Drone imagery classification, Port Fourchon, 2023

Website: https://www.bco-dmo.org/dataset/947918
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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 contains habitat classifications based on drone based imagery collected at the location of sites sampled during the Fall 2022 drop sampling season. The imagery includes geospatial coverage of estuarine and adjacent terrestrial habitats, providing detailed landscape features such as vegetation type, water bodies, and land use around each sampling site. The spatial resolution of the satellite imagery allows for precise analysis of habitat variables at multiple scales. The resolution of this data is less than 1 meter. The satellite imagery used to classify the habitats in this dataset was taken during the spring following our sampling season, but is still within six months of our sampling period. The imagery was analyzed to extract environmental variables, such as land-water ratios, vegetation coverage, and proximity to habitat edges. These variables are crucial for defining habitat characteristics and exploring their relationship to species abundance. The primary purpose of this dataset is to investigate how habitat scale influences models linking species abundance to landscape metrics. This information is particularly useful for researchers studying estuarine ecosystems, landscape ecology, and habitat management. Data collection and interpretation were conducted by Herbert Leavitt, Dr. James Nelson, and Alex Thomas, with affiliations at the time of sampling being with 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

Dataset Description

Column Name,Column Description [Include meaning of any codes or flags used in data column as well as detection limits.],Units of measurement,missing data/no data value

- FID ,Numerical identifier for each polygon,unitless ,
- Shape ,Classification of feature type (all polygons in this case) ,unitless ,
- Area_Pxl ,number of pixels in the polygon ,count,
- Class_name,"Catagories of habitat types: Listed as Mangroves (mangrove vegetation), Spartina (spartina

vegetation, equivolent to saltmarsh in the satelite data, Water (open water), Spillbank (Equivolent to man-made) in the satellite data) ",,

- Max_diff,"A Normalized Difference Vegetation Index created using the Red and NIR color bands. This was used as a parameter for species identification as it helps quantify plant health and habitat composition (Broussard et al., 2018).",,
- Mean_Blue,Mean reflectance in blue color band (444 nm) for the polygon ,,
- Mean_DSM ,Mean digital surface model value for the polygon. Note: these values are not corrected and only represent relative elevation. DSM values broadly represent vegetation heigh but should not be interpreted beyond distinguishing vegetation classes,,
- Mean_Green,Mean reflectance in green color band (560 nm) for the polygon ,,
- Mean_NDVI,Mean NDVI value for the polygon,,
- Mean_NIR,Mean reflectance in near-infrared color band (842 nm) for the polygon ,,
- Mean_Red,Mean reflectance in red color band (668 nm) for the polygon ,,
- Mean_Red_E,Mean reflectance in Rededge color band (717 nm) for the polygon ,,

Methods & Sampling

Images were taken using a carrying a RedEdge-MX Dual Camera Imaging System. Images were stitched into maps using OpenODM (OpenDroneMap Authors, 2024) and segmented in eCognition (Trimble Geospatial, 2024). Drone flight polygons were constructed to maximize the area covered while maintaining a flight duration under the maximum limit of 90 minutes.

Data Processing Description

Georeferenced orthomosaics were created using Pix4D mapper software (Version 4.4.12) and OpenODM image stitching software run on UGA's high-performance computing cluster. The georeferenced photos were uploaded to the Pix4D interface where they underwent an image calibration correction for the reflectance and camera downwelling light sensor (DLS) values. This calibration corrects the image color values using the reflectance data gained from the onground panels, as well as the values calculated from the camera system during flight to create an orthomosaic that is accurately representative of the conditions seen in the field. The geotagged images were then stitched together using the GPS coordinates assigned in the previous step, outputting georeferenced orthomosaics for all ten color bands. The orthomosaic layers were created using the WGS84 UTM zone 15N coordinate system. Orthomosaic layers were then exported to Trimble- eCognition Developer (version 10.4) for image analysis and vegetation classification. Of the ten wavelength orthomosaics created, five were imported into eCognition developer for analysis. The five color layers chosen for this project represent the mean color values for each wavelength of light in which the camera captures images. Five mosaic layers with mean values for Red, Green, Blue, Near InfraRed (NIR), and Red Edge were imported into eCognition developer for habitat classification. A Normalized Difference Vegetation Index was created using the Red and NIR color bands. This was used as a parameter for species identification as it helps quantify plant health and habitat composition (Broussard et al., 2018). Green, Blue, and Red Edge color bands are useful in correcting habitat misclassifications derived from NDVI values. Rule set development was broken into four distinct operations: Initial Segmentation, Initial Classification, Habitat Refinement, and Final Refinement. Initial segmentation entailed using a multiresolution threshold segmentation algorithm that separates the mosaic into image objects based on the imported image layer values. The algorithm is defined by its scale, shape, compactness, and layer weight parameters, which dictate how the algorithm cuts and classifies the image. For the initial orthomosaic segmentation, I used a shape value of 0.3, a compactness value of 0.8, and a scale parameter of 5. Layer weights for red, green, blue, and NDVI were set at 1, meaning the algorithm weighed the influence of these values the same for all four color bands. The weight for Near Infrared (NIR) was set to 2, indicating twice the influence the NIR values carry for image segmentation. These parameters were chosen for this segmentation process after a careful trial and error evaluation, which determined that the effectiveness of the segmentation was sufficient.

I performed initial classifications using a combination of manual rule set class assignments and a Nearest Neighbor Classification algorithm (NN) that categorizes image objects based on input samples and user-defined criteria (Zhao et al., 2020). The Nearest Neighbor algorithm was set to observe image objects based on mean values for Red, Green, Blue, Brightness, Max Difference, and NDVI. The algorithm uses the values for each parameter and attempts to assign a class label to unclassified image objects with similar parameter values. For preliminary classification, water and vegetation classes were created, and samples of each classification were selected for use in the NN algorithm. This algorithm was then run across the entire mosaic, delineating vegetation polygons from water polygons. Water and vegetation image objects were merged into their respective classes, creating super objects for further refinement of classification. Manual rule set corrections were implemented for image objects incorrectly identified by the NN algorithm and merged into the correct super polygons. I classified the vegetation polygon into specific species using a combination of automated NN classification algorithms and manual rule set classifications. Three distinct vegetation classes were created for further image refinement (Mangroves, Spartina, and Spill Bank). The Port Fourchon marsh is comprised primarily of two distinct monoculture species: Spartina alterniflora and Avicennia germinans. The class "Spill Bank" refers to the various berms lining navigation channels created throughout the marsh from the dumping of dredged sediment from the main shipping channel and vegetation such as oak trees that grow atop these berms. In eCognition developer the difference between vegetation classes is clearly seen as the images captured by the Micasense RedEdge dual camera system have a resolution of 8.37 cm/ pixel. Refinement entailed converting incorrectly classified class polygons into refinement polygons to apply localized corrections. Refinement polygons were then segmented individually a second time using a multiresolution threshold segmentation algorithm with a scale value of 5, a shape value of 0.3, and a compactness value of 0.75. Image layer weights for this segmentation algorithm were set to 1 for color bands Red, Green, Blue, NIR, and Red Edge, while the NDVI weight value was set to 2. This second segmentation aimed to more accurately separate the species present within the refinement super polygons and run an additional NN classification to identify the individual species. Samples for all classes were manually selected for this second NN classification, and the algorithm was performed for each of the smaller refinement polygons. Final refinement entailed manually correcting the classification errors from the second NN algorithm using both rule set development and manual editing tools in eCognition developer. Once a class had been verified through careful user observations, all polygons for said class were merged into super polygons. This process was done until the entire image mosaic was fully classified. Final class polygons were then exported as shapefiles for data analysis.

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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.

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Funding

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

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