Trawl survey data and species distribution model predictions for presence, absence and abundance

Website: https://www.bco-dmo.org/dataset/753142
Data Type: Cruise Results, model results
Version: 1
Version Date: 2019-03-05

Project
» Adaptations of fish and fishing communities to rapid climate change (CC Fishery Adaptations)

Contributors	Affiliation	Role
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Abstract
NMFS Trawl Survey data used to fit species distribution models and the resulting modeled predictions for presence/absence and abundance.

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Coverage

Spatial Extent: **N**:44.5 **E**:-65.75 **S**:26 **W**:-75.75
Temporal Extent: 1968 - 2014

Dataset Description

NMFS Trawl Survey data used to fit species distribution models and the resulting modeled predictions for presence/absence and abundance.

These data were published in Selden (2018).

The "Get Data" button on this page provides a tabular version of this dataset. These data are also available in the following R Datafile containing a DataFrame named “historical.”
https://datadocs.bco-dmo.org/data/305/CC_Fishery_Adaptations/753142/1/data/historical.RData

Related dataset:
"Projected species probability of occupancy and abundance under ocean warming": https://www.bco-dmo.org/dataset/753188

Methods & Sampling

NMFS Trawl Survey data was used to fit species distribution models and the resulting modeled predictions for presence/absence and abundance.

We analyzed the influence of environmental characteristics on the spatial distribution of our eight focal species using data collected by the Northeast Fisheries Science Center (NEFSC) spring (March-May), and fall (September-November) bottom trawl surveys along the Northeast US Shelf (65-75°W longitude, and 35-45°N latitude) for the period 1968-2014. Sea surface temperature, sea bottom temperature, and depth were sampled concurrently with trawl samples. We used sediment grain size as a measure of substrate type using existing data layers from the Nature Conservancy. Surveys were trimmed to strata that were sampled in at least 43 of the 46 years. Data from the fall and spring surveys 1968-2014 were combined in order to fit species distribution models (SDMs) using a generalized additive model (GAM) fit separately for each species. Presence or absence of species x in haul location i in year y was modeled using a logistic model with a binomial error distribution and a logit link function. The probability of species occurrence in each haul was modeled as an additive function of the five environmental variables and regional species biomass: haul-specific observations of sea surface temperature, sea bottom temperature, depth, sediment grain size, and average region-wide biomass (kg/tow) of species x in year y in the season in which the haul was conducted. Penalized regression splines were fitted using the “gam” function in the mgcv package in R.

In addition to examining changes in overall range size, we also predicted historical and projected biomass using a delta-lognormal GAM that combines the predictions of the presence/absence model with that for biomass when present.

Range size and species overlap wer calculated using the R-file species_overlap_BCO.R available in the "Supplemental Documents" section on this page.

Data Processing Description

BCO-DMO data manager processing notes:
* exported RData as csv and imported into the BCO-DMO data system.
* periods in column names in the RData Frame changed to underscores in exported csv version to support import into the BCO-DMO data system.
* columns rounded to three decimal places during csv export:
"sed.grain","mean.wtcpue","wtcpue","preds1","preds1.upr","preds1.lwr","preds"

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Data Files

File
historical.csv (Comma Separated Values (.csv), 15.64 MB) MD5:b5d5ae023960fd1315c831a00b3597c0 Primary data file for dataset ID 753142

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Supplemental Files

File

species_overlap_BCO.R (Octet Stream, 5.63 KB)

MD5:c107c518ed26e5fe7f0958c7f034867e

This R-file uses R datafiles available from the following dataset landing pages:

"Observed and modeled presence 1968-2014": https://www.bco-dmo.org/dataset/753142

* historical.RData

"Projected species probability of occupancy and abundance under ocean warming": https://www.bco-dmo.org/dataset/753188

* projected.RData

Range size and species overlap

For each year, observations and predictions of historical species occupancy were aggregated to 0.5°latitude x 0.5°longitude grid cells by taking the average across hauls in each cell. Data in each year was further trimmed to the 113 grid cells that were observed in at least 30 years. Observed range size for species x in year y was calculated as the proportion of grid cells in the study region in which the species was present to account for differences in the intensity of sampling between years. The observed fraction of prey A's range occupied by predator B was defined as the number of sites occupied by both species relative to the total number of sites occupied by species A.

To calculate a species' predicted range extent from the species distribution models, we computed the average occupancy probability of that species across all sites in the region. To predict the fraction of prey A's range occupied by predator B, the cumulative joint probability of both species was divided by the cumulative probability for species A across all sites in the study region.

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Related Publications

Selden, R. L., Batt, R. D., Saba, V. S., & Pinsky, M. L. (2017). Diversity in thermal affinity among key piscivores buffers impacts of ocean warming on predator-prey interactions. Global Change Biology, 24(1), 117–131. doi:10.1111/gcb.13838

Results

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Parameters

Parameter	Description	Units
spp	species scientific name	unitless
haulid	trawl haulid created from CRUISE6 (196803), STATION with max of 3 digits (8), and STRATUM (1010) from NEFSC survey data	unitless
lat_25	latitude	decimal degrees (DD)
lon_25	longitude	decimal degrees (DD)
btemp	in situ bottom temperature from trawl	degrees Celsius
stemp	in situ surface temperature from trawl	degrees Celsius
depth	trawl depth	meters (m)
sed_grain	relative sediment grain size, a proxy for habitat type	unitless
mean_wtcpue	annual mean biomass (kg) per tow for the species for all hauls in region	kilograms per tow (kg/tow)
wtcpue	biomass per tow in given haul	kilograms per tow (kg/tow)
preds1	predicted probability of occurrence (0-1)	dimensionless
preds1_upr	upper bound of predicted probability of occurrence (fit + 2SE)	dimensionless
preds1_lwr	lower bound of predicted probability of occurrence (fit - 2SE)	dimensionless
preds	predicted biomass	kilograms (kg)
year	year in format yyyy	unitless
pres2	observed presence (TRUE) or absence (FALSE)	unitless

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Project Information

Adaptations of fish and fishing communities to rapid climate change (CC Fishery Adaptations)

Coverage: Northeast US Continental Shelf Large Marine Ecosystem

Description from NSF award abstract:
Climate change presents a profound challenge to the sustainability of coastal systems. Most research has overlooked the important coupling between human responses to climate effects and the cumulative impacts of these responses on ecosystems. Fisheries are a prime example of this feedback: climate changes cause shifts in species distributions and abundances, and fisheries adapt to these shifts. However, changes in the location and intensity of fishing also have major ecosystem impacts. This project's goal is to understand how climate and fishing interact to affect the long-term sustainability of marine populations and the ecosystem services they support. In addition, the project will explore how to design fisheries management and other institutions that are robust to climate-driven shifts in species distributions. The project focuses on fisheries for summer flounder and hake on the northeast U.S. continental shelf, which target some of the most rapidly shifting species in North America. By focusing on factors affecting the adaptation of fish, fisheries, fishing communities, and management institutions to the impacts of climate change, this project will have direct application to coastal sustainability. The project involves close collaboration with the National Oceanic and Atmospheric Administration, and researchers will conduct regular presentations for and maintain frequent dialogue with the Mid-Atlantic and New England Fisheries Management Councils in charge of the summer flounder and hake fisheries. To enhance undergraduate education, project participants will design a new online laboratory investigation to explore the impacts of climate change on fisheries, complete with visualization tools that allow students to explore inquiry-driven problems and that highlight the benefits of teaching with authentic data. This project is supported as part of the National Science Foundation's Coastal Science, Engineering, and Education for Sustainability program - Coastal SEES.

The project will address three questions:
1) How do the interacting impacts of fishing and climate change affect the persistence, abundance, and distribution of marine fishes?
2) How do fishers and fishing communities adapt to species range shifts and related changes in abundance? and
3) Which institutions create incentives that sustain or maximize the value of natural capital and comprehensive social wealth in the face of rapid climate change?

An interdisciplinary team of scientists will use dynamic range and statistical models with four decades of geo-referenced data on fisheries catch and fish biogeography to determine how fish populations are affected by the cumulative impacts of fishing, climate, and changing species interactions. The group will then use comprehensive information on changes in fisher behavior to understand how fishers respond to changes in species distribution and abundance. Interviews will explore the social, regulatory, and economic factors that shape these strategies. Finally, a bioeconomic model for summer flounder and hake fisheries will examine how spatial distribution of regulatory authority, social feedbacks within human communities, and uncertainty affect society's ability to maintain natural and social capital.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1426891

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