Relative growth rate of Gracilaria with depth below the water surface in Charleston Harbor, South Carolina in 2013 (Gracilaria effects project)

Website: https://www.bco-dmo.org/dataset/641628
Data Type: Other Field Results
Version:
Version Date: 2016-04-07

Project
» Cascading effects of an invasive seaweed on estuarine food webs of the southeastern US (Gracilaria effects)

Contributors	Affiliation	Role
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Coverage

Spatial Extent: **N**:32.78144 **E**:-79.90142 **S**:32.75131 **W**:-79.96291

Methods & Sampling

Study sites
We conducted field surveys and experiments near Charleston, South Carolina (SC) (Fort Johnson: 32.751305°N, 79.90142°W; Stono River: 32.75253°N, 80.0076° W) and Savannah, Georgia (GA) (Priest's Landing: 31.96012° N, 81.01223°W; Bull's River: 31.97458°N, 80.92287°W) in the USA. The hydro- dynamic forces in southeastern estuaries generate high turbidity and fluid soft sediments which reduce light attenuation and thus create a habitat that is largely inhospitable to macrophyte attachment and persistence (Byers et al. 2012 and references therein). Gracilaria invaded SC and GA estuaries in the early 2000s (E. E. Sotka unpubl. data), and on intertidal mudflats where Diopatra worms are common, Gracilaria presently represents 90-99% of the total macroalgal biomass (Byers et al. 2012). The green alga Ulva sp. can be found in colder months and attached to oyster shells, wooden debris, the hard calcareous tubes of the soda-straw worm and only rarely on Diopatra tubes (Berke 2012; N. M. Kollars, E. E. Sotka & C. Plante pers. obs.). Other macroalgae present in the system include red algae that are epiphytic on Gracilaria (of the genera Polysiphonia and Ceramium; Berke 2012, C. E. Gerstenmaier and E. E. Sotka pers. obs.) and rarely, Gracilaria tikvahiae (Berke 2012, N. M. Kollars & E. E. Sotka pers. obs.). The non-native Gracilaria and native Diopatra are both rare within the salt marshes and oyster beds that fringe the upper-intertidal edge of these mudflats. We performed all laboratory experiments within the Grice Marine Laboratory (College of Charleston, SC, USA). See related reference for citations.

Tidal growth

We measured the growth of Gracilaria at 3 tidal heights of the Fort Johnson mudflat (‘high’, approx. +0.61 m MLLW; ‘mid’ approx. +0.09 m MLLW; and ‘low’ approx. -0.02 to -0.09 m MLLW) during the spring (March-April; n = 3 per tidal height), summer (July-August, n = 5 per tidal height), and fall (September- October, n = 8 per tidal height) of 2013. At each tidal height, we strung a 3.00 g (± 0.05, acceptable range of variation) blotted wet mass piece of Gracilaria (predominantly collected from the mid-intertidal at ~0.0 m MLLW) through the end of a 15 cm piece of a 0.76 cm diameter 3-strand rope, attached the rope to a 30 cm long × 0.76 cm diameter PVC-post, and drove the post into the sediment until the seaweed laid on the surface of the benthos (see photograph of a replicate before transplantation in Supplement 1A at http://www.int-res.com/articles/suppl/m545p135_supp/). During the spring assay, we enclosed the seaweed within flexible mesh bags (1.5 cm mesh size) constructed from wildlife fencing and zipties to protect the biomass from potential loss due to water flow. We observed few broken-off Gracilaria fragments present in the bags at the end of the spring assay, and therefore, we did not enclose the seaweed in the summer or fall assays. After 4-6 wk, we recovered and defaunated the seaweed and calculated change in wet mass as relative growth rate per week (hereafter RGR; Hoffmann & Poorter 2002).

To measure Gracilaria growth along a water-depth gradient of the subtidal zone, we weaved seaweed pieces of 3.00 g (± 0.05, acceptable range of variation) blotted wet mass through rope and attached the rope pieces (n = 5) at 2.5 m intervals along a 10 m rope strung vertically between a surface buoy and a cement block. We enclosed the seaweed within mesh bags (1.5 cm mesh size) as in the spring intertidal assay. We lowered the buoy-rope-block system onto the benthos at 9 replicate locations of ~10 m depth (at high tide) in Charleston Harbor within 7.3 km of the Fort Johnson site. With this design, the pieces of seaweed at the ‘0 m’ mark remained just below the surface of the water, regardless of fluctuations in tidal height. Because Charles ton Harbor has an average tidal range of ~2 m, the other 4 chosen depths fluctuated with the tidal cycle and the true depth ranges were estimated at 0.5-2.5, 3-5, 5.5-7.5, and 8-10 m. After 8 wk (February through April 2013), we recovered and defaunated the seaweed pieces, measured blotted wet mass, and calculated RGR as before.

Related Reference:
Kollars, N.M., J.E. Byers and E.E. Sotka (2016) Invasive decor: an association between a native decorator worm and a non-native seaweed can be mutualistic. Marine Ecology Progress Series (DOI: 10.3354/meps11602)

Related Datasets:
MEPS_2016: Fig.2A - survey
MEPS_2016: Fig.2B - Gracilaria growth rate
MEPS_2016: Fig.4A - worm growth
MEPS_2016: Fig.4B - stable isotopes
MEPS_2016: Fig.5A - field expt 2012
MEPS_2016: Fig.5B - field expt 2013

Data Processing Description

Because the residuals of the field survey and the intertidal and subtidal RGR assays were non-normally distributed, we analyzed differences among factors with non-parametric permutation tests and 1000 permutation replicates (Anderson 2001). We removed from analyses replicates in which all seaweed biomass was lost during the experiment (only 4% of replicates per assay) under the assumption that any biomass loss was due to methodological errors rather than a reflection of habitat conditions. In the intertidal RGR assay, we tested the interaction between season and tidal height with unrestricted data (Anderson 2001). Post-hoc significant differences were determined using a series of pairwise permutation tests. All statistical analyses were performed in R (version 2.15.1; R Core Team 2012). See related reference for citations.

BCO-DMO Processing:
- added conventional header with dataset name, PI name, version date, reference information
- renamed parameters to BCO-DMO standard
- replaced NA with nd
- added lat and lon

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Data Files

File
Kollars_fig3.csv (Comma Separated Values (.csv), 1.01 KB) MD5:e5f0169b94c7925a19ed760b5cfd4374 Primary data file for dataset ID 641628

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Parameters

Parameter	Description	Units
site	positions in Charleston Harbor SC: FJ= Fort Johnson; WA=Wappoo Cut; N17= North 17	unitless
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
buoy	buoy replicate	unitless
depth	average depth from the surface	meters
wetmass	final wet mass of field-outplanted experimental units with an initial mass of 3.00 g	grams
RGR	relative growth rate	percent per week

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Instruments

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

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Deployments

Sotka_2013

Website	https://www.bco-dmo.org/deployment/641612
Platform	Coll_Charleston
Start Date	2012-01-01
End Date	2013-12-31
Description	Benthic interactions of polychaetes and macroalgae

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Project Information

Cascading effects of an invasive seaweed on estuarine food webs of the southeastern US (Gracilaria effects)

Coverage: Georgia and South Carolina coasts

Description from NSF award abstract:
During the last decade, the Asian seaweed, *Gracilaria vermiculophylla*, has proliferated along high-salinity mudflats in several Georgia and South Carolina estuaries. The invasion is noteworthy because the mudflats in these estuaries were historically devoid of macrophyte-based primary production and structure. *Gracilaria* has few native analogues in these mudflat environments, and thus represents an opportunity to examine the ecosystem consequences of an invasion within an historically-unexploited niche. In theory, *Gracilaria* affects populations of species that are directly dependent on the invader for structure and food, as well as altering community- and ecosystem-level processes such as detrital production and food web structure. Through a combination of manipulative field experiments, laboratory assays and stable isotope analysis, the investigators will test three mechanisms by which *Gracilaria* influences native community structure. The novel structure and primary production generated by *Gracilaria vermiculophylla* may be 1) increasing rates of secondary production, 2) increasing levels of mudflat microbial production through leeching of dissolved nutrients, and 3) increasing detrital input to microbial and macrobial food webs.

This project will provide a mechanistic understanding of the multiple cascading impacts of an invasive species within the estuarine community. Species invasions that alter ecosystem functions are usually the most profound. These alterations are often generated by a small number of invaders that create physical structure, including important biogenic habitat, de novo. By altering physical structure, these non-native ecosystem engineers alter local abiotic conditions, interactions between species, and species composition. Highly influential invaders may also change food web structure and trophic flow of energy and materials. Such substantive food web changes can occur when an influential invader provides nutrients or resources that are different in quality, quantity or both. An invasive species that both provisions new physical structure and fundamentally alters food web structure could exert an overwhelming influence on native communities when these mechanisms act in synergy.

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Funding

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NSF Division of Ocean Sciences (NSF OCE)	OCE-1057707
NSF Division of Ocean Sciences (NSF OCE)	OCE-1057713

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