Black mangrove habitat change analysis in Port Fourchon, LA from 2002, 2014, and 2022.

Website: https://www.bco-dmo.org/dataset/941477
Data Type: model results
Version: 1
Version Date: 2025-02-19

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 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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Coverage

Location: Port Fourchon, Louisiana, USA (29.10 °N, 90.19 °W)
Spatial Extent: **N**:29.164 **E**:-90.16 **S**:29.095 **W**:-90.244
Temporal Extent: 2002 - 2022

Methods & Sampling

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 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.

The spectral bands utilized for the year 2022 habitat classification are as follows:

    i.   Band 2 – Visible Blue (0.450 - 0.51 μm)

    ii.   Band 3 – Visible Green (0.53 - 0.59 μm)

    iii.   Band 4 – Visible Red (0.64 - 0.67 μm)

    iv.   Band 5 – Near-Infrared (0.85 - 0.88 μm)

    v.   Band 6 – Short-Wave Infrared 1 (1.57 - 1.65 μm)

    vi.   Band 7 – Short-Wave Infrared 2 (2.11 - 2.29 μm)

The spectral bands utilized for the year 2014 habitat classification are as follows:

    i.   Band 2 – Visible Blue (0.450 - 0.51 μm)

    ii.   Band 3 – Visible Green (0.53 - 0.59 μm)

    iii.   Band 4 – Visible Red (0.64 - 0.67 μm)

    iv.   Band 5 – Near-Infrared (0.85 - 0.88 μm)

    v.   Band 6 – Short-Wave Infrared 1 (1.57 - 1.65 μm)

    vi.   Band 7 – Short-Wave Infrared 2 (2.11 - 2.29 μm)

The spectral bands utilized for the year 2002 habitat classification are as follows:

    i.   Band 1 – Blue (0.45 - 0.52 μm)

    ii.   Band 2 – Green (0.52 - 0.60 μm)

    iii.   Band 3 – Red (0.63 - 0.69 μm)

    iv.   Band 4 – Near-Infrared (0.77 - 0.90 μm)

    v.   Band 5 – Short-Wave Infrared (1.55 - 1.75 μm)

* For 2002, the Landsat 7 sensor contained only one band for Short-Wave Infrared. For this year, the single band of SWIR was used in habitat classification instead of the two used in the classifications for 2014 and 2022.

Data Processing Description

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.

Software and Versions:

- eCognition Developer (Version 10.4, Trimble Germany GmbH, Munich, Germany)

- R version 4.3.3 (2024-02-29 ucrt)

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units_0.8-5

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Data Files

File
941477_v1_fourchon_twenty_years.csv(Comma Separated Values (.csv), 712 bytes) MD5:664db3e25bf14a64d772292d77732bd0
Primary data file for dataset ID 941477, version 1. Analysis output from Port Fourchon, LA

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Supplemental Files

File
Classified_Landsat_Shapefiles.zip (ZIP Archive (ZIP), 1.85 MB) MD5:463176be9e6c02532395e6121a91ca25
Classified .tif Files for Port Fourchon, LA habitat analysis
Fourchon_Code.zip (ZIP Archive (ZIP), 3.35 KB) MD5:abe27ce9e638f5e78824e0a546500b74
R code and instructions for Landscape Analysis for Mangrove habitat change in Port Fourchon, LA
Raw_Mosaic_Files.zip (ZIP Archive (ZIP), 11.79 MB) MD5:f7ece24f65d30a94793985b331610be6
Bands from raw data that were used to classify habitat for years 2002, 2014 and 2022

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Related Publications

Leavitt, H., Thomas, A., Doerr, J., Johnson, D., & Nelson, J. (2024). Generalists and competition may be important in limiting range expansion, evidence from the frontlines of climate change. https://doi.org/10.22541/au.173090741.17018561/v1
Results

Osland, M. J., Enwright, N., Day, R. H., & Doyle, T. W. (2013). Winter climate change and coastal wetland foundation species: salt marshes vs. mangrove forests in the southeastern United States. Global Change Biology, 19(5), 1482–1494. Portico. https://doi.org/10.1111/gcb.12126
Methods

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Related Datasets

IsRelatedTo

Nelson, J. (2024) **Data and code from an analysis of twenty years of winter minimum temperature data near Port Fourchon, LA from 2002 to 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-10-28 http://lod.bco-dmo.org/id/dataset/941490 [view at BCO-DMO]
Relationship Description: Data collected as part of the same study published in Leavitt et al. (2024).

Nelson, J., Leavitt, H., Thomas, A. (2024) **Port Fourchon, LA species range data from presence and absence data from 2002, 2014, and 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-10-24 http://lod.bco-dmo.org/id/dataset/941250 [view at BCO-DMO]
Relationship Description: Data collected as part of the same study published in Leavitt et al. (2024).

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Parameters

Parameter	Description	Units
Year	Year of satellite image taken	unitless
Class_number	Class number	unitless
Class_name	Class name: Man Made Structure, Mangrove, Spartina Marsh & Water	unitless
area_hectares	Area of the class	hectare
Percent_Cover	Coverage percentage of the class	percentage (%)
Percent_of_total_land	Percentage of total land	percentage (%)
Total_Land_ha	Total land	hectare

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.

Funding

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