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Aquatic Invertebrate Assessment at the North Campus Open Space

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Introduction

In 2013, 64 acres of the former Ocean Meadows golf course were purchased by The Trust for Public Land and gifted to The Regents of the University of California (1). Since then, UC Santa Barbara's Cheadle Center has been managing the land and restoring it to its natural state, with the reconstructed upland and wetland habitat coming to be known as North Campus Open Space (NCOS). This space contains the upper Devereux Slough, a temporarily open/closed estuary, which has been under observation since its creation to assess the health of this restored ecosystem.

One method of assessing ecosystem health is sampling the presence and abundance of aquatic macroinvertebrate and zooplankton populations. These organisms are crucial to aquatic ecosystems due to their roles as primary consumers processing both live and dead organic material, as they cycle nutrients for predators such as aquatic birds, mammals, fish, amphibians, and reptiles (2). A variety of methods can be utilized to sample aquatic macroinvertebrate and zooplankton populations; two of these methods are filter beaker sampling and dipnetting, which assess surface water organisms and benthic organisms, respectively. As these two methods focus on different levels of the water column, they likely present two very different pictures of aquatic ecosystem health.

As the Cheadle Center's Aquatic Invertebrates Lab introduces dip net sampling, it's essential to recognize the unique advantages each method offers in assessing aquatic macroinvertebrate and zooplankton populations. Utilizing both techniques allows for a more comprehensive understanding of the ecosystem, ensuring that species occupying various niches are accounted for in studies.

Methods

In this study, samples of aquatic macroinvertebrates and zooplankton were collected from three sites around the Devereux Slough. The site at East Creek Bridge (NEC), is located within the main body of the slough, and therefore subject to varying conditions depending on whether the mouth of the slough is open or closed. The site located in the freshwater Phelps Creek (NPB1) flows down into the site at Phelps Bridge (NPB), a portion of a stream that remains connected to the main body of the slough year round. A map of the study sites is provided in Figure 1.

Sampling was conducted by small groups of students, composed of one Cheadle Center aquatic invertebrate lab undergraduate student leader and two to three lab interns. Two distinct sampling methods were utilized: a filter beaker with a 250 micron mesh and dip nets with either a 250 micron mesh or 500 micron mesh. In 2023, same-day dipnet and surface samples were collected across the three sites. The filter beaker method, also referred to as surface sampling, involves taking 70 1-litre scoops of water and running them through the mesh, with small sampler movements around the site to avoid re-sampling areas where disturbance may have led to organism evacuation. The dipnet method involves sweeping the net three feet across the benthic layer, capturing a calculated 61.26 litres of water. Organisms and organic material captured in the mesh were then stored in 70% isopropyl alcohol, and were sorted through under a microscope by lab interns who identified organisms to either Class, Order, or Family, according to standards of confidence in accurate identification. Identifications were verified by a Student Leader, and data was converted to organisms per litre to account for differences in sampling volume.

The organisms per litre results were compared between methods for each of the three sites. Additionally, the organisms per litre results of several recent NPB dipnet samples were compared to those of past NPB surface samples to further compare the differing insights into the diversity and distribution of organisms within the Devereux Slough ecosystem offered by each method. To determine species diversity the Shannon-Wiener diversity index was utilized, chosen for its ability to provide a comprehensive measure that considers both species richness and evenness, as it takes into account both the number of species present and their relative abundances.

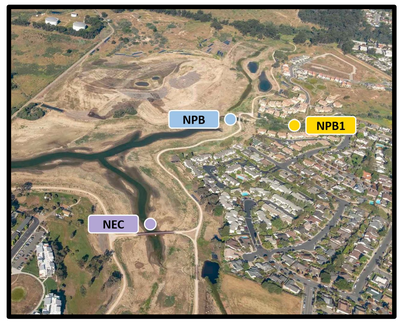

Figure 1. Map of sampling locations. NEC is located beside East Creek Bridge (34°25'15.0"N 119°52'26.6"W), NPB is located beside Phelps Bridge (34°25'16.9"N 119°52'43.9"W), and NPB1 is located north of Phelps Bridge, along Phelps Creek (34°25'21.8"N 119°52'46.5"W).

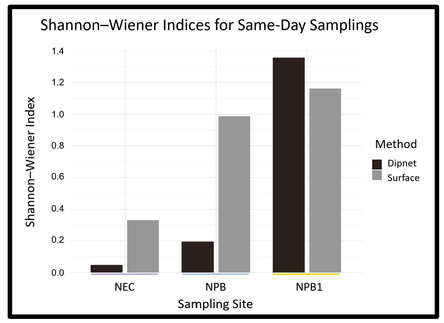

Figure 2. A bar chart displaying the Shannon-Wiener diversity indices of same-day dipnet and surface samplings conducted at three different sites. The higher the index, the higher the species diversity in the site (3). NEC sampling occurred November 11, 2023, NPB sampling occurred June 6, 2023, and NPB1 sampling occurred July 17, 2023.

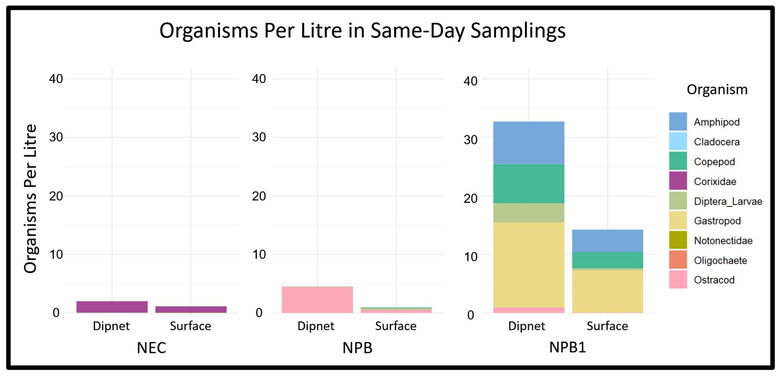

Figure 3. A stacked bar chart depicting the organisms per litre found through same-day dipnet and surface samplings conducted at three different sites. Dipnet benthic sampling resulted in a higher concentration of organisms per litre.

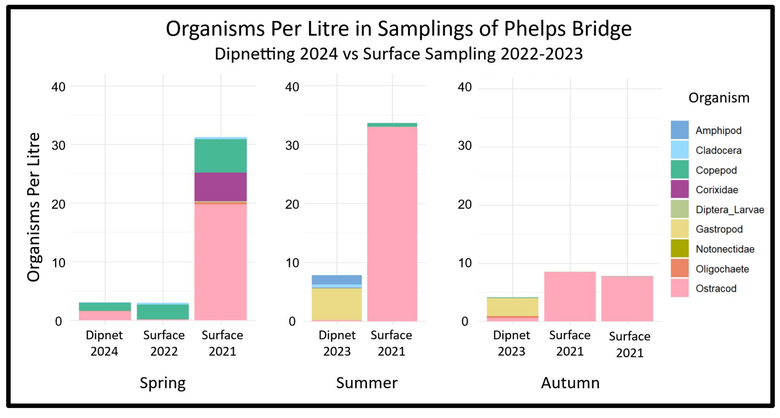

Figure 4. A stacked bar chart depicting the organisms per litre found through dipnet and surface samples, with samplings grouped by season. Spring dipnet sampling occurred in March of 2024, with surface sampling having occurred February 2022 and April 2021. Summer dipnet sampling occurred August of 2023, with surface sampling occurring August 2021. Autumn dipnet sampling occurred October 2023, while both surface samplings were conducted in November of 2021.

Results

Figure 2 depicts higher Shannon-Wiener diversity indices for filter beaker surface samples conducted at NEC and NPB, indicating a greater diversity of surface water species. Shannon- Wiener indices for NPB1 are high for both sampling methods, though slightly higher for the dipnetting sample. Though both NEC samples contain primarily Corixidae, the additional presence of Notonectidae and Copepods in the surface sample results in a higher index comparatively. Similarly, the predominance of Ostracods in the NPB dipnet sample results in a lower diversity index than the one generated by the surface sample's greater variety of species.

Figure 3 depicts the organisms per litre recorded for three instances where surface and dipnet sampling were conducted at the same site on the same day. In all three comparisons, dipnet samples contained a higher concentration of organisms. Species tended to be detected by both methods, though in differing concentrations, with the exception of Notonectidae which was only captured by surface sampling. Both Ostracods and Diptera larvae were detected in higher concentrations with dipnetting.

Figure 4 depicts the organisms per litre found in 2024 dipnet and 2022-2023 surface samplings of Phelps Bridge, which are grouped by season. In contrast to Figure 3, filter beaker surface samples appear to typically contain a higher concentration of organisms. Similar to Figure 3, species tended to be detected by both methods. In the Summer comparison, Corixidae, Gastropods, and Cladocera were detected by dipnet sampling but not surface sampling. However, it is important to note that only one past sample was available for Summer comparisons.

Discussion

This analysis revealed that Phelps Creek (NPB1) exhibited the highest species diversity compared to the other two sites. This finding suggests that NPB1 may harbor a more diverse range of aquatic habitats or environmental conditions that support a greater variety of species. Notable spikes in species abundance occurred at Phelps Bridge (NPB) during Spring and Summer, suggesting the occurrence of significant booms in organism populations during these months. Most organisms were detected using both sampling methods and some, such as Ostracods, varied in which method detected them in the highest concentrations. The sampling method which detected the highest organisms concentrations varied, as well. This variance underscores the importance of employing multiple sampling methods to capture a comprehensive representation of species diversity and abundance.

While our study provides insights into the diversity and abundance of aquatic invertebrate and zooplankton populations, it had several limitations. Firstly, our sampling was conducted over a limited time period and at a specific set of sites, and thus does not fully capture the seasonal and spatial variability of invertebrate communities within the entire North Campus Open Space ecosystem. Additionally, environmental factors such as water temperature and nutrient levels can influence invertebrate distributions and were not accounted for in our analysis. Furthermore, though standard procedures are followed, samplings are conducted by many different interns and thus exact replication is difficult to achieve.

By employing a combination of sampling methods and analyzing data across different sites and time points, we can gain valuable insights into the dynamics of aquatic ecosystems. Understanding the abundances of aquatic invertebrates is particularly important, as these organisms serve as a primary food source for many bird species within the North Campus Open Space ecosystem. Therefore, insights gained from studying aquatic invertebrate and zooplankton populations are crucial to understanding ecosystem health and supporting efforts to maintain and enhance habitats for both invertebrates and bird populations.

References

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