# Quantifying the Structure of Salt Marsh Harvest Mouse Habitat

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## Introduction

- The salt marsh harvest mouse (*Reithrodontomys raviventris*) is a federal and state listed endangered species that occupies the San Francisco Bay Estuary. Understanding the characteristics of its habitat is critical for conservation and management actions.
- Previous studies of the salt marsh harvest mouse have identified the importance of various plants for cover[1] and food[2] .
- Here we quantify the structural characteristics of their habitat, in terms of the density and robustness of the vegetation at traps where mice were, and were not, captured.
- We leveraged the collective effort of 12 students enrolled in the CSUSM Spring 2023 "Applied Animal Ecology Field Experience" course to obtain a variety of measurements that would otherwise be infeasible on a large scale.
- These data will contribute to ongoing research on salt marsh harvest mouse morphology and locomotor performance[3], to better understand how their physical environment shapes their form and function.


## Methods

- Mice were captured and released in the Suisun Marsh, CA (Fig. 1) following standard small-mammal trapping protocols[1], state and federal permits, and IACUC (#21-002) approvals.
- A 7 x 8 grid of 56 traps (spaced 10 m apart) was established in Hill Slough Wildlife Area Pond 4, from which 24 (12 capture & 12 non-capture; Fig. 1) were randomly chosen for vegetation sampling and structure analysis.

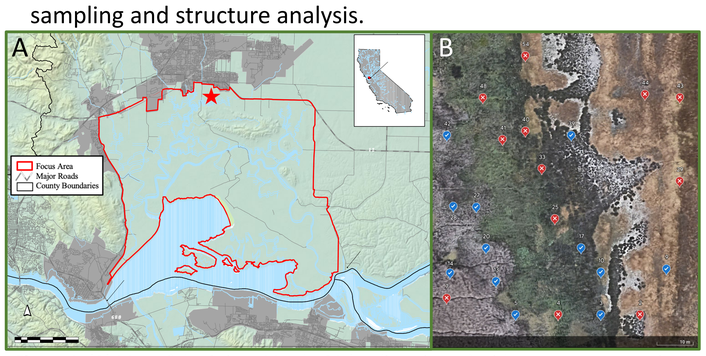


**Figure 1. (A)** Map of the Suisun Marsh, CA (outlined in red) with red star representing where small-mammal trapping and vegetation analysis took place. Map from the California Department of Fish and Wildlife. **(B)** Satellite image from Google Earth of the Hill Slough Wildlife Area (Pond 4) survey site (red star in A) with trap locations marked according to GPS coordinates obtained while in the field. Red markers represent non capture locations (n=12) and blue markers represent capture locations (n=12).

### Vegetation Structure

- We created a cover board[4] (91.4 cm H x 38.1 cm L) using a polycarbonate sheet.
- GoPro cameras mounted on tripods were set up one meter away from the cover board to capture North and South planar images of vegetation against the cover board (Fig. 2).
- Images were corrected for brightness and shadows using Adobe Photoshop, followed by conversion to 8bit and threshold adjustment in ImageJ[5].
- Images were converted to grayscale in RStudio[6] using package imager[7] to obtain the following variables: leaf area index, maximum vegetation height, height of closed vegetation, visual obstruction reading, and foliage height diversity.


### Vegetation Diameter and Compliance

- Cross bars, consisting of four perpendicular meter sticks, were positioned at each trap site. Vegetation at the ends of the meter sticks was measured using calipers.
- Compliance[8] ($C$) was calculated by dividing the vertical displacement ($\Delta d$) of a branch when the force of a 14g weight was applied.

$$C = \frac{\Delta d}{9.81(0.014)}$$

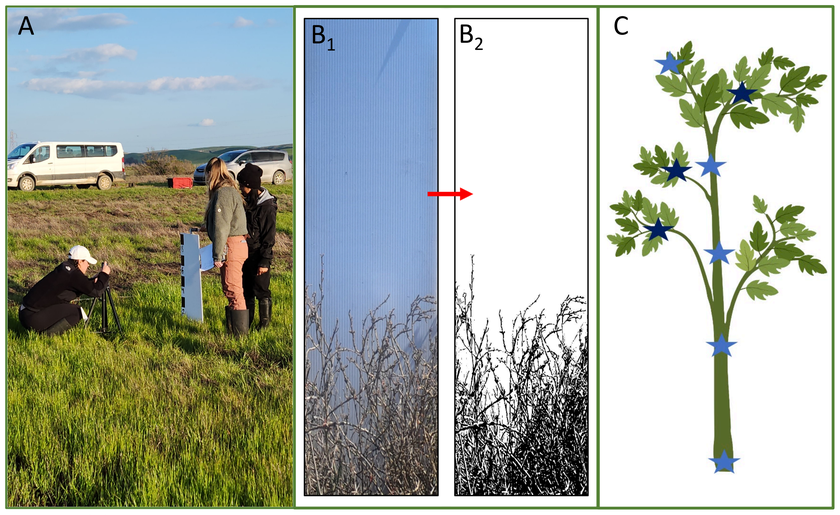


**Figure 2. (A)** GoPro camera, tripod, and cover board used to capture images of vegetation at trap locations. **(B)** Example of vegetation images taken in the field ($B_1$) converted to grayscale ($B_2$) in RStudio[1]. **(C)** Example of vegetation diameter and compliance taken. Stars indicate diameter measurements and dark blue color indicates compliance measurements. Created using BioRender.

## Preliminary Results

- Leaf area did not differ between traps where mice were and were not captured (Wilcoxon's ranked sign test; p=0.241), but capture traps had significantly taller vegetation (p=0.0125)

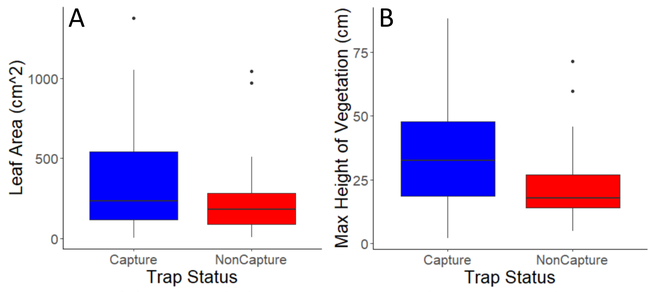


**Figure 3. (A)** Leaf area (LA), measured as the % of black pixels in the grayscale images converted to $cm^2$, and **(B)** maximum height of vegetation (MHV), measured as the highest black pixel position in the greyscale images converted to cm, for capture (n=11) and non-capture (n=12) traps.

- Foliage height diversity was marginally nonsignificant between groups (Wilcoxon's ranked sign test; p=0.0595), although VOR, a measure of aboveground vegetation density, was significantly higher at capture sites (p=0.0274).

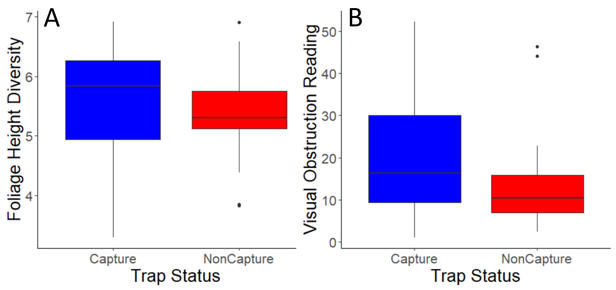


**Figure 4. (A)** Foliage height diversity (FHD), calculated as the Shannon index of the count of black pixels in each pixel row of an image, and **(B)** modified visual obstruction reading (VOR), calculated as the average of height of closed vegetation and maximum vegetation height, for capture (n=11) and non-capture (n=12) traps.

- Pairwise correlations among structural variables within groups were significant (p<0.05), suggesting redundancy among visual obstruction reading (VOR) with other variables.

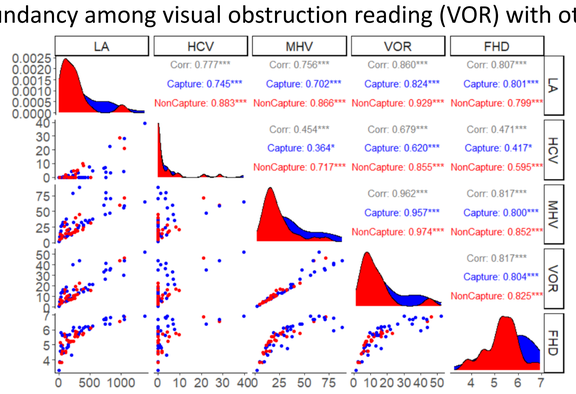


**Figure 5.** Pearson correlation matrix among vegetation structure variables for capture (blue; n=11) and non-capture (red; n=12) traps.

- Neither stem diameter (student's t-test; p=0.41) nor compliance (Wilcoxon's signed rank test; p=0.23) differed significantly between capture and non-capture traps.

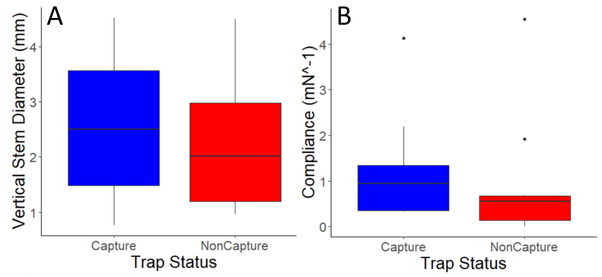


**Figure 6. (A)** Vertical stem diameters for capture (n=11) and non-capture (n=12) traps, and **(B)** compliance, a measure of branch displacement with given a force, between capture (n=8) and non-capture (n=10) traps.


## Discussion

- Salt marsh harvest mice were caught in traps where there was taller and more dense vegetation, which likely provides greater cover and a means for navigating periods of flooding.
- Diameter and compliance did not differ between trap status, suggesting that these characteristics might not be as important as vegetation cover and height. However, the sample size is limited and data from other sites within Suisun Marsh are needed for a more robust comparison.
- These data represent the first attempt at characterizing the "fine branch niche"[9] of the salt marsh harvest mouse, which will help identify key attributes of their habitat that could influence their functional morphology and fitness.

## Future Directions

- Streamline methodology to deploy these measurements more efficiently across a greater range of trap sites throughout the Suisun Marsh.
- Ground truth the visual obstruction readings by taking measurements of above ground vegetation biomass.
- Use these structural variables to establish the context of variation in locomotor behavior among coexisting rodents.

## References

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