Data from an analysis of habit change in Port Fourchon, LA from 2002, 2014, and 2022

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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
Nelson, James	University of Georgia (UGA)	Principal Investigator
Leavitt, Herbert	University of Georgia (UGA)	Student
Thomas, Alexander	University of Georgia (UGA)	Student
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This data set contains the analysis of habit change in Port Fourchon, LA from 2002, 2014, and 2022. The analysis uses LandSat9 data to determine the change in black mangrove cover across the three time points.

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Methods & Sampling

Location description: All data for this analysis were collected near Port Fourchon, Louisiana, USA (29.10 °N, 90.19 °W). The marshes around the port are microtidal, with a mean tidal range of ~0.37 m. The site sits at the precise edge of black mangrove expansion into saltmarsh habitats and although some land loss in the areas has occurred, mangroves in the area have been expanding since the 1990s (Osland et al., 2013).

Satellite Imagery

Satellite imagery data products used for analysis in this paper were obtained solely from the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS). Multispectral satellite imagery was chosen based on the best available data for the given year of observation. Image analysis for the year 2022 used Landsat-9 satellite imagery, analysis for 2014 utilized Landsat-8 satellite imagery, and analysis for 2002 utilized Landsat-7 satellite imagery. Imagery from each satellite displays a spatial resolution of 30 m for each spectral band. All image layers were clipped from their original sizes to encompass the greater Port Fourchon, LA marsh, spanning an area of 49,427 hectares.

Of the eight spectral layers acquired from the U.S Geological Survey, six were isolated and used for segmentation and analysis. The six spectral layers imported into eCognition for this project corresponded to the mean pixel values for Red, Green, Blue, Near Infrared (NIR), and two bands of Short-Wave Infrared (SWIR). A Normalized Difference Vegetation Index (NDVI) was calculated using the color bands Red and NIR. Habitat classification was completed using eCognition Developer (Version 10.4, Trimble Germany GmbH, Munich, Germany) through a combination of manual rule set class assignments and a Nearest Neighbor classification algorithm (NN). The NN classification algorithm categorizes image objects based on their respective spectral values. These values of interest are manually input into a training set along with other parameters of interest defined by the user. The features influencing the NN algorithm for this project include mean spectral values for: Red, Green, Blue, NIR, and NDVI.

Habitat delineation began with separating the class “water” from the mosaic. A multiresolution segmentation algorithm using a scale parameter of 30, a shape parameter of 0.3, and a compactness parameter of 0.75 (using the bands Red, Green, and Blue) followed by a spectral difference algorithm with a parameter of 50 (using all layers) segmented and merged the majority of water habitat into a super polygon. The remaining areas of water were delineated through a combination of algorithmic rule set assignments and NN classification, ensuring all water bodies were accurately classified. The second class to be classified included all man-made structures within Port Fourchon. Man-made structures included all areas of human development including port structures, roads, debris found within the marsh, as well as regions of sand accumulation from restoration efforts. Man-made structure also included the beach area lining the entirety of the southern end of the port as this region has seen extensive human restoration throughout the years (CPRA Master Plan 4th edition 2023). Isolation of man-made structures included the use of a multiresolution algorithm with a scale parameter of 5, a shape parameter of 0.3 and a compactness parameter of 0.75 (using the bands: Red, Green, Blue, NIR, and NDVI). Rule set class assignments utilizing the red band were especially useful in isolating these areas of human development and needed little manual correction. The vegetated areas of Spartina alterniflora and Avicennia germinans were subsequently classified using the same combination of algorithmic rule set assignments and NN classification. NDVI was used as a major parameter for vegetated habitat classification as it is particularly useful for distinguishing between Spartina alterniflora marshland and Avicennia germinans habitat (Chandra et. al 2010) due to the mangroves increased mean NDVI value. All classes were subsequently merged into their respective polygons and exported as shapefiles for area analysis in R statistical software.

Data Processing Description

Using a list of all species collected in the drop sampler from the three sampling events we queried the Global Biodiversity Information Facility (GBIF) for all occurrences in the western hemisphere of the species in the data set from 2002-2022. We used python code to download the human observation and preserved specimen occurrences in the GBIF database for each species. We then generated estimated ranges using the GBIFrange package in R to generate the latitudinal range and midpoint for each species. We also ran PERMANOVA statistical tests in R to determine if species distributions differed by year.

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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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