Beetles Around North Campus Open Space - A Cheadle Center Coverboard Chronicle

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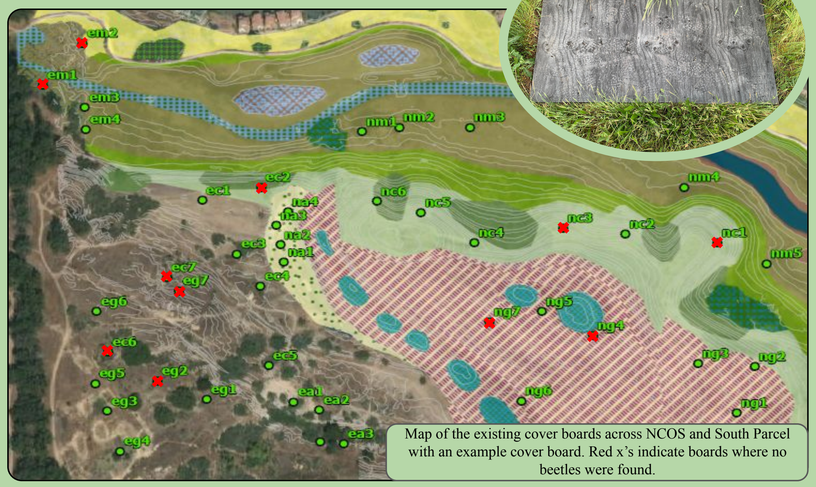
Map Legend:
e = ungraded and managed area (South Parcel)
n = fully graded and managed area (NCOS)
m = marsh
c = coast sage scrub
a = woodland
g = grassland



Map of the existing cover boards across NCOS and South Parcel with an example cover board. Red x's indicate boards where no beetles were found.

Desert Stink Beetle
(*Eleodes dentipes*)
Family Tenebrionidae

Acknowledgement & References

We would like to thank Katja Seltmann for her guidance and their contributions to this study. Alistair Dobson's initial inspiration and enthusiasm were instrumental in launching this project. Their support and mentorship have been invaluable, shaping our research journey and academic growth. We extend our heartfelt thanks for their encouragement and belief in our work.

Dobson, A. L, Sullivan, K., & Stratton, L. (2022). *Reptiles and Restoration: Coverboard Monitoring before and after Wetland Reconstruction.* UC Santa Barbara: Cheadle Center for Biodiversity and Ecological Restoration. Retrieved from https://escholarship.org/uc/item/869559br

Wu, B., Jiao, X., Sun, A., Li, F., He, J. Z., & Hu, H. W. (2023). Precipitation seasonality and soil pH drive the large-scale distribution of soil invertebrate communities in agricultural ecosystems. *FEMS Microbiology Ecology*, *99*(11), fiad131.

What are we Observing at NCOS?

Macroinvertebrates provide essential ecosystem functions by breaking down organic matter, recycling nutrients back into the ecosystem and serve as insightful bioindicators of ecosystem health. In agricultural systems, mean annual precipitation and soil pH are the largest predictors of soil invertebrate distribution (Wu et al. 2023). In this study, we **hypothesize** that humidity, as a proxy for mean annual precipitation, and soil pH accurately predict patterns of macroinvertebrate distribution in a restored ecosystem, focusing on one of the most diverse macroinvertebrate orders, Coleoptera.

Materials & Methods

- Forty-four pre-existing plywood **coverboards** (3' x 4') dispersed across NCOS (Dobson et al. 2022) in **four distinct habitats** (grassland, woodland, coast sage scrubland, and marshland).
- Hand collection and curation of specimens under coverboards and identification through the BugGuide community.
- **Soil pH** found by collecting soil under coverboards and suspending material in solution to analyze with a pH meter.
- **Relative humidity** recorded by placing hygrometers in the interspace between the soil and the coverboard.
- **Statistical analysis** through R includes one-tailed t tests, one-way ANOVA, logistic regression and a generalized linear model to explore how habitat type, surface humidity, and average pH of study sites correlate to beetle presence.

Results

- We fit our variables to a model to evaluate their predictability of beetle presence and found that habitat type, relative humidity, and site pH were the most balanced between fit and model complexity (*Generalized Linear Model, binomial, AIC = 45.80*).
- Using an alpha level of 0.05, we compared coverboards within habitats, with or without beetles, and found no significant differences in relative humidity between beetle presence (*One-tailed T Test and One-sample Wilcoxon Signed Rank Test, p >> 0.05*).
- Comparing soil pH of coverboards, we found that woodland and marsh habitats were not significantly different from neutral pH (*One-sample Wilcoxon Signed Rank Test, p >> 0.05*) whereas the grassland and coast sage scrub habitats were greater than neutral pH (*One-sample Wilcoxon Signed Rank Test,* $p_{grassland} = 0.0386$, $p_{coast\ sage} = 0.00305$)*.
- In analyzing the differences of mean humidity and pH among habitats, we found that differences were not statistically significant (*One-way ANOVA and Non Parametric One-way ANOVA,* $p_{humidity} = 0.0667$ *and* $p_{pH} = 0.0543$).
- A logistic regression was performed to fit probabilities for predicting beetle presence according to our data.

Discussion

Variance among habitats of humidity and pH were nearly significant but sample size may have prevented reaching conventional levels of statistical significance. There was no statistical significance with humidity and pH in habitats with or without beetles - marsh and woodland habitats didn't have enough data for statistical testing. Though, the grassland and coastal sage habitats had pH values above the hypothesized neutral value. Greater statistical significance and resolution may be achieved through more comprehensive surveys by recording multiple soil parameters every survey event. Our findings may suggest potential ecological nuances that were not fully captured by the model. Factors such as microhabitat variation, interspecies interactions, and seasonal fluctuations could contribute to the observed patterns. Additionally, the relatively small sample size ($N_{humidity} = \sim 220$, $N_{pH} = 88$) along with outliers may have influenced the model's ability to detect significant associations. Further investigation via finer-scale environmental data and less sampling error may offer deeper insights into the complex dynamics underlying beetle presence in these habitats.

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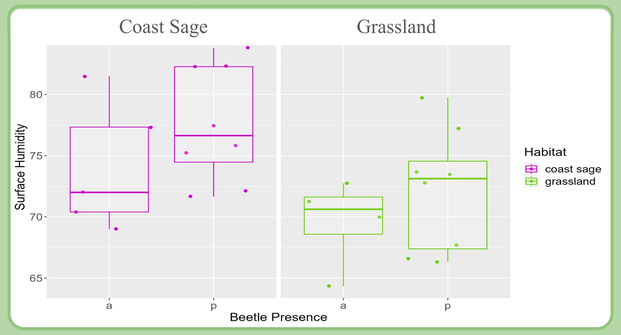
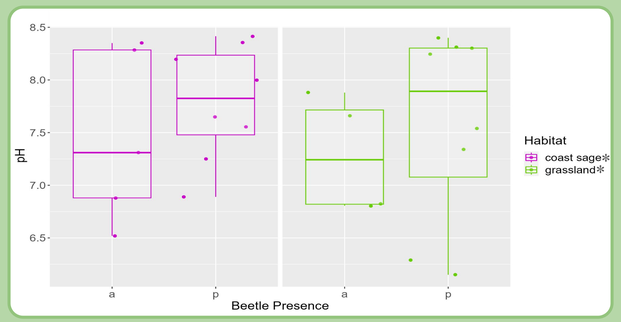
Habitat Beetle Presence - Humidity & pH

Beetle presence (a: absent, p: present) represented on the x-axis while humidity (%) and pH are indicated on the y-axes. The box plots represent the interquartile ranges, medians, minimums and maximums of parameters per habitat.





Predicted Beetle Presence - Humidity & pH

The predictive line graph demonstrates the changing probability of beetle presence as humidity and pH vary across the different habitats. Humidity (%) and pH are plotted on the x-axes, while the predicted probability of beetle presence is indicated on the y-axis. Woodland probability does not change with variables as we found beetles at every site.