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# Aquatic Invertebrate Community Differences In Constructed and Natural California Vernal Pools



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## Introduction

- Vernal pools are seasonal wetlands found in Mediterranean climates worldwide which provide habitat for a unique fauna and flora
- California vernal pools are dry during hot summers but inundate during the winter, during which they support threatened and endangered aquatic invertebrates (e.g., vernal pool fairy shrimp)
- Over 90% of vernal pools have been lost from California due to agricultural and urban related habitat destruction
- Vernal pool construction is frequently used as mitigation to offset the destruction of natural vernal pools and their communities from development
- The purpose of this study was to assess whether human-constructed vernal pools can replicate the aquatic invertebrate assemblages of their natural counterparts

## Methods

- Ten sites ranging from Southern Oregon to San Diego known to contain both constructed and natural pools were selected for study (Fig. 1)
- At each site, 18 vernal pools (9 constructed and 9 natural paired by surface area) were randomly selected
- Soils collected from each pool were placed into separate mesocosms and filled with water
- Mesocosms were sampled at two-week intervals over 10 weeks via aquarium net sweeping
- All captured aquatic invertebrate species were identified and enumerated (Fig. 2)
- Paired t-tests and GLMs were used to evaluate hypotheses

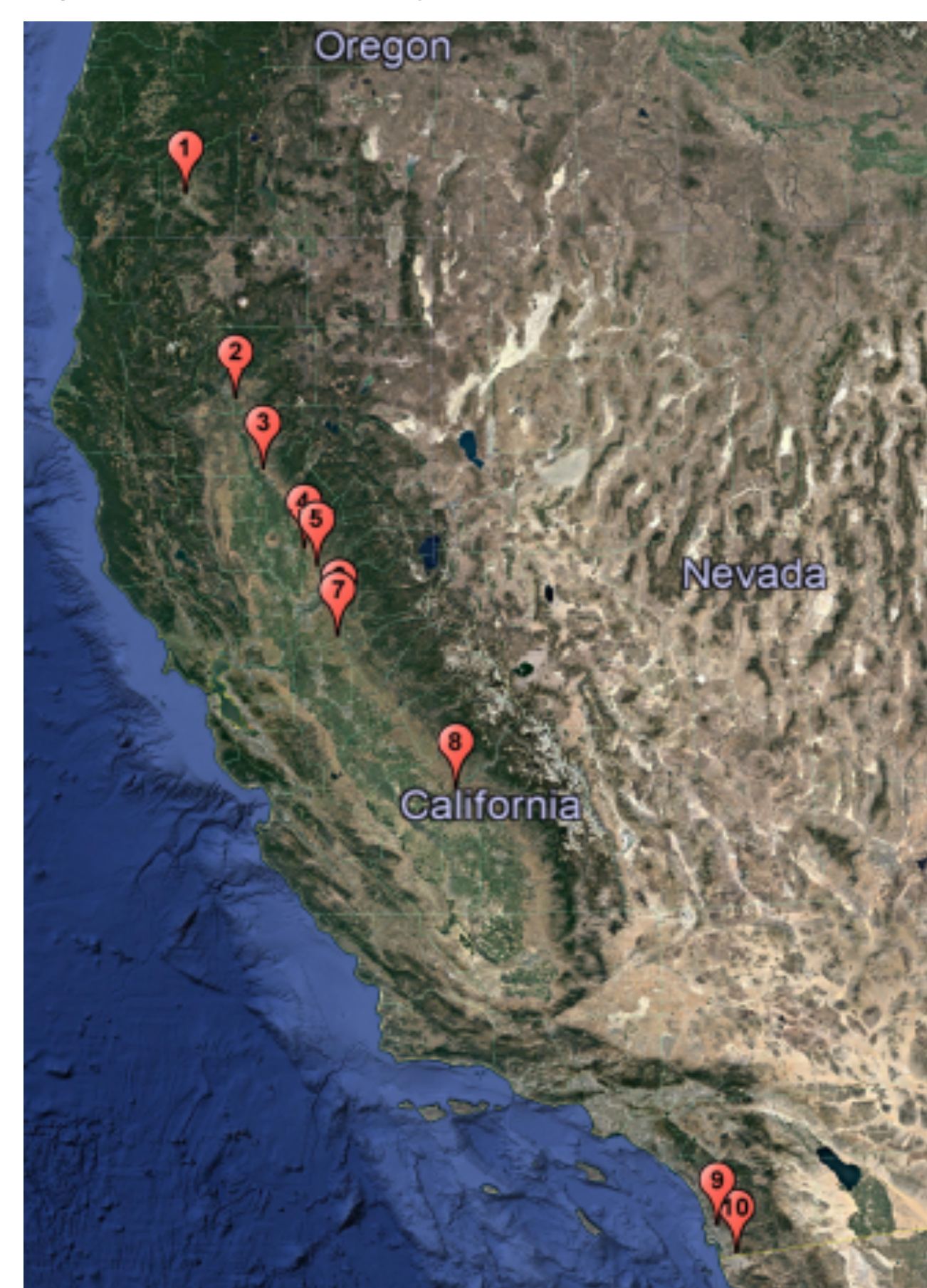


Fig. 1: Ten sites selected for study



Fig. 2: Federally listed branchiopods hatched from mesocosms. Left: vernal pool fairy shrimp (*Branchinecta lynchi*), Center: vernal pool tadpole shrimp (*Lepidurus packardii*), Right: Riverside fairy shrimp (*Streptocephalus woottoni*)

## Results

- Overall, species richness was not significantly different between constructed and natural pools
- However, listed branchiopod abundance and invertebrate abundance was 218% and 274% greater in natural pools than constructed ones, respectively (Figs. 3 and 4)
- Listed branchiopod abundance in constructed pools was positively associated with average depth (Fig. 5), whereas in natural pools was negatively associated with elevation and total vegetative cover
- Species richness in constructed pools was positively associated with average depth and negatively associated with total vegetative cover (Fig. 6), whereas it was positively associated with latitude in natural ones
- The age of constructed pools was not associated with any measurements of richness or abundance

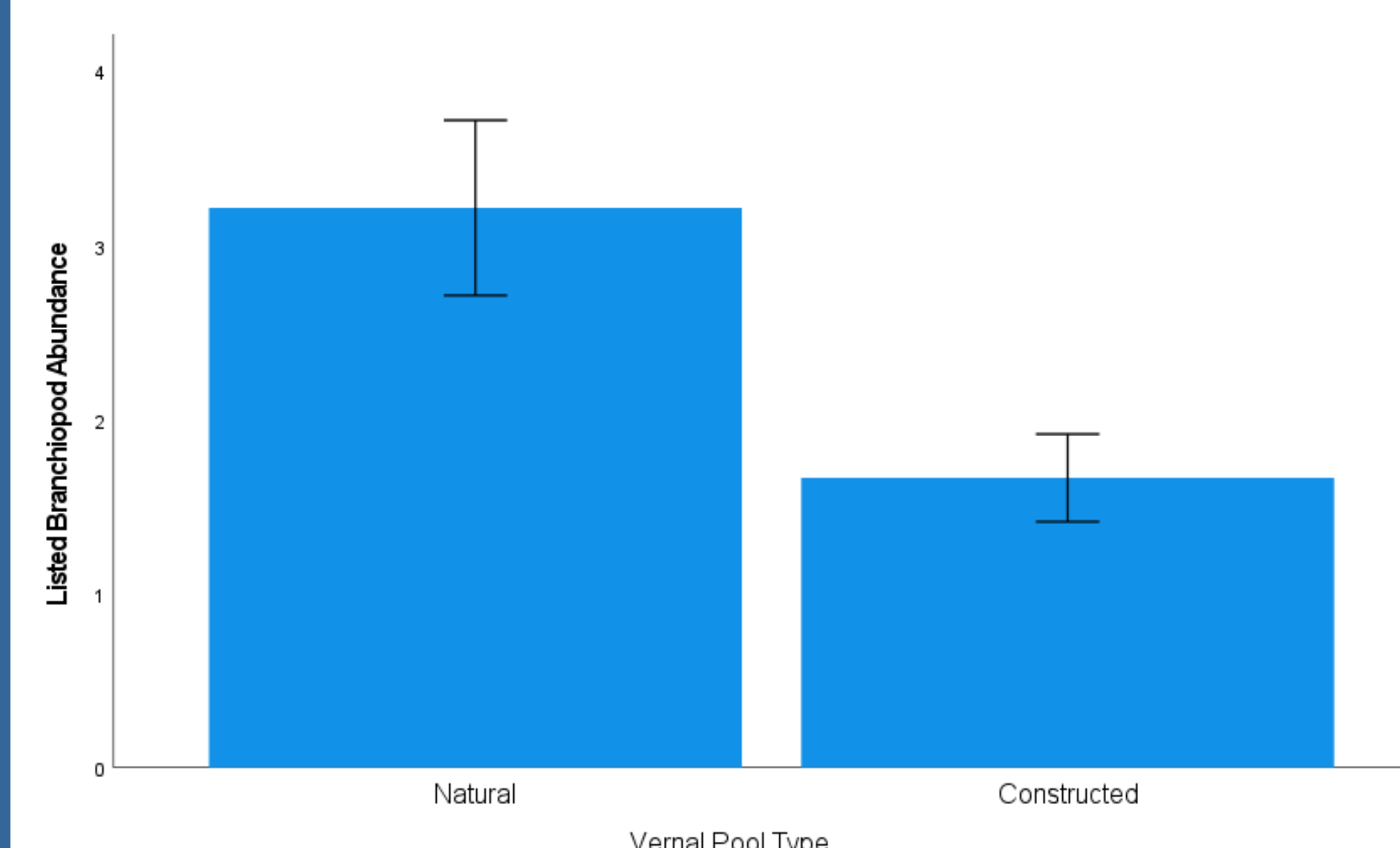


Fig. 3: Bar graph comparing mean (+/- SE) listed large branchiopod abundances in natural and constructed vernal pools

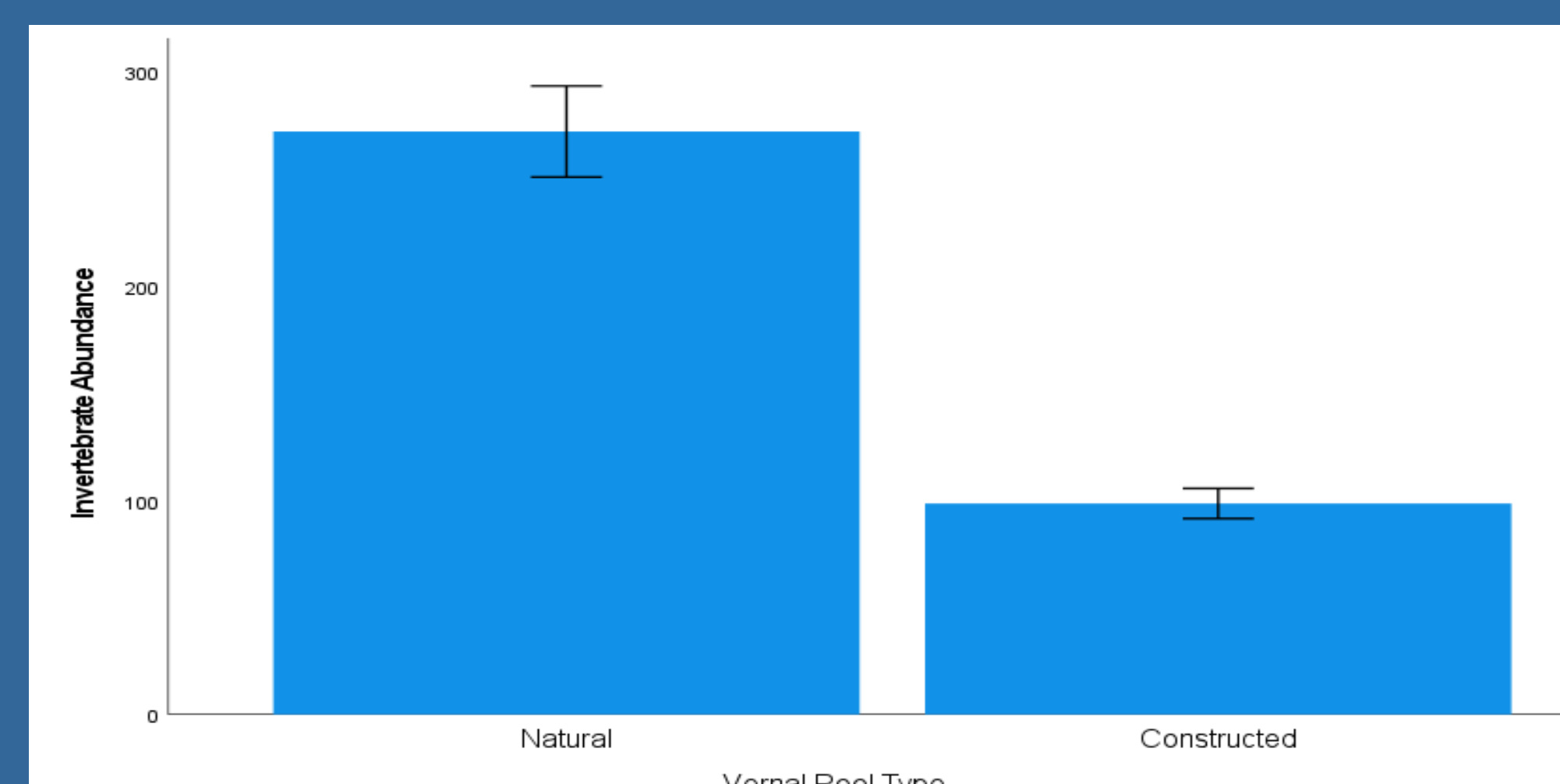


Fig. 4: Bar graph comparing mean (+/- SE) invertebrate abundances in natural and constructed vernal pools

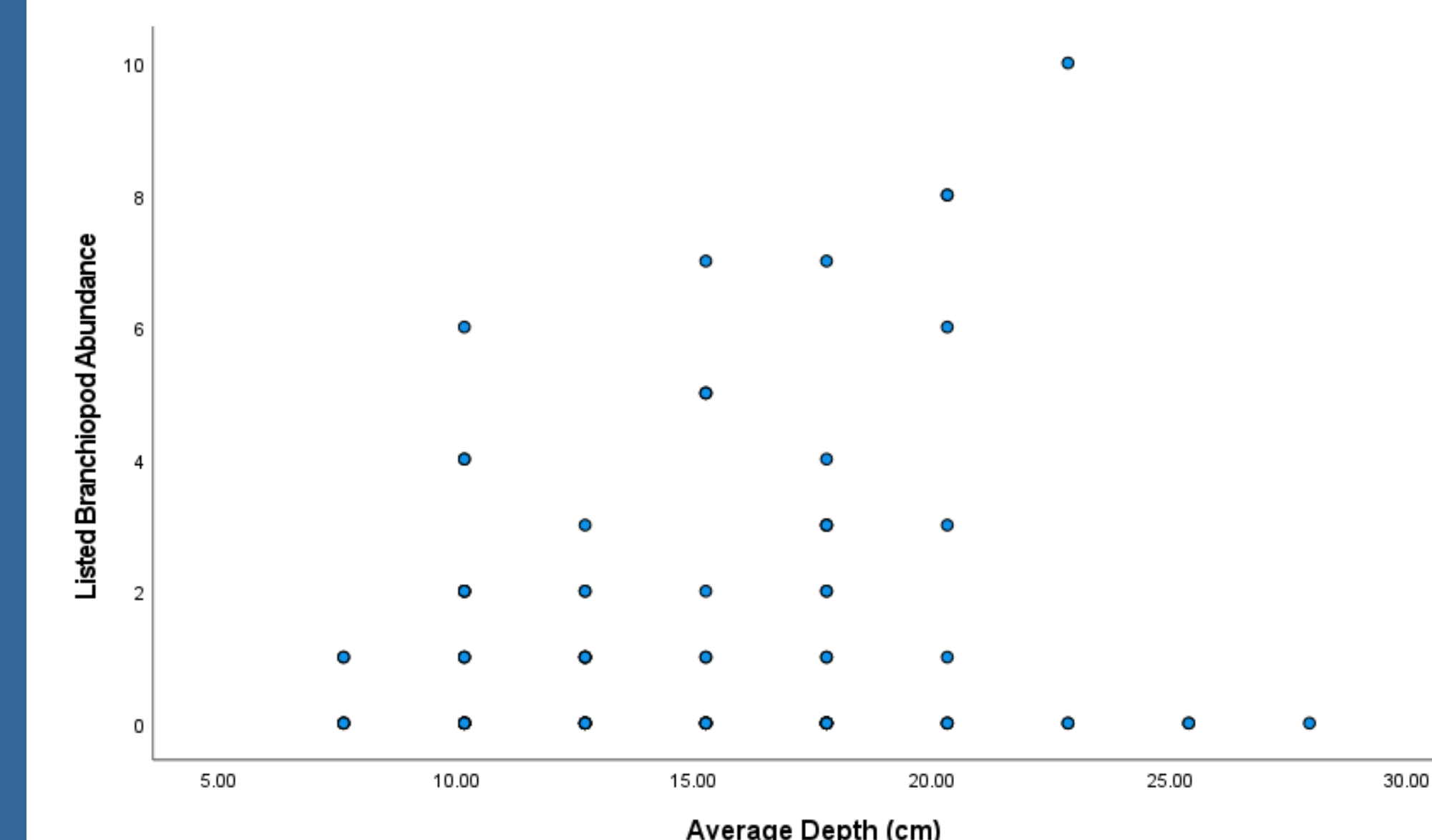


Fig. 5: Scatter plot showing the relationship between average depth and listed branchiopod abundance for constructed pools

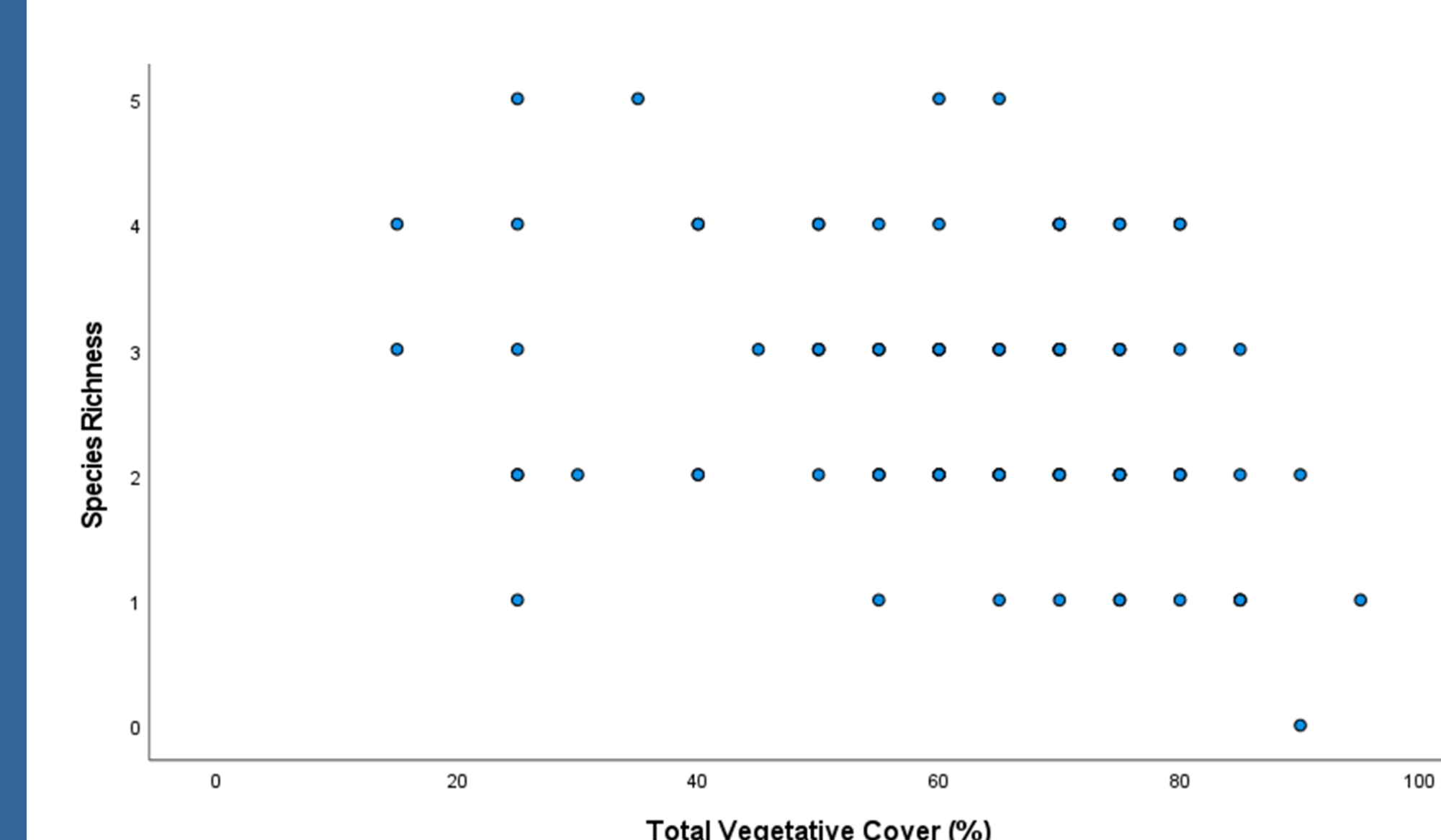


Fig. 6: Scatter plot showing the relationship between total vegetative cover and species richness for constructed pools

## Discussion

- Richness, but not abundances, were the same in constructed and natural pools. Prior studies have found constructed wetlands are ~25% less biodiverse and functional than natural wetlands decades or even centuries after construction (Ruhi et al. 2016)
- Increasing average depth was associated with higher listed branchiopod abundances and species richness for constructed pools, supporting other studies indicating that diversity and density tends to increase as hydroperiod increases (King et al. 1996). However, ideal average depths for invertebrate abundances was species-specific.
- Decreasing total vegetative cover was associated with higher listed branchiopod abundances in natural pools and higher species richness in constructed pools, which supports findings that thatch negatively impacts vernal pool aquatic invertebrates (Kneitel et al. 2017)
- The age of constructed pools was not associated with any measurements of richness or abundance, contrary to expectations that time is positively associated with richness and abundance (Ruhi et al. 2016)

## Conclusions

- Constructed vernal pools have an important role in combating habitat destruction and understanding their strengths and weaknesses is vital for conservation and restoration efforts
- These results suggest that wildlife managers should account not only for listed branchiopod presence, but also for listed branchiopod abundance
- Vernal pool construction should consider average depths which promote target species abundances and managed for vegetative cover (e.g., grazing)
- Further ecological research into vernal pool construction should focus on long-term evaluations of various construction techniques

## Acknowledgements

This research was funded in part through the CSUS Delisle Student Research Fund.

## References

- King, J. L., M. A. Simovich & R. C. Brusca, 1996. Species richness, endemism and ecology of crustacean assemblages in northern California vernal pools. *Hydrobiologia* 328: 85–116.
- Kneitel, J.M., Samiylenko, N., Rosas-Saenz, L. and Nerida, A., 2017. California vernal pool endemic responses to hydroperiod, plant thatch, and nutrients. *Hydrobiologia*, 801(1), pp.129-140.
- Ruhi, A., Fairchild, G.W., Spieles, D.J., Becerra-Jurado, G. and Moreno-Mateos, D., 2016. Invertebrates in created and restored wetlands. In *Invertebrates in Freshwater Wetlands* (pp. 525-564). Springer, Cham.