Fish measurements sampled by Dual Frequency Identification Sonar (DIDSON) within Artificial Seagrass Units (ASU) in Back Sound, NC from July to September 2018

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Data Type: Other Field Results
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Project
» Collaborative Research: Habitat fragmentation effects on fish diversity at landscape scales: experimental tests of multiple mechanisms (Habitat Fragmentation)

Contributors	Affiliation	Role
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Abstract
To parse the ecological effects of habitat area and patchiness on faunal community structure and dynamics of estuarine nekton, we employed artificial seagrass unit (ASU) landscapes at a scale relevant to habitat fidelity of common fish and macroinvertebrates in our temperate study system, Back Sound, NC. These ASU landscapes were designed along orthogonal axes of artificial seagrass area (i.e., percent cover of each landscape = 10-60 percent) and fragmentation per se (i.e., percolation probability; 0.1-0.59) to delineate their independent and interactive effects on seagrass fish communities. To examine potential differences among faunal responses to habitat configuration within structured habitat (i.e., artificial seagrass) versus matrix habitat (i.e., sand/mudflat) within the borders of the landscape footprint, fish densities (catch per unit effort; CPUE) were sampled by Dual Frequency Identification Sonar (DIDSON) at three locations within each landscape from June to October, 2018. Fish densities were sampled within the largest ASU patch of each landscape (“largest patch”) and at two locations within the matrix: 1-meter away from the largest patch ("near-patch") and bisecting the largest interpatch distance ("interpatch"). Interpatch samples were not taken in landscapes with 0.59 percolation probability, as they only had one patch. DIDSON samples were collected by Drs. F. Joel Fodrie, James W. Morley, and Amy H. Yarnall for the Estuarine Ecology Laboratory of the University of North Carolina at Chapel Hill’s Institute of Marine Sciences.

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Coverage

Spatial Extent: **N**:34.707 **E**:-76.589 **S**:34.701 **W**:-76.603
Temporal Extent: 2018-07 - 2018-09

Methods & Sampling

This dataset represents fish measurements sampled at three locations within each landscape on Oscar Shoal and an adjacent unnamed shoal in Back Sound, NC, USA (34°42′20" N to 34°41′60" N, 76°36′ 15" W to 76°35′17" W) during the summer of 2018. Benthopelagic fishes were sampled with Dual Frequency Identification Sonar (DIDSON). DIDSON allowed us to reliably detect fishes regardless of water visibility (compared to traditional video cameras) and diversify the size range of organisms we were able to sample. However, DIDSON did not generally allow for species identification.

DIDSON recordings (hereafter “samples”, n = 166), each 1 minute in length, were taken in each landscape's largest patch in July, September, and October, and in each matrix location (i.e., interpatch, near-patch) in July and September. The sampling field of view ranged from 2 meters to 6.5 meters from the DIDSON, and artificial seagrass unit (ASU) and mudflat habitats could be easily distinguished in samples. DIDSON samples were standardized by positioning the sample targets at a range of 4.5 meters in the center of the viewing field. The DIDSON was mounted to a kayak, held stationary by a person on the opposite side of the sampling field, and was operated at a consistent depth below the surface (approximately 10 centimeters) and oriented to include most of the water column and also the substrate.

Known Issues:
October fish lengths were excluded from this dataset, as we were interested in comparing z-scores across all three landscape locations (i.e., largest patch, near-patch, and inter-patch). DIDSON samples were only taken in the largest patch during October.

Data Processing Description

Using DIDSON software (V5.26.06), fishes were counted and measured on 10 randomly selected frames from each 1-minute sample. Random frame selection was constrained such that all frames were spaced a minimum of 25 frames apart to improve sub-sample independence. Fish counts for all 10 frames per sample were summed (i.e., number per sample) for further statistical analysis. This method does not differentiate between fishes that are maintaining position within the area versus transiting through, but represents a cumulative total of fish presences.

To account for potential reader bias in fish counts and length measurements (in centimeters), some samples were analyzed by two (n = 18) or three (n = 15) readers (reading identical sample frames). Readers counted statistically similar numbers of fishes per sample (paired two-sample t-test, $P > 0.05$), ruling out significant reader bias on fish counts.

To examine potential reader bias in fish length measurements, we subset the data to only include frames on which the same fishes were observed by all three readers (i.e., all readers agreed on fish count). We used a linear mixed model with fish length as the response variable, reader identity as the fixed effect, and frame number as a random intercept. In this case, significant bias in fish measurement was observed among readers ($\chi^2 = 101.1$, $DF = 2$, $P < 0.001$), where some readers consistently measured fishes at smaller or larger sizes than other readers. Therefore, we took the mean fish length per frame and converted all mean fish lengths to z-scores.

Data output text files from DIDSON software were reformatted, reduced to relevant information, and output as a master Excel file using R statistical software (v3.6.2).

BCO-DMO Processing Description:
- Missing data identifier ‘NA’ replaced with blank (BCO-DMO's default missing data identifier)
- Added Latitude and Longitude columns and rounded to three decimal places
- Removed "%" sybmol from data cells

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Data Files

File
asufrag_didson_fish_zscore.csv (Comma Separated Values (.csv), 376.43 KB) MD5:60e8b653897024e63b5d8c2805718654 Primary data file for dataset 891686, Version 1.

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Related Publications

R Core Team (2019). R: A language and environment for statistical computing. R v3.6.1. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/
Software

Yarnall, A. H., Yeager, L. A., Lopazanski, C., Poray, A. K., Morley, J. M., Hurlbert, A., and Fodrie, F.J. Habitat area more consistently affects seagrass faunal communities than fragmentation per se.
Results

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Related Datasets

IsRelatedTo

Yarnall, A., Fodrie, F. J., Lopazanski, C., Poray, A. K., Yeager, L. (2023) **Epibenthic faunal densities sampled from within Artificial Seagrass Units (ASU) in Back Sound, NC from June to October 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-15 doi:10.26008/1912/bco-dmo.891859.1 [view at BCO-DMO]

Yarnall, A., Fodrie, F. J., Lopazanski, C., Poray, A. K., Yeager, L. (2023) **Landscape fine-scale complexity of seagrass, fish and macroinvertebrate communities within Artificial Seagrass Units (ASU) in Back Sound, NC from July to September 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-17 doi:10.26008/1912/bco-dmo.891652.1 [view at BCO-DMO]

Yarnall, A., Fodrie, F. J., Lopazanski, C., Poray, A. K., Yeager, L. (2023) **Landscape parameters of seagrass, fish and macroinvertebrate communities within Artificial Seagrass Units (ASU) in Back Sound, NC from July to September 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-27 doi:10.26008/1912/bco-dmo.891670.1 [view at BCO-DMO]

Yarnall, A., Fodrie, F. J., Lopazanski, C., Poray, A. K., Yeager, L. (2023) **Settlement rates of fishes and crab megalopa within Artificial Seagrass Units (ASU) in Back Sound, NC from June to August 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-20 doi:10.26008/1912/bco-dmo.891835.1 [view at BCO-DMO]

Yarnall, A., Fodrie, F. J., Lopazanski, C., Poray, A. K., Yeager, L. (2023) **Squidpop consumption probability within Artificial Seagrass Units (ASU) in Back Sound, NC from October to November 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-15 doi:10.26008/1912/bco-dmo.891794.1 [view at BCO-DMO]

Yarnall, A., Fodrie, F. J., Morley, J., Yeager, L. (2023) **Fish densities sampled by Dual Frequency Identification Sonar (DIDSON) within Artificial Seagrass Units (ASU) in Back Sound, NC from June to October 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2023-03-13 doi:10.26008/1912/bco-dmo.891779.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
Site_ID	Artificial seagrass unit (ASU) landscape name (Percent cover value-Percolation probability value)	unitless
Latitude	Latitude North (South is negative) of sampling site	decimal degrees
Longitude	Longitude East (West is negative) of sampling site	decimal degrees
Per_cov	Percent cover of ASUs in 234 square meter landscape footprint (10, 22.5, 35, 47.5, 60)	percent (%)
Frag	ASU landscape fragmentation per se indexed by percolation probability (0.1, 0.225, 0.35, 0.475, 0.59)	unitless
Sample_ID	Month_Site ID_Class ID	unitless
Frame_ID	Month_Site ID_Class ID_Frame	unitless
L_z	Z-score of mean fish length of all fish in frame	unitless
Month	Month of sample round completion	unitless
Class	Focal sample location within ASU landscape (largest patch, near-patch, inter-patch)	unitless
Class_ID	Class abbreviation (LP = largest patch, NP = near-patch, IP = inter-patch)	unitless
Frame	Frame number	unitless
Reader	Initials of data processor	unitless

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Instruments

Dataset-specific Instrument Name	Dual Frequency Identification Sonar (DIDSON 3000m)
Generic Instrument Name	Dual Frequency Identification Sonar (DIDSON 3000m)
Generic Instrument Description	The Sound Metrics DIDSON 3000 (Dual-Frequency Identification Sonar) multibeam imaging sonar is an acoustic camera that provides almost video-quality images in turbid or dark water where optical systems are ineffective. DIDSON uses acoustic lenses to focus beams and form an acoustic image on the transducer array. DIDSON forms images differently than an optical camera. DIDSON sends out short acoustic pulses in 48 or 96 acoustic beams. These beams are very narrow in the horizontal dimension (0.3° to 0.8°) and wide in the vertical dimension (14°). The beams are adjacent to each other and together form a field-of-view 29° horizontal and 14° vertical. The Didson 3000 is rated to a depth of 3000 meters. It has both Detection and Identification modes. The max frame rate (window length dependent) is 4-21 frames per second.

Dataset-specific Instrument Name	Ohaus H-5276
Generic Instrument Name	scale or balance
Generic Instrument Description	Devices that determine the mass or weight of a sample.

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Project Information

Collaborative Research: Habitat fragmentation effects on fish diversity at landscape scales: experimental tests of multiple mechanisms (Habitat Fragmentation)

Coverage: North Carolina

Amount and quality of habitat is thought to be of fundamental importance to maintaining coastal marine ecosystems. This research will use large-scale field experiments to help understand how and why fish populations respond to fragmentation of seagrass habitats. The question is complex because increased fragmentation in seagrass beds decreases the amount and also the configuration of the habitat (one patch splits into many, patches become further apart, the amount of edge increases, etc). Previous work by the investigators in natural seagrass meadows provided evidence that fragmentation interacts with amount of habitat to influence the community dynamics of fishes in coastal marine landscapes. Specifically, fragmentation had no effect when the habitat was large, but had a negative effect when habitat was smaller. In this study, the investigators will build artificial seagrass habitat to use in a series of manipulative field experiments at an ambitious scale. The results will provide new, more specific information about how coastal fish community dynamics are affected by changes in overall amount and fragmentation of seagrass habitat, in concert with factors such as disturbance, larval dispersal, and wave energy. The project will support two early-career investigators, inform habitat conservation strategies for coastal management, and provide training opportunities for graduate and undergraduate students. The investigators plan to target students from underrepresented groups for the research opportunities.

Building on previous research in seagrass environments, this research will conduct a series of field experiments approach at novel, yet relevant scales, to test how habitat area and fragmentation affect fish diversity and productivity. Specifically, 15 by 15-m seagrass beds will be created using artificial seagrass units (ASUs) that control for within-patch-level (~1-10 m2) factors such as shoot density and length. The investigators will employ ASUs to manipulate total habitat area and the degree of fragmentation within seagrass beds in a temperate estuary in North Carolina. In year one, response of the fishes that colonize these landscapes will be measured as abundance, biomass, community structure, as well as taxonomic and functional diversity. Targeted ASU removals will then follow to determine species-specific responses to habitat disturbance. In year two, the landscape array and sampling regime will be doubled, and half of the landscapes will be seeded with post-larval fish of low dispersal ability to test whether pre- or post-recruitment processes

drive landscape-scale patterns. In year three, the role of wave exposure (a natural driver of seagrass fragmentation) in mediating fish community response to landscape configuration will be tested by deploying ASU meadows across low and high energy environments.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1635950

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