Port Fourchon, LA species range data from presence and absence data from 2002, 2014, and 2022

Website: https://www.bco-dmo.org/dataset/941250
Version: 1
Version Date: 2024-10-24

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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Coverage

Location: near Port Fourchon, Louisiana, USA
Spatial Extent: **N**:29.168 **E**:-90.16 **S**:29.095 **W**:-90.244
Temporal Extent: 2002-01-01 - 2022-12-31

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).

Species Collections

All species in this study were collected using a drop sampler method specifically designed for flooded marsh habitats, providing a standardized approach across sampling years. The design of the drop samplers used in 2005, 2015, and 2022 varied slightly in terms of construction materials and deployment mechanisms to adapt to equipment improvements over time, but the essential structure remained the same. Each sampler employed a 1-m² cylinder, suspended from a boom arm, to minimize disturbance prior to deployment. The cylinder was rapidly lowered to enclose a section of flooded marsh habitat, ensuring precise capture of benthic and water-column organisms (Nelson et al., 2019; Zimmerman et al., 1984).

Once the sampler was in position, a submersible pump was used to evacuate the water inside the cylinder to concentrate captured organisms. Special care was taken to prevent loss of organisms during pumping by filtering the outflow through a fine mesh screen. After the water was removed, captured animals were collected manually or with fine nets, transferred to containers with preservatives appropriate for long-term identification and analysis, such as ethanol or formalin. Each sample was meticulously labeled with the date, location, and environmental parameters at the time of collection to facilitate later analysis. Salinity, water temperature, and depth were also recorded at each sampling event to characterize habitat conditions during collection.

All samples were transported to the laboratory for taxonomic identification. Species were identified to the lowest taxonomic level possible, typically genus or species, with multiple experts cross-validating questionable identifications to ensure data quality.

Data Processing Description

Species Range Estimation

To estimate species ranges, we employed the gbif.range R package (Chauvier et al., 2022) for its ability to integrate multiple data sources, including GBIF occurrences and ecoregion boundaries curated by The Nature Conservancy (2012). We accessed the Global Biodiversity Facility (GBIF) database focusing on species occurrences based on both human observations and preserved specimens spanning 2005 to 2022 (GBIF 2024). The downloaded data were subjected to rigorous cleaning, removing any records outside of the western hemisphere or observations that did not align with Atlantic coastal regions. This step ensured that our analyses focused on species relevant to the ecosystem under study.

The gbif.range package offers automated range delineation by grouping observations into ecoregions. We applied these tools to each species observed at Port Fourchon to estimate both their historical and current ranges. Spatial range estimates were refined using polygon overlays, restricting them to the latitudinal gradients from the North to South Poles along the Atlantic coast. We also evaluated the completeness of occurrence data by assessing whether species records covered their known ecological niches.

For species with sparse or conflicting records, range estimates were adjusted manually based on prior literature and known habitat preferences. Final outputs included range maps for each species, with ecoregion-based polygons providing clear visualizations of distribution shifts over time. The complete list of species, with associated GBIF records and curated metadata, is included in the supplementary materials.

Statistical Analysis of Species Ranges

To test for shifts in species distributions, we hypothesized that northward range expansion would result in a southward shift in the latitudinal ranges of species observed at Port Fourchon over time. We utilized PERMANOVA (Permutational Multivariate Analysis of Variance), a robust statistical approach that accounts for non-parametric data distributions and complex multivariate relationships. The PERMANOVA was run on latitude metrics (mean, minimum, and maximum latitudes) for all species observed during each sampling year (2005, 2015, 2022).

In addition to comparing latitudinal range metrics across years, we assessed the dispersion of species assemblages using beta-dispersion tests. These tests evaluated whether differences in latitudinal spread varied significantly across years, ensuring our PERMANOVA met assumptions of homogeneity of dispersion. If significant differences in dispersion were detected, we adjusted interpretations accordingly to avoid Type I errors in our statistical comparisons. Specifically, beta-dispersion in 2014 was higher than in 2005 ($p = 0.048$), which we accounted for when analyzing year-to-year differences.

Each PERMANOVA model was validated through permutation-based significance testing with 999 iterations to ensure robustness against potential biases due to sampling variability. We report effect sizes and R^2 values to assess the magnitude of latitudinal shifts across time points. As a further check, we conducted post hoc pairwise comparisons to explore year-specific trends in range shifts, ensuring no significant temporal bias in our dataset. All analyses were performed using R statistical software (version 4.2.2).

The data were processed and analyzed using R and python code. The README for Climate-Driven Range Expansion Analysis Code ("README_Species_Range_figure.R" in "Supplemental Files") provides details for code and input files included in this dataset.

This project analyzes the range expansion of black mangroves into areas traditionally dominated by smooth cordgrass using quantitative nekton sampling and satellite imagery analysis. The analysis includes species range estimation, satellite imagery processing, and statistical testing on species distributions over two decades.

BCO-DMO Processing Description

* Data table from submitted file "species_latitudes.csv" was imported into the BCO-DMO data system for this dataset.
** In the BCO-DMO data system missing data identifiers are displayed according to the format of data you access. For example, in csv files it will be blank (null) values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as blank (null) values.

* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]

* Life Science Identifier (LSID) added to the table using the World Register of Marine Species (WoRMS) taxa match tool. All names matched exactly (or exact_subgenus) to WoRMS names on 2024-10-24 except Species provided as "Pattern not found" since it wasn't a species name. Note that some names are not the currently accepted synonym for the organism. Accepted names change over time and the LSID can be used to consult WoRMS for up to date information about the status of names used in this dataset.

* Primary data table attached to the dataset as Data file "941250_v1_species-latitudes.csv"

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Related Publications

Chauvier, Y., Hagen, O., Albouy, C., Descombes, P., Fopp, F., Nobis, M. P., Brun, P., Lyu, L., Csilléry, K., & Pellissier, L. (2022). gbif.range - An R package to generate species range maps based on ecoregions and a user-friendly GBIF wrapper (Version 0.2) [Computer software]. EnviDat. https://doi.org/10.16904/ENVIDAT.352 https://doi.org/10.16904/envidat.352
Software

Ellingsen, K. E., Yoccoz, N. G., Tveraa, T., Frank, K. T., Johannesen, E., Anderson, M. J., Dolgov, A. V., & Shackell, N. L. (2020). The rise of a marine generalist predator and the fall of beta diversity. Global Change Biology, 26(5), 2897–2907. Portico. https://doi.org/10.1111/gcb.15027
Methods

Freeman, B. G., Strimas-Mackey, M., & Miller, E. T. (2022). Interspecific competition limits bird species’ ranges in tropical mountains. Science, 377(6604), 416–420. https://doi.org/10.1126/science.abl7242
Methods

Nelson, J. A., Lesser, J., James, W. R., Behringer, D. P., Furka, V., & Doerr, J. C. (2019). Food web response to foundation species change in a coastal ecosystem. Food Webs, 21, e00125. https://doi.org/10.1016/j.fooweb.2019.e00125
Methods

Poloczanska, E. S., Burrows, M. T., Brown, C. J., García Molinos, J., Halpern, B. S., Hoegh-Guldberg, O., Kappel, C. V., Moore, P. J., Richardson, A. J., Schoeman, D. S., & Sydeman, W. J. (2016). Responses of Marine Organisms to Climate Change across Oceans. Frontiers in Marine Science, 3. https://doi.org/10.3389/fmars.2016.00062
Methods

Spalding, M. D., Agostini, V. N., Rice, J., & Grant, S. M. (2012). Pelagic provinces of the world: A biogeographic classification of the world’s surface pelagic waters. Ocean & Coastal Management, 60, 19–30. https://doi.org/10.1016/j.ocecoaman.2011.12.016
Methods

Spalding, M. D., Fox, H. E., Allen, G. R., Davidson, N., Ferdaña, Z. A., Finlayson, M., Halpern, B. S., Jorge, M. A., Lombana, A., Lourie, S. A., Martin, K. D., McManus, E., Molnar, J., Recchia, C. A., & Robertson, J. (2007). Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. BioScience, 57(7), 573–583. doi:10.1641/B570707

Methods

Zimmerman, R.J., Minello, T.J., & Zamora, G. (1984). Selection of vegetated habitat by brown shrimp, Penaeus aztecus, in a Galveston Bay salt marsh. https://spo.nmfs.noaa.gov/sites/default/files/pdf-content/fish-bull/zimmerman.pdf
Methods

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Related Datasets

IsDerivedFrom

GBIF.Org User. (2024). Occurrence Download[Data set]. The Global Biodiversity Information Facility. Accessed 24 October 2024. https://doi.org/10.15468/DL.VHUZ42 https://doi.org/10.15468/dl.vhuz42

IsRelatedTo

The Nature Conservancy (2012). Marine Ecoregions and Pelagic Provinces of the World. GIS layers developed by The Nature Conservancy with multiple partners, combined from Spalding et al. (2007) and Spalding et al. (2012). Cambridge (UK): The Nature Conservancy. DOIs: 10.1641/B570707; 10.1016/j.ocecoaman.2011.12.016. Data URL: http://data.unep-wcmc.org/datasets/38

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Parameters

Parameter	Description	Units
Species	This column contains the species name (e.g. Acetes americanus) or 'Pattern not found.'	unitless
Min_Latitude	minimum latitude point in range	decimal degrees
Max_Latitude	maximum latitude point in range	decimal degrees
Mean_Latitude	mean latitude point in range	decimal degrees
LSID	Life Science Identfier (LSID) for the species name in the column 'Species'.	unitless

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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:

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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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