Relative crab mortality (binomial) data from a tethering experiment in summer 2017 in Back Sound, North Carolina

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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
Relative crab mortality (binomial) data from a tethering experiment in summer 2017 in Back Sound, North Carolina.

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Coverage

Spatial Extent: **N**:34.703251 **E**:-76.526267 **S**:34.651056 **W**:-76.587826
Temporal Extent: 2017-06-09 - 2017-07-13

Dataset Description

Relative crab mortality (binomial) data from a tethering experiment in summer 2017 in Back Sound, North Carolina.

Acquisition Description

For Table and Figure references below, see the document "PredationAssay_statistical_analysis.pdf" in the Supplemental Files section.

Study Site Selection

We conducted our study across eight discrete seagrass meadows (hereafter referred to as landscapes) located in Back Sound, North Carolina (NC), USA (3442′ N to 3439′ N, 7637′ W to 7631′ W) (Fig. S1). All of our sampled landscapes were composed of a mixture of Back Sound's dominant seagrasses: eelgrass and shoal grass, Halodule wrightii (Ascherson 1868) (Yeager et al. 2016). Landscapes were chosen based upon available aerial imagery in Google Earth Pro as of February 19, 2017, and ground-truthed for changes in seasonal seagrass growth/senescence using summer, 2017, drone photography and ImageJ 1.x (Schneider et al. 2012). No discernable differences in landscape fragmentation states (e.g. total area, number of patches) were found between the two aerial imagery sources. All landscapes were relatively shallow (1-1.5 m depth at high tide), reasonably isolated from other seagrass beds (distance to nearest seagrass meadow = 112 17 m [mean standard error]) and were appropriately sized to encompass short-term (e.g., daily, monthly) movements of common seagrass-associated fauna in this system (Yeager et al. 2016). We identified similarly sized landscapes (25882 6592 m2) available in Back Sound by defining the minimum convex polygon surrounding the seagrass meadow, regardless of the total seagrass cover within the polygon. Among eight candidate landscapes of similar size, we defined four continuous landscapes and four fragmented landscapes based on the number of patches, the perimeter-to-area ratio, and the largest patch's percent cover of the total seagrass area (Table 1). Seagrass fragmentation is often naturally coupled with habitat loss (Wilcove et al. 1986), resulting in the mean seagrass area of our fragmented landscapes being nearly half that of our continuous landscapes (Table 1). Thus, our experiment was designed to examine the effects of fragmentation (i.e., the breaking apart of habitat concomitant with habitat loss) rather than fragmentation per se (i.e., the breaking apart of habitat without habitat loss; sensu Fahrig 2003).

Predation Assays

Relative predation (i.e., mortality) was measured using tethered juvenile blue crabs (Callinectes sapidus Rathbun) of carapace widths 10-40 mm. Tethering is commonly used to measure relative predation on juvenile blue crabs (Wilson et al. 1990; Hovel and Lipcius 2001). We note that tethering cannot be used to determine absolute predation rates, as tethered prey have restricted flee potential, generally raising the incidence of predation (Peterson and Black 1994). Still, when interpreted conservatively, tethering data can elucidate differences the relative directionality of environmental factors affecting prey survival (i.e., positive or negative effects). Juvenile blue crabs were chosen for tethering due to their economic and ecological importance to coastal regions (McCann et al. 2017) and because they have served as a model prey organism in several previous studies of related design (e.g., Hovel and Lipcius 2001, 2002; Mahoney et al. 2018).

Crab predation assays were run from June to July as this was the period during which we could obtain sufficient numbers of appropriately sized crabs for our experiment. All juvenile blue crabs were captured in seine nets from Oyster Creek, NC (3449'19"N, 7627'07"W). Crabs were glued (active ingredient cyanoacrylate) to 30-cm segments of 12-lbs test monofilament. We chose to use 30-cm segments of monofilament for tethers to allow crabs to exhibit natural burrowing behavior (Hovel and Fonseca 2005), mitigating some tethering artifacts of prey visibility (Peterson and Black 1994). Tethered crabs were attached to 60-cm long, 0.5-cm diameter, fiberglass stakes with attached floats for easy relocation. Once tethered, crabs were held overnight as a check for attachment integrity, and then deployed across our landscapes on the following day.

Twenty tethered crabs were deployed (stakes pushed completely into the sediment) in each continuous and fragmented landscape per predation assay date. Within each landscape, 10 tethered crabs were haphazardly placed within seagrass edges, defined as 30 cm (a tether length) from the seagrass-mudflat interface. The other 10 tethered crabs were haphazardly placed in seagrass interiors, defined as ≥1 m from the seagrass-mudflat interface. Only patches with a radius of 1 m or larger were used for tethers classified as 'interior'. However, patches with a radius of <1 m were used for a portion of our 'edge' tethers. All tethers were placed at least 1 m apart. We returned to landscapes at 1 h and 24 h to check crab status (live, eaten). All missing crabs were presumed eaten, as no crabs escaped tethers during the 24-h holding period. After 24 h, any remaining live crabs were removed from tethers and released. Crab tethering cycles were repeated four times in 2017 (June 9, June 14, July 5, and July 13). On July 13, only half of the continuous and fragmented landscapes were included in tethering assays due to a lack of crab availability. A total of 550 tethered juvenile blue crabs were deployed during our trials (see Table S1 for full sampling schedule and assay sample sizes).

Point measurements of water temperature (C) were taken in each landscape at the location and time of all tethering assays and faunal sampling using hand-held thermometers (Table S1). We chose temperature as our seasonality proxy (Fig. S2) because several other seasonally affected factors including faunal densities correlate with water temperature variability. Additionally, the measurement of temperature is easy, cheap, reliable, and comparable to previous studies.

Tether materials:
EcoStakes – tomato plant stakes
Locktite glue
12-lbs test monofilament fishing line
Pool noodles – cut into rounds for tether relocation floats
Hand-held digital thermometer- LYNCH Waterproof thermometer 39240
Hand-held refractometer-VEE GEE STX-3 Salinity 0-100‰
Hand-held Garmin GPSmap 78
Electronic calipers – INOX waterproof IP54

Processing Description

Data processing: All data were entered electronically into an Excel spreadsheet.

BCO-DMO Data Manager Processing Notes:
* exported submitted excel file to csv format
* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions
* date format converted to ISO 8601 standard format yyyy-mm-dd
* cells with just a period as a value replaced will no-data values. No-data values in this dataset are displayed as the missing data identifier "nd" for "no data" in the BCO-DMO system.
* added ISO_DateTime_ISO_In from local date and time in columns.
* commas in comments replaced with semicolons to support csv output

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Related Publications

Fahrig, L. (2003). Effects of Habitat Fragmentation on Biodiversity. Annual Review of Ecology, Evolution, and Systematics, 34(1), 487–515. doi:10.1146/annurev.ecolsys.34.011802.132419

Hovel, K. A., & Lipcius, R. N. (2001). HABITAT FRAGMENTATION IN A SEAGRASS LANDSCAPE: PATCH SIZE AND COMPLEXITY CONTROL BLUE CRAB SURVIVAL. Ecology, 82(7), 1814–1829. doi:10.1890/0012-9658(2001)082[1814:HFIASL]2.0.CO;2

Hovel, K. A., & Lipcius, R. N. (2002). Effects of seagrass habitat fragmentation on juvenile blue crab survival and abundance. Journal of Experimental Marine Biology and Ecology, 271(1), 75–98. doi:10.1016/S0022-0981(02)00043-6

Hovel, K., & Fonseca, M. (2005). Influence of seagrass landscape structure on juvenile blue crab habitat-survival function. Marine Ecology Progress Series, 300, 179–191. doi:10.3354/meps300179

Mahoney, R. D., Kenworthy, M. D., Geyer, J. K., Hovel, K. A., & Joel Fodrie, F. (2018). Distribution and relative predation risk of nekton reveal complex edge effects within temperate seagrass habitat. Journal of Experimental Marine Biology and Ecology, 503, 52–59. doi:10.1016/j.jembe.2018.02.004

McCann, M. J., Able, K. W., Christian, R. R., Fodrie, F. J., Jensen, O. P., Johnson, J. J., … Ziegler, S. L. (2017). Key taxa in food web responses to stressors: theDeepwater Horizonoil spill. Frontiers in Ecology and the Environment, 15(3), 142–149. doi:10.1002/fee.1474

Peterson, C., & Black, R. (1994). An experimentalist's challenge: when artifacts of intervention interact with treatments. Marine Ecology Progress Series, 111, 289–297. doi:10.3354/meps111289

R Core Team (2016) R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria. https://www.R-project.org

Schneider CA, Rasband WS, Eliceiri KW (2012) NIH Image to ImageJ: 25 years of image analysis. Nat Methods 9:671-675, PMID 22930834.

Wilcove DS, McLellan CH, Dobson AP (1986) Habitat fragmentation in the temperate zone. In: Soule ME (ed) Conservation Biology, Sinauer, Sunderland, MA pp 237–256. https://www.fws.gov/southwest/es/documents/r2es/litcited/lpc_2012/wilcove_et_al_1986.pdf

Wilson KA, Able KW, Heck KL Jr (1990) Habitat use by juvenile blue crabs: a comparison among habitats in southern New Jersey. Bull Mar Sci 46:105–114

Yeager, L. A., Keller, D. A., Burns, T. R., Pool, A. S., & Fodrie, F. J. (2016). Threshold effects of habitat fragmentation on fish diversity at landscapes scales. Ecology, 97(8), 2157–2166. doi:10.1002/ecy.1449

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Parameters

Parameter	Description	Units
Date	Date tethered crab deployed in ISO 8601 format yyyy-mm-dd	unitless

SiteID	Name of seagrass bed in which tether was deployed	unitless
C_F	Fragmentation state of seagrass bed: C = Continuous, F = Fragmented	unitless
lat	Latitude	decimal degrees
lon	Longitude	decimal degrees
AirTemp_C	Air temperature at time and place of tether deployment	degrees Celsius (C)
WaterTemp_C	Water temperature at time and place of tether deployment	degrees Celsius (C)
Salinity_PSU	Salinity of water at time and place of tether deployment	Practical Salinity Units (PSU)
Depth_m	Depth of water at time and place of tether deployment	meters (m)
HighTide	Time of high tide at place of tether deployment	unitless
LowTide	Time of low tide at place of tether deployment	unitless
TimeInFromHigh	At time of tether deployment, time passed since high tide	unitless
Tide	At time of tether deployment, ebb or flow tide	unitless
Bobber_Num	Individual ID number of tether (numbers may be repeated across dates)	per individual
CW_mm	Carapace width (measured from spine to spine of crab)	millimeters (mm)
Claw_Num	Number of claws the crab had intact at time of tethering	per individual claw
E_I	Position of tether deployment with seagrass bed; E = edge (≤0.3 m from seagrass/mudflat interface), I = Interior (>1 m from seagrass/mudflat interface)	unitless

TimeIn	Local time of tether deployment [EDT][GMT-4h] in format h:mm	unitless
TimeOut	Local time of tether removal [EDT][GMT-4h] in format h:mm	unitless
hr1	Status of crab on tether at 1 hour from deployment time; 1 = live/present, 0 = dead/missing	unitless
hr24	Status of crab on tether at 24 hours from deployment time; 1 = live/present, 0 = dead/missing	unitless
ISO_DateTime_UTC_In	Date Time (UTC) in ISO 8601 format yyyy-mm-ddTHH:MMZ	unitless
Notes	Notes relevant to individual tether	unitless

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Instruments

Dataset-specific Instrument Name	INOX waterproof IP54
Generic Instrument Name	unknown
Dataset-specific Description	Electronic calipers – INOX waterproof IP54
Generic Instrument Description	No relevant match in BCO-DMO instrument vocabulary.

Dataset-specific Instrument Name	VEE GEE STX-3
Generic Instrument Name	Refractometer
Dataset-specific Description	Hand-held refractometer-VEE GEE STX-3 Salinity 0-100‰
Generic Instrument Description	A refractometer is a laboratory or field device for the measurement of an index of refraction (refractometry). The index of refraction is calculated from Snell's law and can be calculated from the composition of the material using the Gladstone-Dale relation. In optics the refractive index (or index of refraction) n of a substance (optical medium) is a dimensionless number that describes how light, or any other radiation, propagates through that medium.

Dataset-specific Instrument Name	Hand-held Garmin GPSmap 78
Generic Instrument Name	GPS receiver
Generic Instrument Description	Acquires satellite signals and tracks your location.

Dataset-specific Instrument Name	LYNCH Waterproof thermometer 39240
Generic Instrument Name	Thermometer
Dataset-specific Description	Hand-held digital thermometer- LYNCH Waterproof thermometer 39240

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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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