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

Website: https://www.bco-dmo.org/dataset/941250
Data Type: Synthesis
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)

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Abstract
We used presence and absence data from 2002, 2014, and 2022 for species collected via drop sampling to determine if the distribution of species were changing in Port Fourchon, LA over a 20 year time frame and if the species were more frequently from species with more southern species ranges. This dataset comprises species distribution and range data for marine and estuarine organisms, processed for ecological and conservation research. The data were sourced from the Global Biodiversity Information Facility (GBIF) using DOI-referenced species occurrence records, which were subsequently cleaned, validated, and filtered to ensure geospatial accuracy and relevance. The final outputs include species range maps in GeoTIFF format, generated through an integrative workflow combining Python and R tools and a csv file with the min, maximum, and mean latitude range for each species.

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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-m^2 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.

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). We limited the downloaded material to the first 15000 observations of any species to limit file size. 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 Occurrences

To assess changes in species distributions over time, we hypothesized that the presence or absence of species across sampling years (2005, 2014, 2022) might indicate shifts in their ecological distributions. To test this hypothesis, we employed a chi-squared test for independence, a statistical method suitable for categorical data, to evaluate whether species presence and absence differed significantly across years.

Data Processing Description

Climate-Driven Range Expansion Analysis Code:

The data were processed and analyzed using R and python code (See "Supplemental Files" section for code and supplemental data tables discussed here).

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.

Species Range Mapping Workflow

Overview

This workflow processes species occurrence data to generate range maps in GeoTIFF format (see tiff_outputs.zip). It includes three scripts, each designed to perform specific tasks in the pipeline. At the end of the workflow, nine species are merged based on taxonomic changes.

Workflow Components

GBIF_DOI_Species_Download.py

Purpose: Automates the download of species occurrence data from GBIF using DOI references.
Details: Retrieves occurrence records for specified species. Outputs data in CSV format for further processing.

GBIF_Species_Data_Filtered.py

Purpose: Cleans and filters the downloaded species data.
Details: Removes invalid or missing geospatial data (e.g., NA coordinates, outliers). Prepares the data for range mapping.

R_gbig.ranges.r

Purpose: Generates species range maps using filtered occurrence data.
Details: Creates range maps as GeoTIFFs for individual species. Incorporates bioregional data for spatial validation (see File "tiff_outputs.zip" for access to the GeoTIFFs).

Taxonomic Name Merging

After the GeoTIFF files are created, nine species pairs are merged due to taxonomic reclassifications. These changes reflect current accepted names and improve dataset consistency.
Merged Species List: "Port_Furchon_merged_species_list.csv"

Merging Process:

Occurs after the individual .tiff files are created.

The GeoTIFFs for the previous and current names are combined into a single file under the current accepted name.

Species Occurrence Data Merging

Manually merge the presence/absence data for all species across 2005, 2014, and 2022 into a single dataset.

Ensure data consistency by aligning species names and resolving taxonomic differences where applicable.

How to Run the Workflow

1. Prepare Species List:

Ensure the input species list includes both historical and current taxonomic names for proper processing.
Supply this list to variable species_names in GBIF_DOI_Species_Download.py.

2. Run Python Script GBIF_DOI_Species_Download.py

a. Supply credentials for GBIF access in script GBIF_DOI_Species_Download.py, define the location of the

desired output folder then execute to download raw occurrence data (downloads as zip containing a tabular data file). The citation for the data download is provided by the script. The citation for the GBIF occurrence data used in this dataset is:
GBIF.org (14 November 2024) GBIF Occurrence Download https://doi.org/10.15468/dl.c88hxd

See https://techdocs.gbif.org/en/data-use/download-formats for more information about the GBIF occurrence data (simple) format.

3. Run Python Script GBIF_Species_Data_Filtered.py

Use **GBIF_Species_Data_Filtered.py** to clean and filter the data. Removes invalid or missing geospatial data (e.g., NA coordinates, outliers). Prepares the data for range mapping.
* Input: GBIF occurrence data (simple).
* Output: Individual .csv file per species (see filtered_species.zip). Example: Acetes_americanus_filtered.csv

4. Generate Range Maps:

Run **R_gbig.ranges.r** in R to create GeoTIFF files for each species.
* Input: filtered species csv files (see "filtered_species.zip"). Example: Achirus_lineatus_filtered.csv
* Output: GeoTIFF files for each species (see "tiff_outputs.zip"). Example: Achirus_lineatus_filtered_range.tif

Merge Taxonomically Revised Species:

Combine range maps for the nine species pairs listed above under their accepted names.

Chi-Squared Test for Independence

Run **chi_square_test.py** to perform a chi-squared test to evaluate whether the distributions of species presence (True) and absence (False) are significantly different across years.

BCO-DMO Processing Description

Version 1:

* Data table from submitted file "species_latitudes_merged.csv"(uploaded to BCO-DMO 2024-11-18) was imported into the BCO-DMO data system for this dataset. This table was added as the primary table for this dataset and will appear as Data file "941250_v1_species-latitudes.csv"
** 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]

* Over the course of correspondence with the data provider taxaonomic identifiers were included in the data table (as referenced by GBIF and are the AphiaIDs also used at the World Register of Marine Species). The full Life Science Identifier (LSID)s for all names were included in supplemental species list 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. Notes about the name used in the data and the currently accepted name are in the supplemental species list table.

* Redacted authentication details from scripts. Comments and instructions clarify how to configure for running.

* script name updated before attaching as supplemental file GBFI_Species_Data_Filtered.py -> GBIF_Species_Data_Filtered.py

Issue: Which source raw data used from GBIF is ambiguous.
* The supplied file 0014997-241107131044228.csv (GBIF occurrence data download) was not added as a supplemental file to this dataset. The DOI and citation for that download was found using GBIF tools as https://doi.org/10.15468/dl.c88hxd and can be accessed from there. Full citation as suggested by GBIF in the

"Related Datasets" section.
* A different source DOI (https://doi.org/10.15468/DL.VHUZ4) was indicated as the source for the filtered species csv files so both wer cited as related datasets to this BCO-DMO dataset.

* The chi_square_test.py uploaded by the data submitter on 2024-11-18 has 0bytes and will be updated with a valid file before publication if possible. Or metadata describing the absent file will be provided.

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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

Global Biodiversity Information Facility (2024) Occurrence download formats :: Technical Documentation. https://techdocs.gbif.org/en/data-use/download-formats
Methods

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

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

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

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

IsRelatedTo

Leavitt, H., Thomas, A., Nelson, J. (2025) **Black mangrove habitat change analysis in Port Fourchon, LA from 2002, 2014, and 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-02-19 doi:10.26008/1912/bco-dmo.941477.1 [view at BCO-DMO]
Relationship Description: Data collected as part of the same study published in Leavitt et al. (2024).

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).

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

IsDerivedFrom

GBIF.Org User. (2024). Occurrence Download[Data set]. The Global Biodiversity Information Facility. Accessed 24 October 2024. https://doi.org/10.15468/DL.VHUZ4

GBIF.org (2024) GBIF Occurrence Download [Data set]. The Global Biodiversity Information Facility. Accessed November 14th, 2024 https://doi.org/10.15468/dl.c88hxd

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Parameters

Parameter	Description	Units
original_range_name	This column contains the species name (e.g. Acetes americanus) or 'Pattern not found.'	unitless
mean_latitude	mean latitude point in range	decimal degrees
max_latitude	description	decimal degrees
min_latitude	minimum latitude point in range	decimal degrees
longitude	the assigned longitude for plotting not associated with species distribution	decimal degrees
Year_2005	was a species oberved in the year 2005 true or false	unitless
Year_2014	was a species oberved in the year 2014 true or false	unitless
Year_2022	was a species oberved in the year 2022 true or false	unitless
AphiaID	species id fom GBIF (The AphiaID is the identifier used at the World Register of Marine Species and other related databases). The	unitless
Species_name	accepted species name (as of 2024-11-24)	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:
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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