Drone habitat variables, Port Fourchon 2023

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Project
» CAREER: Integrating Seascapes and Energy Flow: learning and teaching about energy, biodiversity, and ecosystem function on the frontlines of climate change (Louisiana E-scapes)

Contributors	Affiliation	Role
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Abstract
This dataset consists of drone-derived habitat data tables used to quantify fine-scale landscape metrics in an estuarine environment undergoing rapid climate-driven habitat change. The data were generated as part of a study evaluating the effects of mangrove encroachment and marsh loss on species-landscape relationships in coastal Louisiana. Habitat variables were derived for buffer zones ranging from 20 to 150 meters around 52 field sampling sites and edge zones 1, 3, and 5 meters from the water's edge, providing detailed metrics such as percent land cover, edge area, and proportional mangrove cover. The fine spatial resolution of the drone imagery allowed for precise identification of small-scale habitat features that are often missed in satellite-based analyses. The data were collected during the Spring 2023 sampling season in the region surrounding Port Fourchon, LA, an area experiencing significant landscape changes due to sea-level rise, subsidence, and the expansion of mangroves. This dataset enables testing of species-specific responses to habitat features at ecologically relevant fine scales, particularly for nekton species interacting with marsh edges and immediate surrounding areas. The primary purpose of this dataset is to inform ecological research focused on habitat suitability, landscape ecology, and the impacts of fine-scale habitat changes on estuarine species distributions. Researchers and resource managers can use these data to improve habitat suitability models, identify critical habitat features, and guide conservation strategies. The data were collected and interpreted by Herbert Leavitt, Dr. James Nelson, and Alex Thomas, with institutional affiliation at the time of collection being the University of Louisiana at Lafayette.

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Coverage

Location: Marshes surrounding Port Fourchon, Louisiana.
Spatial Extent: **N**:29.164671 **E**:-90.149744 **S**:29.092646 **W**:-90.269831
Temporal Extent: 2022-09-23 - 2022-09-29

Methods & Sampling

No raw data is included in this dataset. For information pertaining to the collection methods for the data used to generate this dataset, refer to methods sections of linked datasets

Data Processing Description

The data processing workflow combines a Bash script (*permutations_smallscale.sh*) and a Python script (*smallscale_permutations_241029.py*) to calculate habitat metrics and spatial relationships for sites sampled in Port Fourchon, LA. The workflow begins with the Bash script, which submits a job to UGA's Slurm-based high-performance computing cluster, Sapelo2, requesting 50 CPUs, 280 GB of memory, and a 5-hour time limit. The script sets up the required Python environment and executes the main Python script to process habitat shapefiles and site data.

The Python script prepares the input datasets, which include habitat shapefiles containing classifications like "Water," "Mangrove," and "Spartina," site data (*drop_field.csv*) with georeferenced sample points, and wind data (*CO-OPS_8761724_met.csv*) for calculating fetch distance (wind exposure). The spatial data is projected into the *EPSG:32615* coordinate system for accurate spatial analysis. Wind vectors (u, v components) are calculated from wind speed and direction, and the prevailing wind direction is determined for use in fetch calculations.

For each combination of *buffer distances* (20–150 m) and *edge distances* (1, 3, 5 m), the script calculates habitat metrics around the sampled sites. Circular buffers are created around each site, and habitat polygons are clipped to these buffers to calculate land-to-water ratios and percent edge area within edge distances. Mangrove and marsh edge proportions are calculated as *edge_l.mangrove* and *edge_l.marsh*, respectively. Sites are classified into categories ("mangrove," "marsh," or "mixed") based on threshold values for edge proportions. Fetch distances, representing the exposure of each site to wind, are also calculated using the prevailing wind direction.

To improve efficiency, the workflow leverages *parallel processing* with a *ProcessPoolExecutor* to simultaneously process multiple shapefiles across all buffer and edge distance combinations. Habitat metrics for each site and scale are saved as individual CSV files in the output directory, named in the format *shapefile_name_edge[distance]_buf[distance].csv*. Once processing is complete, the script merges results across shapefiles for each buffer and edge distance into combined CSV files.

This workflow plays a critical role in calculating *fine-scale habitat metrics* needed to evaluate relationships between species abundance and habitat structure. By processing spatial data across multiple scales, it allows for scale-dependent analyses that identify the optimal spatial extents for modeling species-habitat relationships. Key metrics, such as edge proportions, land-to-water ratios, and fetch distances, serve as predictors in species distribution models, supporting the broader project goals of understanding habitat suitability in rapidly changing estuarine environments. The code environment for this analysis will be added to files in this dataset.

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Parameters

Parameters for this dataset have not yet been identified

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Project Information

CAREER: Integrating Seascapes and Energy Flow: learning and teaching about energy, biodiversity, and ecosystem function on the frontlines of climate change (Louisiana E-scapes)

Website: http://www.nelsonecolab.net/career

Coverage: Saltmarsh ecosystem near Port Fourchon, LA

NSF Award Abstract:
Coastal marshes provide a suite of vital functions that support natural and human communities. Humans

frequently take for granted and exploit these ecosystem services without fully understanding the ecological feedbacks, linkages, and interdependencies of these processes to the wider ecosystem. As demands on coastal ecosystem services have risen, marshes have experienced substantial loss due to direct and indirect impacts from human activity. The rapidly changing coastal ecosystems of Louisiana provide a natural experiment for understanding how coastal change alters ecosystem function. This project is developing new metrics and tools to assess food web variability and test hypotheses on biodiversity and ecosystem function in coastal Louisiana. The research is determining how changing habitat configuration alters the distribution of energy across the seascape in a multitrophic system. This work is engaging students from the University of Louisiana Lafayette and Dillard University in placed-based learning by immersing them in the research and local restoration efforts to address land loss and preserve critical ecosystem services. Students are developing a deeper understanding of the complex issues facing coastal regions through formal course work, directed field work, and outreach. Students are interacting with stakeholders and managers who are currently battling coastal change. Their directed research projects are documenting changes in coastal habitat and coupling this knowledge with the consequences to ecosystems and the people who depend on them. By participating in the project students are emerging with knowledge and training that is making them into informed citizens and capable stewards of the future of our coastal ecosystems, while also preparing them for careers in STEM. The project is supporting two graduate students and a post-doc.

The transformation and movement of energy through a food web are key links between biodiversity and ecosystem function. A major hurdle to testing biodiversity ecosystem function theory is a limited ability to assess food web variability in space and time. This research is quantifying changing seascape structure, species diversity, and food web structure to better understand the relationship between biodiversity and energy flow through ecosystems. The project uses cutting edge tools and metrics to test hypotheses on how the distribution, abundance, and diversity of key species are altered by ecosystem change and how this affects function. The hypotheses driving the research are: 1) habitat is a more important indirect driver of trophic structure than a direct change to primary trophic pathways; and 2) horizontal and vertical diversity increases with habitat resource index. Stable isotope analysis is characterizing energy flow through the food web. Changes in horizontal and vertical diversity in a multitrophic system are being quantified using aerial surveys and field sampling. To assess the spatial and temporal change in food web resources, the project is combining results from stable isotope analysis and drone-based remote sensing technology to generate consumer specific energetic seascape maps (E-scapes) and trophic niche metrics. In combination these new metrics are providing insight into species’ responses to changing food web function across the seascape and through time.

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