Results of a species pool analysis identifying species of interest responding to climate changes in Port Fourchon, LA in 2006, 2016, 2022 and 2023

Website: https://www.bco-dmo.org/dataset/991182
Data Type: Synthesis
Version: 1
Version Date: 2026-01-08

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
This dataset is part of a larger workflow analyzing three drop sampling studies from Port Fourchon, Louisiana in 2006, 2016, and 2022/2023 to look for signs of species pool turnover. The code and filters in this dataset's workflow screen the Port Fourchon nekton assemblage to pinpoint potential mangrove co-migrators. It synthesizes abundance/presence trends across survey years with GBIF sampling sufficiency, thermal niche position, and range-edge proximity, then flags taxa with low false-absence risk. The pipeline outputs species retained at each filter stage and visualizes CTI trajectories against local winter temperatures to highlight warm-adapted taxa advancing into the study area.

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Coverage

Location: Port Fourchon, LA
Spatial Extent: **N**:29.168 **E**:-90.16 **S**:29.095 **W**:-90.244
Temporal Extent: 2006 - 2023

Dataset Description

This is one of four datasets in the BCO-DMO catalog that were produced with the "Fourchon Nekton Turnover Workflow" (v1.0.0, doi: https://doi.org/10.5281/ZENODO.18165331). BCO-DMO hosts the datasets and supplemental data produced by this workflow that have had minor modifications to enhance the interoperability of the data and were imported into the BCO-DMO data system (See more in section "BCO-DMO Processing"). The workflow contains the exact formats of the data files produced and used by the workflow scripts. The workflow contains scripts, configurations, readme files, and input/output files for four stages listed below. Each workflow stage corresponds to a BCO-DMO dataset (See "Related Datasets" section on the BCO-DMO pages).

"Fourchon Nekton Turnover Workflow" steps with corresponding BCO-DMO dataset IDs:

- "1_raw_data" = includes raw drop-sampling data corresponding to BCO-DMO dataset 991168 (doi: 10.26008/1912/bco-dmo.991168.1)
- "2_gbif_workflow" = includes GBIF species observation data corresponding to metadata in BCO-DMO dataset 991175 (doi: 10.26008/1912/bco-dmo.991175.1)
- "3_CTI_calculations" = includes community temperature index (CTI) data corresponding to BCO-DMO dataset 941250 (doi: 10.26008/1912/bco-dmo.941250.1)
- "4_species_of_interest" = includes the results of a species pool analysis identifying species of interest corresponding to BCO-DMO dataset 991182 (doi: 10.26008/1912/bco-dmo.991182.1)

The workflow release (v1.0.0) contains data and scripts used to run analyses and produce figures for publication Leavitt, H; Thomas, A; Doerr, J; Johnson, D; Nelson, J. (In press) Resilient Nekton Composition in the Face of Climate-Driven Foundation Species Shifts. Ecology. Accepted 2025-11-14

Methods & Sampling

Species Thermal Indices (STIs) were calculated from cleaned GBIF occurrence records to represent the typical thermal conditions occupied by each taxon across its realized range. For each species, all vetted occurrence records with valid geographic coordinates were compiled and associated with air temperature values extracted from the WorldClim bioclimatic dataset (BIO6: mean temperature of the coldest month), used here as a consistent proxy for thermal regime in coastal and estuarine systems. To ensure all points could be associated with a land-surface temperature, temperature was calculated as the mean value of pixels within 0.05 degrees of the point.

To minimize spatial sampling bias caused by uneven GBIF reporting density, occurrence records were spatially thinned prior to STI calculation. Records were projected into a metric coordinate system and overlaid with a 50-km hexagonal grid. Within each grid cell, a single occurrence per species was retained at random, ensuring that no region disproportionately influenced thermal estimates.

Following thinning, STI for each species was calculated as the mean SST across all retained occurrences. To characterize uncertainty and thermal breadth, we also computed the 2.5th and 97.5th percentiles of SST values, their difference (thermal range), and a robust estimate of the northern thermal limit based on the 99th percentile of latitude. These metrics describe both central tendency and variability in species' thermal associations while reducing sensitivity to outliers and oversampled regions.

Community Temperature Index (CTI) was calculated by integrating species-level STIs with site-level community composition data. A community matrix containing species abundances (or counts) per sample was first aligned with the STI dataset so that only taxa present in both datasets were included. See related BCO-DMO dataset (941250) for more information about the CTI calculations (linked in "Related Datasets" section of this page).

For each sample, CTI was computed as the abundance-weighted mean of species STIs, such that species contributing more individuals to a community had proportionally greater influence on the index. Formally, CTI for a given sample is the sum of each species' abundance multiplied by its STI, divided by the total abundance of all species in that sample. This formulation yields a continuous metric reflecting the thermal affinity of the community as a whole.

To estimate the average low-temp limit for the community, parallel CTI calculations were performed using the lower (2.5th percentile) STI estimates and STI thermal ranges, producing complementary community-level metrics that reflect minimum temperature estimates and thermal niche breadth. These CTI values were then appended to the community dataset along with sample metadata (e.g., year and sample ID) for downstream analyses of temporal and spatial trends.

Data Processing Description

Identification of climate co-migrator candidates

Species potentially acting as climate co-migrators were identified using a sequential, filter-based framework integrating community abundance trends, species thermal limits, range position, and detection probability. All filters were applied conservatively and in series, such that only species passing every step were retained. Data for this analysis comes from three other datasets associated with this project cited in the related datasets section.

Filter 1: Abundance trends and recent appearance

Community abundance data with CTI metrics were first reshaped into long format to quantify temporal trends in species abundance. For each species, mean abundance was calculated per year across all sampled sites. We then evaluated evidence for population increase using two complementary criteria:

Abundance trend: Pearson correlation between year and mean abundance, with species retained if the correlation coefficient exceeded 0.7.

Presence gain: Logical detection criteria identifying species absent in early years (2006) but present in later surveys (2016 and/or 2023).

Species meeting either criterion were retained as preliminary co-migrator candidates. This step ensured inclusion of both steadily increasing species and newly established taxa that may not yet show strong linear trends.

Filter 2: GBIF data sufficiency

To ensure reliable estimation of species thermal indices, candidate species were required to have sufficient spatial representation in the GBIF-derived STI dataset. Species with fewer than five spatially thinned GBIF grid cells were excluded, reducing sensitivity to sparse or geographically biased occurrence records.

Filter 3: Thermal tolerance relative to local climate

Remaining species were filtered by minimum thermal tolerance using the lower bound of their Species Thermal Index (STI). Species were retained only if the 2.5th percentile of their STI exceeded ~3 °C, corresponding to the approximate lower bound of winter temperatures at Port Fourchon. This step excluded cold-associated and temperate species.

Filter 4: Range-edge proximity

To target species likely responding to poleward or range-edge expansion rather than long-established residents, we retained only taxa whose northern range limit (estimated as the 99th percentile of latitude from GBIF occurrences) fell south of 30.7° N. This threshold reflects proximity to the study region and emphasizes species near their contemporary northern distribution limit.

Filter 5: False-absence probability

For species passing the first four filters, we explicitly quantified the likelihood that apparent absences in early years reflected sampling failure rather than true absence. Detection probability was estimated as the average proportion of sampled sites in which a species was detected when present. Using the number of sites sampled per year, we calculated the probability of failing to detect a species despite its presence (false absence) for each year.

Species were retained only if the combined probability of false absence in key early comparisons (2006–2016) was <5%. This step ensured that inferred range expansion was unlikely to be an artifact of limited sampling or low detectability.

Species passing all five filters were designated as final co-migrator candidates

This dataset corresponds to Step 4 of the study's processing workflow 'Fourchon Nekton Turnover Workflow' (doi: 10.5281/zenodo.18165331). See "Description" and "BCO-DMO Processing" sections for context about the relationship between the workflow files and the data as published at BCO-DMO.

Workflow README for Step "4_species_of_interest" : Step 4: Species of Interest and CTI Plotting

Abstract

This step screens the Port Fourchon nekton assemblage to pinpoint potential mangrove co-migrators. It chains abundance/presence trends across survey years with GBIF sampling sufficiency, thermal niche position, and range-edge proximity, then flags taxa with low false-absence risk. The pipeline outputs species retained at each filter stage and visualizes CTI trajectories against local winter temperatures to highlight warm-adapted taxa advancing into the study area.

Purpose: identify co-migrator candidates via sequential filters (abundance trends, GBIF sufficiency, thermal limits, range position, false-absence probability) and plot CTI alongside winter temperatures.

Primary script

- ID_species_of_interest_BCODMO.R: annotated script applying filters and generating CTI vs winter temperature plot.

Inputs

- ../3_CTI_calculations/outputs/pivot_clean.csv: community matrix with CTI metrics.
- ../3_CTI_calculations/outputs/STI_results_by_taxon.csv: species thermal indices.
- ../1_raw_data/inputs/species_presence_2006_2016_2022.csv: coarse presence by year.
- ../1_raw_data/inputs/avg_winter_temp_yearly.csv: Port Fourchon winter temperatures.

Outputs (outputs/)

- filter1_species.csv, filter2_species.csv, filter3_species.csv, filter4_species.csv, filter_final.csv: species retained after each filter stage.
- plots/species_temp_plot.png: CTI (weighted and unweighted) overlaid with winter temperature.

Software

- R >= 4.3 with tidyverse, ggplot2, ggrepel, janitor, brms, ggspatial, maptiles, sf.

Run order

1. Ensure STI/CTI outputs from Step 3 are available.
2. Run ID_species_of_interest_BCODMO.R.
3. Review filtered species lists and plot in outputs/.

BCO-DMO Processing Description

Version 1 (2026-01-08):

Data from the processing workflow were prepared and published at BCO-DMO after reorganization into datasets with minor changes performed to meet the required conventions implemented by BCO-DMO designed for interoperability, standardization, and a variety of data access methods.

Submitted data files for this dataset correspond to the study's outputs in workflow (doi: 10.5281/zenodo.18165331) step 4:

"Fourchon Nekton Turnover Workflow/4_species_of_interest/output/"

* filter1_species.csv - (added as a supplemental file after minor changes)
* filter2_species.csv - (added as a supplemental file after minor changes)
* filter3_species.csv - (added as a supplemental file after minor changes)
* filter4_species.csv - (added as a supplemental file after minor changes)
* filter_final.csv - (imported into the BCO-DMO data system as the primary table for this dataset. Added to dataset as "991182_v1_port-fourchon_species-of-interest.csv"(imported into the BCO-DMO data system as the primary table for this dataset.

Changes made to all tables in this dataset:
* The unnamed first column was not imported. The data submitter indicated this is an unnecessary legacy column.

* Taxon identifiers added to all filter#_species.csv tables by joining the name in the dataset to the from the related dataset BCO-DMO dataset (991168) aphia_codex.csv "true_name" column. "Panopeus spp." was not present in the aphia_codex.csv so the AphiaID and WoRMS value were filled in using the WoRMS identifiers for the genus.
* Columnn names adjusted to conform with naming conventions designed for interoperability. This includes changing columns that start with numbers (e.g. 2016_detected -> detected_2016).

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Related Datasets

IsRelatedTo

Nelson, J. (2026) **Cleaned species occurrence data from 2005 to 2025 from GBIF as part of a workflow to assemble species and community temperature indices for Port Fourchon, LA in 2006, 2016, 2022 and 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-01-08 http://lod.bco-dmo.org/id/dataset/991175 [view at BCO-DMO]
Relationship Description: Datasets that are part of the same workflow (doi: 10.5281/zenodo.18165331) for a study to be published: Leavitt, H; Thomas, A; Doerr, J; Johnson, D; Nelson, J. (In press) Resilient Nekton Composition in the Face of Climate-Driven Foundation Species Shifts. Ecology.

Nelson, J. (2026) **Drop Sampling Data from Port Fourchon, Louisiana collected in 2006, 2016, 2022 and 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-01-08 http://lod.bco-dmo.org/id/dataset/991168 [view at BCO-DMO]
Relationship Description: Datasets that are part of the same workflow (doi: 10.5281/zenodo.18165331) for a study to be published: Leavitt, H; Thomas, A; Doerr, J; Johnson, D; Nelson, J. (In press) Resilient Nekton Composition in the Face of Climate-Driven Foundation Species Shifts. Ecology.

Nelson, J., Leavitt, H., Thomas, A. (2026) **Community Temperature Index Calculations for Port Fourchon, Louisiana Drop Sampling data from 2006 to 2023.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2026-01-08 http://lod.bco-dmo.org/id/dataset/941250 [view at BCO-DMO]
Relationship Description: Datasets that are part of the same workflow (doi: 10.5281/zenodo.18165331) for a study to be published: Leavitt, H; Thomas, A; Doerr, J; Johnson, D; Nelson, J. (In press) Resilient Nekton Composition in the Face of Climate-Driven Foundation Species Shifts. Ecology.

IsPartOf

heleavitt. (2026). *heleavitt/Workflow-for-Leavitt_et_al_Resilient-Species-Nekton-Composition-in-the-Face-of: Workflow for Resilient Nekton Composition in the Face of Climate-Driven Foundation Species Shifts* (Version v1.0.0) [Computer software]. Zenodo. https://doi.org/10.5281/ZENODO.18165331
https://doi.org/10.5281/zenodo.18165331

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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.

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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