas R.. (1972). Early Life-History of *Melampus* and the Significance of Semilunar Synchrony. *Biological Bulletin*. 143(3). 623-656.

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Discussion:

In the past, *Spartina patens* was the dominant vegetation at the Banca Marsh. *Spartina patens* patches have been reduced and short *Spartina alterniflora* has become more abundant, likely due to some combination of reductions in sediment supply and climate related increases in tidal inundation. According to literature, *Melampus* are mostly found in *Spartina patens* vegetation. However, research at the Banca Marsh has shown that for the last few years the dominant vegetation for *Melampus* has alternated between *Spartina patens* and short *Spartina alterniflora*. In this study similar abundances of *Melampus* were found in *Spartina patens*, short *S. alterniflora* patches, and *S. patens* hummocks (Fig. 5).

Although similar *Melampus* were seen in *these patches*, the number of egg cases found in S. patens hummocks was much lower than in short *Spartina alterniflora and S. patens (*Fig. 6). However, ANOVA showed that the egg case abundances were not significantly different among patches. But the egg cases are found in aggregated clumps, thus causing high variation in the mean number per patch. These results indicate that in the field snails lay their eggs while they are aggregated (Fig, 9).

Many *S.patens* meadows on salt marshes are changing over to hummocked areas. Although snail abundances are similar to that found in other patches, low numbers of eggs cases and numbers of eggs per egg case suggest that snails in these habits have a lower fecundity and thus may make smaller contributions to overall population maintenance in the salt marsh.

According to the literature , *Melampus bidentatus* is typically found in *Spartina patens*. My results indicate that while changes in salt marsh vegetation patterns and hydrologic characteristics may cause increasing areas of short *Spartina alterniflora* and hummocked S. patens, while areas of *Spartina patens* decrease, *Melampus* abundances do not appear to be affected. However, my study indicates that their reproductive characteristics may be changing in some patch types.

Also, according to the literature, Melampus was thought to lay their egg cases on the stems of plants based on strictly lab observations. My observations indicate that they do not do this in the field as all eggs cases were found on the marsh surface n moist med or on the underside of hard surfaces such as logs. This may allow the egg cases to withstand hot period and desiccation, but make them more vulnerable to predation.

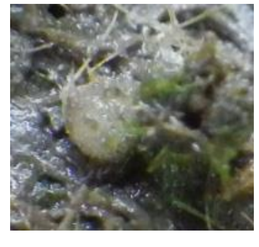

Figure 10. Close up view of an egg case

Figure 9. Cluster of *Melampus* egg cases

Conclusions:

Since this was the first summer *Melampus* reproduction has been studied at the Banca Marsh, it is difficult to come to a precise conclusion on how the change of vegetation dominance is affecting *Melampus* reproduction. The distribution of egg cases indicates that eggs are being laid in clumps which supports the idea that the snails lay their eggs while they are aggregated. More eggs are being laid in short *Spartina alterniflora*, which suggests that the *Melampus* may be able to adapt to a transition from *Spartina patens* to short *Spartina alterniflora*. However, the average amount of eggs per egg case is lower than previoulsy rep[orted in literature ,suggesting a possible decline in the overall fecundity due to environmental conditions. However, more research is needed in order to determine trends and draw more robust conclusions.