Satellite habitat variables, Port Fourchon, 2022

Website: https://www.bco-dmo.org/dataset/947975
Data Type: Other Field Results
Version: 1
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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 satellite-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 150 to 600 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 greater spatial coverage of the satellite imagery allowed for larger habitat scales to be encompassed in the analysis. Satellite images used in this analysis were all taken during the year 2022, within a few months of our sampling season, in the region surrounding Port Fourchon, LA. 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 satellite-scale habitat data processing workflow uses a combination of Bash and Python scripts to calculate habitat metrics and spatial relationships across multiple scales. Designed for use on a Slurm-based high-performance computing cluster, the workflow efficiently handles large spatial datasets through parallelized processing. It is divided into two main phases: preprocessing and scale-specific calculations.

The preprocessing phase, managed by the *preprocess_satscale.sh* Bash script and executed through the *satscale_preprocessing_241022.py* Python script, prepares habitat shapefiles and site data for subsequent analyses. Habitat polygons from *google2022.shp* are reprojected to EPSG:32615 and assigned numerical identifiers for efficient processing. Water and mudflat polygons are consolidated into a single "Water" multipolygon for streamlined analyses. The processed habitat polygons are saved as GeoPackage files (*habitat_poly.gpkg*, *water_poly.gpkg*), while site data from *drop_field.csv* is georeferenced, reprojected, and saved as *pffw_sites.gpkg*. Wind data from *CO-OPS_8761724_met.csv* is used to calculate fetch distances for each site based on the prevailing wind direction, determined from average wind vectors. These fetch distances are then integrated into the site dataset.

The scale-specific calculations phase, managed by the *permutations_satscale.sh* Bash script and the *satscale_permutations_241022.py* Python script, calculates habitat metrics for various combinations of buffer distances (100–1000 meters) and edge distances (1, 3, 5 meters). Buffers are generated around each site, and habitat polygons are clipped to these buffers to calculate land-to-water ratios, edge proportions (e.g., mangrove and marsh edge lengths), and classifications of sites into "mangrove," "marsh," or "mixed" categories based on habitat thresholds. Fetch distance is also included as a metric for wind and wave exposure. The outputs for each buffer and edge combination are saved as CSV files in the *output/satscale* directory, with filenames structured as *google2022_edge[distance]_buf[distance].csv*.

To improve efficiency, the workflow employs a Slurm job array, enabling parallel processing of multiple scale permutations. The Python scripts utilize *geopandas* for spatial processing and implement memory management to handle large datasets effectively. This workflow plays a critical role in calculating fine-scale habitat metrics required for analyzing species-habitat relationships in estuarine environments. The calculated metrics, including edge proportions, land-to-water ratios, and fetch distances, serve as key predictors for ecological models, supporting analyses of habitat suitability and the impacts of habitat changes such as mangrove encroachment. By optimizing calculations across scales, the workflow ensures accurate and efficient processing, making it integral to the project’s success.

Problem Description

Computation time and memory was a barrier in this analysis. For this reason, although we originally intended to perform calculations out to 1000m we limited our analysis to 600m. We do not believe this altered our final results in any way.

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Related Publications

Broussard, W., Suir, G., & Visser, J. (2018). Unmanned Aircraft Systems (UAS) and satellite imagery collections in a coastal intermediate marsh to determine the land-water interface, vegetation types, and Normalized Difference Vegetation Index (NDVI) values. Engineer Research and Development Center (U.S.). https://doi.org/10.21079/11681/29517
Methods

Zhao, J., Fang, Y., Zhang, M., & Dong, Y. (2020). Identification of Remote Sensing-Based Land Cover Types Combining Nearest-Neighbor Classification and SEaTH Algorithm. Journal of the Indian Society of Remote Sensing, 48(7), 1007–1020. https://doi.org/10.1007/s12524-020-01131-6
Methods

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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.

This project is jointly funded by Biological Oceanography and the Established Program to Stimulate Competitive Research (EPSCoR).

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2418012

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