Reptiles and Restoration:

Coverboard Monitoring before and after Wetland Reconstruction

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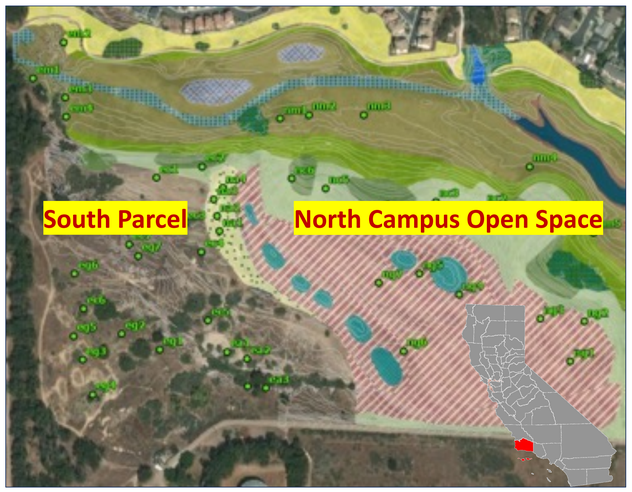
North Campus Open Space (NCOS) restoration project in Santa Barbara, California, USA.

UC Santa Barbara's NCOS restoration project comprises 136 acres of upland and wetland habitats adjacent to the Coal Oil Point and Ellwood-Devereux open spaces. The upper arms of this slough were filled in 1960 to create Ocean Meadows Golf Course (OMGC), but in 2017 major excavation reshaped the slough and mesa which historically existed there. This provided a barren landscape that has since been subject to intensive ecological restoration, including major planting, weeding, and monitoring efforts. In the South Parcel (SP) restoration site adjacent to NCOS, restoration efforts also began, but with without the major soil disturbance of excavation.

How are Reptile and Amphibian populations affected by the restoration of Devereux slough and adjacent habitats?

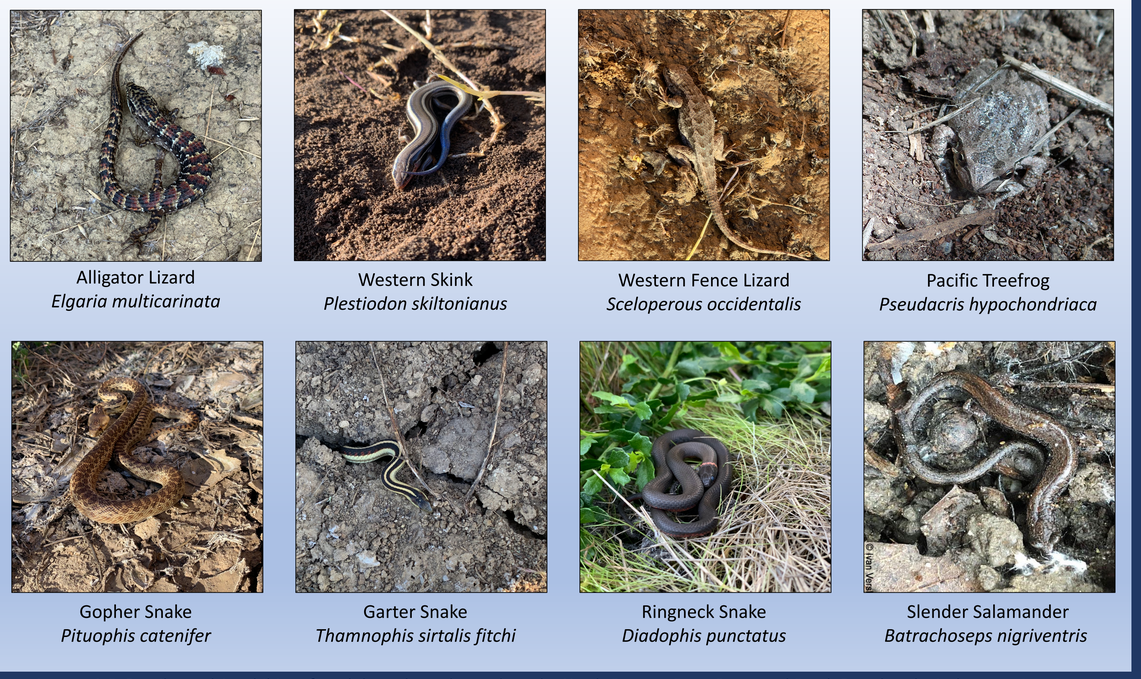
- Initiated an undergraduate-led long-term monitoring study using coverboards to assess diversity and abundance herpetological populations.
- Compared encounter rates of herps across restoration regimes/areas and planned habitat types.
- Compared monitoring data to a similar coverboard study that took place before major ecological restoration efforts began. (Before/after restoration assessment).



Map 1. North Campus Open Space (NCOS) habitats and adjacent South Parcel (SP) with forty-four coverboard locations. Santa Barbara County, CA is highlighted in red.

Methods:

- Between 2012-2014, twenty-two coverboards were monitored bi-weekly across SP and NCOS before major restoration began at NCOS.
- In September 2020, forty-four coverboards were deployed across four habitat types (grassland, coastal scrub, salt marsh, sandy annual vegetation) in the recently excavated NCOS and SP restoration sites. In 2017, NCOS experienced excavation with a bulldozer, whereas in SP the soil remained intact.
- Coverboards were monitored weekly between October 2020 and June 2022, and data will be compared over the same period in the previous study.
- Vertebrate species type and abundance was recorded under each board along with environmental data and invertebrate species presence.



Images 1-8. Reptiles and Amphibians found throughout the study at the North Campus Open Space and South Parcel ecological restoration sites.

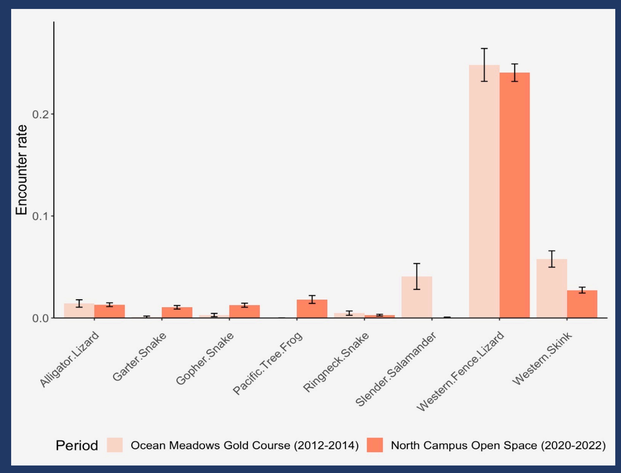


Figure 1. Herp populations before and after Restoration.
Encounter rates (Average # of individuals per board flipped) for each species vary between the populations of reptiles and amphibians studied before and after the transformation of Ocean Meadows Golf Course into North Campus Open Space which began in 2017. Error bars show standard error. Populations of western fence lizards, alligator lizards, and ringneck snakes remained the same before and after the disturbance. Populations of garter snakes, gopher snakes , and pacific treefrogs drastically increased after the restoration event, whereas populations of slender salamanders and western skinks decreased.

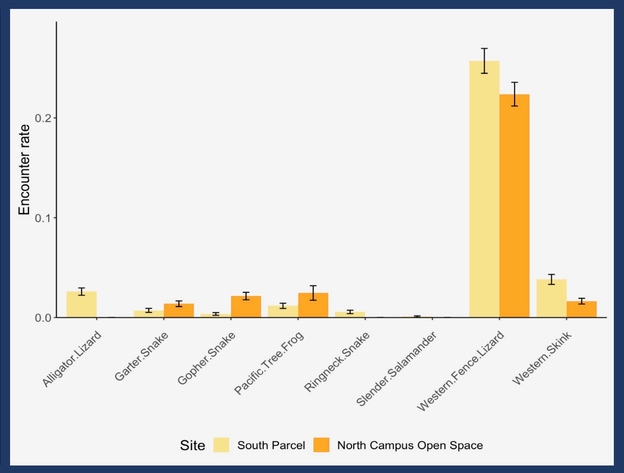


Figure 2. Herp populations vary between restoration sites.
After restoration (2020-22), encounter rates for herp species vary between North Campus Open Space and the adjacent South Parcel sites: two areas that experienced different intensities of restoration, with excavation at NCOS but not in SP. Alligator lizards, ringneck snakes, and slender salamanders have not been observed at NCOS under coverboards or elsewhere since the excavation occurred and restoration began. Meanwhile, populations of garter snakes, gopher snakes, and pacific treefrogs are greater on the NCOS restoration site than in the adjacent SP plot. Finally, western skinks and fence lizards are slightly more abundant in the SP restoration area.

Discussion.

- Herpetological diversity and composition remained the same before and after restoration with six species of reptiles and two species of amphibians. Additionally, the California kingsnake has been observed both before and after restoration on the property, but not under coverboards. Herp species richness is higher in the greater Santa Barbara County region, but development surrounding the restoration site likely impairs the likelihood for new species to colonize the restored habitat.
- Encounter rates for gopher and garter snakes increased after the restoration efforts. The encounter rates for both species were highest in the newly restored NCOS salt marsh habitat, which has likely been subjected to the most intensive restoration efforts.
- Species such as the slender salamander, alligator lizards, and ringneck snake have not been observed on the NCOS side of the property since excavation. Perhaps this intensive disturbance in the restoration process was harmful for the more sensitive species. As the site's soil and vegetation structure matures it will be interesting to see if the populations of these species increase.

Future Directions.

- Each year, a new undergraduate intern will be selected and trained to conduct weekly (or bi-weekly) monitoring.
- After five years of monitoring, we will revisit this analysis and compare herp populations to data about restored vegetation and other faunal monitoring programs at NCOS.
- Potential for mark and recapture of some reptile species:
  - In 2022 we began collaborating with Dr. Amanda Sparkman of Westmont College to provide her with DNA samples to compare with Channel Islands reptile populations. In exchange, she has the permits to mark captured animals, which have the potential to be recaptured in the future, giving us insights about the survivorship of local populations.

Acknowledgments.
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Image 9. Kyra and Gabriele check a coverboard at South Parcel.