Otolith chemistry from Menhaden nurseries collected from multiple sites along the US Eastern Coast from 2009-2011 (Contribution of Menhaden Nurseries project)

Website: https://www.bco-dmo.org/dataset/528569
Data Type: Other Field Results
Version: 1
Version Date: 2014-10-01

Project
» The impact of multiple nursery areas and adult age structure on the population dynamics of marine fishes (Contribution of Menhaden Nurseries)

Contributors	Affiliation	Role
Jones, Cynthia M.	Old Dominion University (ODU)	Principal Investigator
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Abstract
This dataset reports otolith chemistry measurements from Menhaden nurseries collected from multiple sites along the US Eastern Coast from 2009-2011.

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Coverage

Spatial Extent: **N**:41.48 **E**:-72.09 **S**:32.84 **W**:-79.99
Temporal Extent: 2009 - 2011

Methods & Sampling

Sample Collection:
Collected By: Multiple State Agencies - Connecticut Department of Marine Fisheries, Rhode Island Marine Fisheries, New York Department of Environmental Conservation, New Jersey Department of Fish and Wildlife, Maryland Department of Natural Resources Fisheries Service, Chris Newsome, National Marine Fisheries Service, North Carolina Division of Marine Fisheries, South Carolina Department of Natural Resources, and

Florida Fish and Wildlife.

Location:
Samples were collected by multiple boats and from multiple sites in the Thames and Essex Rivers in Connecticut; Hudson River in New York; Delaware Bay in Delaware; Potomac, Patuxent, Choptank, and Nanticoke Rivers in Maryland; James River in Virginia; Albemarle Sound in North Carolina; and Charleston Harbor in South Carolina.

Georeferences:
Species: Atlantic menhaden *Brevoortia tyrannus*
Date of Collection: 2009-2011; All samples were collected by United States state natural resource agencies from July to October.

Methods:
Samples Processed by: Kristen Anstead, Graduate Student, Old Dominion University
Method 1: Catch & Storage
Samples were mailed to the CQFE and stored in a Baxter Cryo-Fridge at approximately -20°C until thawed and measured in the wet lab.

Method 2: Measurement and Otolith Removal
Menhaden were thawed and weighed on a model EA15DCE-1 Sartorius scale in pounds to the nearest thousandth. Fish were measured for total length, fork length, and standard length in the wet lab to the nearest mm on a CThru YMS-1 measuring board. Using a serrated knife, the head was cut open to expose the sagittal otoliths for removal with metal forceps. Otoliths were rinsed in tap water and placed in a storage vial. Once the otoliths were removed, fish were discarded.

Method 3: Sample Preparation
In a class-100 clean room using acid-washed glass probes, excess tissue was cleaned from the otolith surface by rinsing with ultrapure hydrogen peroxide for 1 minute followed by triple rinsing with ultrapure Milli-Q water. Cleaned samples dried for 24 hours under a laminar flow hood and stored in acid-washed polyethylene vials.

Method 4: Trace Element Analysis
Otoliths were analyzed using a Thermo Finnegan Element 2 (Thermo-Fisher Scientific, Bremen, Germany) inductively-coupled plasma mass spectrometer (ICP-MS) with a New Wave 193 nm excimer laser ablation system (New Wave Research, Sunnyvale, CA) at the Woods Hole Oceanographic Institute's plasma facility. Otolith material was ablated using a laser beam with a 25 µm spot size, 10 µm/s scan speed, 70% power, and a 10 Hz frequency. We ablated and analyzed a transect from the core to the edge of the otolith that resulted in a trench that was approximately 25 µm wide and 30 µm deep in order to capture the juvenile signature. For each transect, we collected counts for 7Li, 25Mg, 55Mn, 85Rb, 88Sr, 89Y, 137Ba, and 208 Pb in low-resolution mode (R=300). Elemental concentration was calibrated using two reference materials and multi-element standards prepared from ultrapure stock solutions. All elements were normalized to Ca and expressed as element-to-calcium molar ratios. Standards were run twice a slide, at the beginning and the end, to account for machine drift.

Method 5: Stable Isotope Analysis
Samples were analyzed for carbon (δ13C) and oxygen (δ18O) concentrations with a Finnigan Delta Plus with Kiel III Carbonate Device (Thermo Fisher Scientific, Waltham, MA) using standard procedures at the University of Washington Stable Isotope Laboratory. Both oxygen and carbon were measured and corrected relative to Vienna Pee Dee belemnite.

Method 6: Region Assignment
Because samples were collected from multiple rivers during different times of the season and in different quantities, the multiple collection sites were grouped into four regions: the Northeast (1), Delaware Bay (2), Chesapeake Bay (3), and the Southeast (4). These regional groups are similar to other studies of this scope based on physical differences in water chemistries of these regions.

Analytical Methodology:
Samples selected for trace element composition were mounted sulcal side up on a glass slide using crystal bond and polished with 30 µm lapping film to expose growth rings followed by 0.3 µm lapping film to produce a smooth surface for laser ablation. Age verification was also made at this point and fish less than 1-year-old were considered to be juveniles. We mounted otoliths in blocks of 20 on a petrographic slide in a randomized order for each year-class. Each petrographic slide was sonicated in Milli-Q (18 MΩ•cm-1) water for 10 minutes to remove contaminants from the surface and allowed to dry under a laminar flow hood. Otoliths were analyzed using a Thermo Finnegan Element 2 (Thermo-Fisher Scientific, Bremen, Germany) inductively-coupled

plasma mass spectrometer (ICP-MS) with a New Wave 193 nm excimer laser ablation system (New Wave Research, Sunnyvale, CA) at the Woods Hole Oceanographic Institute's plasma facility. Otolith material was ablated using a laser beam with a 25 µm spot size, 10 µm s-1 scan speed, 70% power, and a 10 Hz frequency. We ablated and analyzed a transect from the core to the edge of the otolith that resulted in a trench that was approximately 25 µm wide and 30 µm deep in order to capture the juvenile signature. For each transect we collected counts for 7Li, 25Mg, 55Mn, 85Rb, 88Sr, 89Y, 137Ba and 208Pb in low-resolution mode (R=300) (Schaffler and Winkelman 2008). Elemental concentration was calibrated using two reference materials and multi-element standards prepared from ultrapure stock solutions (Yoshinaga et al. 1999; Sturgeon et al. 2005). All elements were normalized to Ca and expressed as element-to-calcium molar ratios (Schaffler and Winkelman 2008). Standards were run twice a slide, at the beginning and the end, to account for machine drift. Blanks were analyzed after every 5 samples and limits of detection (LODs) were calculated as mean blank values plus three standard deviations (Thorrold et al. 1997b) and expressed as a percent of the average sample intensity.

Trace element and stable isotope data were combined to identify natal signatures. Data were normalized using Box Cox transformations (Box and Cox 1964). We assessed normality based on Kolmogorov–Smirnov test and equality of variance using O'Brien's test. Assumptions of multivariate normality were evaluated using tests based on Mardia's multivariate skewness and kurtosis measures (Khattree and Naik 2000) and graphically using Q-Q plots of squared Mahalanobis distances. We performed a multivariate analysis of variance (MANOVA) to detect differences in the multivariate elemental natal signatures in each of the nursery regions and for all cohorts. Pillai's trace statistic quantified significant differences in otolith chemistries between nursery areas and years. Following these analyses, we used univariate analyses of variance (ANOVA) to determine which elements exhibited differences. When nursery grounds were shown to exhibit statistically significant differences, we used a quadratic discriminant function analysis because of the unequal variance-covariance matrices as indicated by Bartlett's test to assign juvenile menhaden to their nursery area. We tested this classification using a jackknife leave-one-out cross-validation approach within years and between years to assess the annual signatures and combined signatures ability to predict other year classes. Additionally, we tested the classification success based solely on either trace element or stable isotope data. Canonical discriminant analysis (CDA) was used to visualize difference among locations.

Data Set:
Data Prepared by: Kristen Anstead, Graduate Student, Old Dominion University
Location of Notes: Lab Notebook, CQFE
Notes: FISH-ID: Samples of sagittal otoliths were named for the group the samples came from followed by a dash and then the individual fish in the sample were numbered sequentially. For example, all fish received from the same catch, from the same boat, on the same date got a group number (ie. 80) and each fish was numbered after that with a -1, -2, -3, -etc. so that all fish in that group would be 80-1, 80-2, 80-3, and so on. The next group of sample fish received by the lab would then be numbered 81.

Data Processing Description

Data Processing:
Blanks were analyzed after every 5 samples and limits of detection (LODs) were calculated as mean blank values plus three standard deviations (Thorrold et al. 1997b) and expressed as a percent of the average sample intensity.

Trace element and stable isotope data were combined to identify natal signatures. Data were normalized using Box Cox transformations (Box and Cox 1964). We assessed normality based on Kolmogorov–Smirnov test and equality of variance using O'Brien's test. Assumptions of multivariate normality were evaluated using tests based on Mardia's multivariate skewness and kurtosis measures (Khattree and Naik 2000) and graphically using Q-Q plots of squared Mahalanobis distances. We performed a multivariate analysis of variance (MANOVA) to detect differences in the multivariate elemental natal signatures in each of the nursery regions and for all cohorts. Pillai's trace statistic quantified significant differences in otolith chemistries between nursery areas and years. Following these analyses, we used univariate analyses of variance (ANOVA) to determine which elements exhibited differences. When nursery grounds were shown to exhibit statistically significant differences, we used a quadratic discriminant function analysis because of the unequal variance-covariance matrices as indicated by Bartlett's test to assign juvenile menhaden to their nursery area. We tested this classification using a jackknife leave-one-out cross-validation approach within years and between years to assess the annual signatures and combined signatures ability to predict other year classes. Additionally, we tested the classification success based solely on either trace element or stable isotope data. Canonical discriminant analysis (CDA) was used to visualize difference among locations.

BCO-DMO Processing Notes
- Generated from original file (resubmitted): "Copy of Juvenile Menhaden Data 2009-2011.xlsx" contributed by Kristen Anstead
- Parameter names edited to conform to BCO-DMO naming convention found at Choosing Parameter Name
- "nd" (no data) inserted into blank cells

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Data Files

File
Menhaden_Otolith_Chem.csv (Comma Separated Values (.csv), 70.67 KB) MD5:e7869d8fe7180fb833f0b6f7093885e0 Primary data file for dataset ID 528569

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Parameters

Parameter	Description	Units
Year	Four-digit year of data collection	unitless
State	State (two letter abbreviation) – See “Sample Collection/Collected By” in Acquisition Description	text
River	River/Area of collection - See “Sample Collection/Location” in Acquisition Description	text
Latitude	Latitude of general sampling area (South is Negative)	decimal degrees
Longitude	Longitude of general sampling area (West is Negative)	decimal degrees
Region	Region of collection – See “Method 6: Region Assignment” in Acquisition Description	dimensionless
Fork_Length	Length of the menhaden measured from the tip of the snout to the end of the middle caudal fin rays	millimeters (mm)
Fish_ID	Fish Id – See “Data Set/Notes: FISH-ID” in Acquisition Description	dimensionless
Li	Elemental concentration of 7Li normalized to calcium	umol
Mg	Elemental concentration of 25Mg normalized to calcium	umol
Mn	Elemental concentration of 55Mn normalized to calcium	umol
Rb	Elemental concentration of 85Rb normalized to calcium	umol
Sr	Elemental concentration of 88Sr normalized to calcium	mmol
Y	Elemental concentration of 89Y normalized to calcium	umol
Ba	Elemental concentration of 137Ba normalized to calcium	umol
Pb	Elemental concentration of 208Pb normalized to calcium	umol
d13C	Carbon (δ13C) concentration	‰
d18O	Oxygen (δ18O) concentration	‰

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Deployments

Menhaden_Nurseries_Collection

Website	https://www.bco-dmo.org/deployment/528566
Platform	Menhaden Nurseries
Start Date	2009-07-01
End Date	2011-10-31
Description	Cruise or Deployment: Collected by Multiple State Agencies - Connecticut Department of Marine Fisheries, Rhode Island Marine Fisheries, New York Department of Environmental Conservation, New Jersey Department of Fish and Wildlife, Maryland Department of Natural Resources Fisheries Service, Chris Newsome, National Marine Fisheries Service, North Carolina Division of Marine Fisheries, South Carolina Department of Natural Resources, and Florida Fish and Wildlife Location: Samples were collected by multiple boats and from multiple sites in the Thames and Essex Rivers in Connecticut, Hudson River in New York, Delaware Bay in Delaware, Potomac, Patuxent, Choptank and Nanticoke Rivers in Maryland, James River in Virginia, Albemarle Sound in North Carolina and Charleston Harbor in South Carolina.

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Project Information

The impact of multiple nursery areas and adult age structure on the population dynamics of marine fishes (Contribution of Menhaden Nurseries)

Coverage: Samples were collected from multiple sites along the Eastern Coast of the US

Description from NSF award abstract:
Many marine populations exhibit complex life histories in which larval and juvenile stages are spatially separated from adults. This is the case for many coastal-spawning, estuarine-dependent fishes which utilize multiple estuaries as nursery grounds to ensure that recruitment failure in any single estuary does not translate to total recruitment failure at the population level. For these species, the location and timing of spawning is believed to regulate the pattern of supply of larvae to potential estuarine nursery areas. Furthermore, many of these species exhibit age-dependent coastal migrations which increase in amplitude with age. Thus, there is the potential that changes in the age structure in the population can affect the pattern of supply of larvae to nursery areas and structure the pattern of recruitment. The investigators will carry out an integrated empirical and simulation approach to study the sources, patterns and consequences of larval supply to estuarine nursery areas for Atlantic menhaden (*Brevoortia tyrannus*) along the East Coast of the US. The first goal will be to quantify the contribution of these nursery areas to coast wide recruitment. Juvenile menhaden from nursery areas from Massachusetts to Georgia will be sampled and the microchemical constituents of their otoliths will be characterized. These chemical signatures will be used to assign the nursery affinities of adult menhaden in the coastwide population. The investigators will test the null hypothesis that the Chesapeake Bay remains the most important source of recruits to the population. By determining the nursery affinities of adults from different year classes in the population they will assess whether the contribution of nurseries varies or has shifted over time. The second goal is use a population model linked to an individual-based coupled physical-biological model of recruitment to evaluate whether the known age-dependent migrations of adult menhaden are sufficient to cause the observed shifts in the distribution of larval menhaden that seed potential nursery areas. The simulation model will assist in evaluating mechanisms behind observed changes in the distribution of juvenile menhaden.

This work will contribute to the fundamental understanding of the regulation of spatially-structured marine populations. The last decade has seen the range extension of several estuarine-dependent marine species with dispersive larvae and the long-term recruitment decline of others. This integrated research program seeks to explore the effects of population demography, oceanographic circulation, and nursery site diversity on subsequent population dynamics. Given the documented changes in habitat quality in many estuarine nursery areas, and the anticipated impacts of climate change on oceanographic circulation, distributional changes in individual species are likely to become more common. Moreover, given the pivotal role that many estuarine-dependent species play in many marine ecosystems, understanding distributional changes will have direct consequences for the structure and function of the ecosystems to which they belong. The project will also

train young scientists in areas of research (quantitative fisheries ecology, physical oceanography) for which there is current a national need.

Note: This project is an NSF Collaborative Research project.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0961421
NSF Division of Ocean Sciences (NSF OCE)	OCE-0961827
NSF Division of Ocean Sciences (NSF OCE)	OCE-0961632

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