Gray's Reef National Marine Sanctuary: Connectivity

Bibliography

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Background & Scope

Gray's Reef National Marine Sanctuary (GRNMS) protects 22 square miles of ocean off the coast of Sapelo Island, Georgia. The vibrant live bottom reef provides habitat for hundreds of ecologically and economically important species. Given the relatively small size of the sanctuary, its biological community is likely dependent on the site's ecological connectivity (the exchange of organisms among populations and locations) to other locations. It is also likely that the sanctuary provides a source of organisms to other areas in the region, making it an important part of the larger ecosystem.

Given the importance of connectivity to GRNMS, the 2014 GRNMS Management Plan outlined an objective to evaluate potential areas outside GRNMS that may have connectivity with GRNMS and may benefit from increased protection. The first step in evaluating this connectivity is to review and synthesize existing knowledge related to ecological connectivity at Gray's Reef in terms of physical oceanographic processes, phyto- and zooplankton distribution, Sargassum, eggs and larvae of invertebrates and fish, reef and demersal fish species, highly migratory species (including coastal sharks, tuna, and billfish), reptiles, and marine mammals. Thus, this annotated bibliography serves as an important supplement to previous reviews on this subject and a vital contribution to the analysis of ecological connectivity at GRNMS.

Sources Reviewed

The following databases were used to identify sources: Clarivate Analytics' Web of Science: Science Citation Index Expanded and Social Science Index; Science.gov; ProQuest's Science and Technology including Aquatic Science Fisheries Abstracts; Elsevier's Science Direct; JSTOR; EBSCO's Academic Search Complete and Environment Complete; NOAA's Institutional Repository; the Biodiversity Heritage Library; BioOneComplete; and Google Scholar.

2019

Burton, M. L., Potts, J. C., Poholek, A. J., Ostrowski, A., & Page, J. (2019). Age, Growth, Natural Mortality, and Reproductive Seasonality of Knobbed Porgy from Southeastern United States Waters. *Marine and Coastal Fisheries, 11*(2), 231-245 https://doi.org/10.1002/mcf2.10074

The Knobbed Porgy Calamus nodosus, an important secondary species in reef fish catches of the southeastern United States, was recently the subject of a fishery closure due to the porgy complex quota being exceeded. Knobbed Porgy (n=448) were aged using sectioned sagittal otoliths. Opaque zones on otolith sections were annular, forming in March-July (peaking in May). Knobbed Porgy ranged from 1 to 21years, and the largest fish measured 507mm TL. Body size relationships relating TL, FL, and total body weight (W) for Knobbed Porgy were TL=1.07·FL+22.93 (n=3,173;r(2)=0.97), FL=0.91·TL-12.54 (n=3,173;r(2)=0.97), W=(1.38x10(-5))TL3.03 (n=12,732; r(2)=0.92), and W=(7.99x10(-5))FL2.79 (n=3,199; r(2)=0.90). Mean length at age was significantly differentbetween Knobbed Porgy collected in North Carolina through southeast Florida (northern region) and those collected in the Florida Keys (southern region). The von Bertalanffy growth equations for Knobbed Porgy were L-t=412[1-e(-0.20(t+1.97))] (n=448) for all regions combined, L-t=403[1-e(-0.38(t+0.0001))] (n=117) for northern region fish, and L-t=326[1-e(-0.42(t+1.61))] (n=331) for southern region fish. Age-varying estimates ofnatural mortality were 0.36-0.79year(-1) (ages 2-21) for the northern region and 0.42-0.67year(-1) (ages 1-12) for fish from the Florida Keys. Hydrated oocytes were present during February-April in macroscopically staged ovaries (n=148) for fish from the Florida Keys, and gonadosomatic index data indicated that the month of peak spawning in females was April. The updated life history information should be useful to fishery managers in formulating effective management strategies.

Campanella, F., Auster, P. J., Taylor, J. C., & Muñoz, R. C. (2019). Dynamics of Predator-Prey Habitat Use and Behavioral Interactions over Diel Periods at Sub-Tropical Reefs. *PLOS ONE, 14*(2), e0211886 https://doi.org/10.1371/journal.pone.0211886

The dynamics of fish communities at tropical and sub-tropical rocky reefs are influenced in many cases by predation activity and predator-prey interactions. These processes usually follow specific diel patterns in reef areas with higher rates of these interactions occurring during the crepuscular periods. However, other factors such as habitat complexity and species-specific behavior may alter these patterns, increasing variability in species interactions. A better understanding of the dynamics of these patterns and processes would allow us to manage and monitor fish communities in these productive and vulnerable areas more efficiently. We investigated behavioral changes of predators and prey fish in sub-tropical “live-bottom” (sandstone) reefs at Gray’s Reef National Marine Sanctuary (GRNMS), located 20 nautical miles off the coast of Georgia, USA, using fisheries acoustic methods in association with visual census and direct observation using SCUBA. Changes in co-location and habitat preferences of predators and prey over time throughout the diel cycle were investigated using species distribution models (MAXENT) based on habitat predictors and by means of spatial statistics. The results indicate that predator and prey distribution patterns changed considerably throughout the day. Prey and predator species exhibited complex spatial dynamics and behavior over diel periods, with prey modifying patterns of habitat use and spatial distribution, likely as a response of their interactions with predators. Crepuscular periods were confirmed to be the most active phases in terms of predator-prey interactions and consequently the most variable. The combination of tools and approaches used in this study provided valuable sources of information that support the inferences of predation risk-driven habitat selection of prey in this sub-tropical reef system.

Evans, D. R., Carthy, R. R., & Ceriani, S. A. (2019). Migration Routes, Foraging Behavior, and Site Fidelity of Loggerhead Sea Turtles (*Caretta caretta*) Satellite Tracked from a Globally Important Rookery. *Marine Biology, 166*(10), 1-19 https://doi.org/10.1007/s00227-019-3583-4

The Archie Carr National Wildlife Refuge, Florida, USA (27.946°N, − 80.494°W) represents one of the largest loggerhead turtle (*Caretta caretta*) nesting sites in the Western Hemisphere. Surprisingly, little work has been conducted to determine females' post-nesting migratory behavior and characteristics of their foraging areas. Between 2008 and 2017, satellite telemetry was used to trace the locations and movements of 45 post-nesting loggerhead turtles. A switching state-space model was employed to estimate the behavioral state of each location. Internesting, migrating and foraging activity periods were determined for 38 loggerheads based on the SSSM. Seven environmental variables were extracted from remote sensing imagery for each location to compare values among behaviors. Core primary foraging areas ranged in size from 5.89 to 4572.80 km2. Four foraging types (primary, secondary, seasonal, and loops) were observed. Most turtles resided at a primary foraging area year round. A few individuals conducted foraging loops away from a primary foraging area. Both seasonal and loop movements were associated with changes in sea surface temperature as turtles moved to avoid temperatures that could cause cold-stunning or mortality. Turtle size and nesting beach offshore currents may play a role in foraging area selection, and date of departure from the nesting beach may be linked to foraging destination. By making the connection among oceanic features, foraging areas, and the influence of environmental variables on these areas, it is possible to identify and characterize critically important feeding areas and migration corridors for loggerheads nesting on the east coast of Florida.

Hensel, E., Allgeier, J. E., & Layman, C. A. (2019). Effects of Predator Presence and Habitat Complexity on Reef Fish Communities in the Bahamas. *Marine Biology, 166*(10), 1-9 http://dx.doi.org/10.1007/s00227-019-3568-3

Reef ecosystems are highly diverse habitats that harbor many ecologically and economically significant species. Yet, globally they are under threat from multiple stressors including overexploitation of predatory fishes and habitat degradation. While these two human-driven activities often occur concomitantly, they are typically studied independently. Using a factorial design, we examined effects of predator presence, habitat complexity, and their interaction on patch reef fish communities in a nearshore ecosystem on Great Abaco Island, The Bahamas. We manipulated the presence of Nassau groupers (Epinephelus striatus), a reef predator that is critically endangered largely due to overharvest, and varied patch reef structure (cinder blocks with and without PVC) to reflect high or low complexity-four treatments in total. To assess changes in fish community composition we measured fish abundances, species richness, and evenness. We found that predators present and high reef complexity had an additive, positive effect on total fish abundance: fish abundance increased by ~ 250% and 300%, compared to predators absent and low complexity reef treatments, respectively. Species richness increased with reef complexity. Variation in community structure was explained by the interaction between factors, largely driven by juvenile Tomtate grunt (Haemulon aurolineatum) abundances. Specifically, Tomtate grunt abundance was significantly higher on high complexity reefs with predators present, but on low complexity reefs predators present had no effect on Tomtate grunt abundance. Our data suggest that both fisheries management of large-bodied piscivores and reef habitat restoration are critical to the management and conservation of reef ecosystem functions and services.

Meadows, M. (2019). *Examining Spatial and Trophic Ecology of Bahamian Stingrays, Styracura schmardae and Hypanus americanus, Using Stable Isotope Analysis.* Masters Thesis, University of Exeter, Retrieved from http://hdl.handle.net/10871/36567

In this thesis I use stable isotope analysis to investigate the spatial and dietary ecology of two species of tropical stingray, the southern stingray (Hypanus americanus) and the Caribbean whiptail ray (Styracura schmardae) from Eleuthera island, The Bahamas. In Chapter 1, I directly compare stable isotopes of carbon, nitrogen and sulphur between the two species (S. schmardae, n = 96 ; H. americanus, n = 102) to investigate if and how these sympatric stingrays exhibit resource partitioning. I show that mangrove creek systems may be important habitat for S. schmardae, mitigating competition with H. americanus, and that trophic resource partitioning may also be occurring, with H. americanus feeding at a higher trophic level than S. schmardae. In Chapter 2, I explore the use of stable isotope analysis in detecting ontogenetic shifts in H. americanus (n = 110) and S. schmardae (n = 94). Here, I use breakpoint analysis to pinpoint shifts in mean δ15N and δ13C as body size increases, on three metabolically distinct tissues, which therefore give insights into different time periods: whole blood, white muscle and cartilage (barb). There were four breakpoints in white muscle samples, two in blood and in cartilage only one. We recommend that future research determining ontogenetic shifts via stable isotopes utilise this range of tissues. Breakpoints in δ13C were observed in both species, indicating ontogenetic habitat shifts occurring at juvenile sizes. A second shift was detected at larger body sizes in both δ15N and δ13C for S. schmardae, we suggest this second ontogenetic niche shift indicates a return to mangroves and concurrent increase in higher trophic level prey by adults. The findings presented in this thesis are novel for both species, emphasising the significance of mangroves habitats as well as providing the first ever assessment of resource use by the poorly studied Caribbean whiptail ray. Findings could be used to build conservation frameworks to protect southern stingrays, Caribbean whiptail rays, and the mangroves that appear to be intrinsic to their ecology.

Miller, M. J., Marohn, L., Wysujack, K., Bonhommeau, S., Kuroki, M., Freese, M., . . . Hanel, R. (2019). Larval Size-Distributions of Ariosoma Balearicum Cryptic Species During the March–April Season in the Sargasso Sea Subtropical Convergence Zone. *Environmental Biology of Fishes, 102*(10), 1231-1252 http://dx.doi.org/10.1007/s10641-019-00900-8

Leptocephali of the shallow-water congrid eel Ariosoma balearicum are abundant during February–April in the Sargasso Sea, and larval and adult meristic data indicates this species includes several regional subpopulations/cryptic species. Four multiple-transect larval surveys (2011, 2014, 2015, 2017) were used to examine the geographic size distribution of two myomere-count types of A. balearicum leptocephali. High-count (HC) larvae were consistently mostly between 80 and 100 mm in size (60–132 mm; 87.9 ± 6.8 mm) as observed previously, and frequently had narrow size ranges. The usually larger LC larvae (78–176 mm; 111.4 ± 26.7 mm) were more abundant in western or central areas. HC larvae tended to decrease in size from west to east and increase from south to north. Catch rates were geographically variable relative to hydrographic structure/frontal positions across the wide 2015 sampling area. Mitochondrial 16 s rRNA sequences of HC and LC larvae show species-level differences, providing evidence of the existence of two cryptic species with different larval dispersal strategies in the Sargasso Sea subtropical gyre region. The HC larvae disperse widely into the gyre, seemingly through Gulf Stream recirculation or eastward frontal-jet flows, and apparently must use directional swimming

to cross the Florida Current to recruit into the South Atlantic Bight. LC leptocephali may mostly be retained near the Bahamas, with few larvae dispersing into the gyre. This seems to indicate natural selection occurred for spawning location and larval behavior due to the powerful Florida Current/Gulf Stream, resulting in two completely different spawning and larval dispersal strategies within a local geographic region.

Richards, V. P., DeBiasse, M. B., & Shivji, M. (2019). Deep Mitochondrial Lineage Divergence among Populations of the Southern Stingray (Hypanus americanus (Hildebrand & Schroeder, 1928)) Throughout the Southeastern United States and Caribbean. *Marine Biodiversity, 49*(4), 1627-1634 https://doi.org/10.1007/s12526-018-0930-5

Although over half of all known elasmobranchs are batoids, with many species exploited and several of conservation concern, little is known of their population genetic structure and micro-evolutionary history. Here, we used sequence variation in 648 bp of the mitochondrial control region to study the phylogeography of the southern stingray (Hypanus americanus (Hildebrand & Schroeder, 1928)) (previously Dasyatis americana) throughout the Carolinas, Florida, and the Caribbean. Out of 267 individuals sampled from eight locations, 67 haplotypes were identified and analysis of molecular variance revealed a high level of genetic partitioning (phi(ST) = 0.49; P < 0.00001) that was delineated into three geographic regions: (i) the USA and Belize, (ii) the Bahamas and the West Indies, and (iii) Grand Cayman Islands. Phylogenetic and statistical parsimony analyses identified three divergent lineages that were largely concordant with the population structure. However, the geographic distribution of haplotypes described a complex phylogeographic pattern with numerous haplotypes from the divergent lineages co-occurring at the same sampling site. The strong genetic partitioning detected for the Grand Cayman population suggests that this small and isolated population might warrant individualized conservation management.

Sandoval Laurrabaquio-A, N., Islas-Villanueva, V., Adams, D. H., Uribe-Alcocer, M., Alvarado-Bremer, J. R., & Díaz-Jaimes, P. (2019). Genetic Evidence for Regional Philopatry of the Bull Shark (Carcharhinus leucas), to Nursery Areas in Estuaries of the Gulf of Mexico and Western North Atlantic Ocean. *Fisheries Research, 209*, 67-74 https://doi.org/10.1016/j.fishres.2018.09.013

Nursery areas are critical for the reproductive cycle and biological requirements of Bull Sharks (Carcharhinus leucas) as they increase the survival of populations. Females tend to be philopatric to these areas as documented in estuaries from Australia, and inferred in the northern Gulf of Mexico and western North Atlantic Ocean, but not yet confirmed in these regions. In coastal waters of the southeastern United States, several sites have been proposed as nurseries for the Bull Shark, but little is known about how adult females utilize these areas during parturition. Philopatry for the Bull Shark was evaluated by comparing sequences of the mitochondrial DNA control-region (mtDNA-CR) and 8 microsatellite loci in juveniles and neonates from four previously reported nursery areas in United States (US) coastal waters; three in the northern Gulf of Mexico (Texas, Louisiana and Charlotte Harbor, Florida) and one in the western North Atlantic Ocean (Indian River Lagoon, Florida). A group of adult individuals from the Gulf of Mexico and Atlantic Ocean off the southeastern US were used to test genetic differences owed to limited gene flow between both regions. The analysis of genetic variation with the mtDNACR showed no differences among nurseries within the Gulf but significant differences when comparing the nursery areas of the two regions (Gulf vs Atlantic). In contrast, genetic homogeneity was observed among nursery areas within and between regions with the nuclear

microsatellites suggesting male biased dispersal among regions. In addition, adult individuals from each of these two broad regions (Gulf of Mexico and Atlantic Ocean) showed no significant differentiation with any of the markers characterized in this study. These patterns of genetic differences support evidence for philopatry, further relaying the importance of protection and effective management of critical nursery habitats for future conservation of the species.

Shein, K., J. Cavanaugh, H. Scalliet, S. Hutto, K. Roberson, B, S., & Wenzel, L. (2019). *Rapid Vulnerability Assessment for Gray's Reef National Marine Sanctuary.* Office of National Marine Sanctuaries ONMS-19-01. Retrieved from https://purl.fdlp.gov/GPO/gpo116181

Gray's Reef National Marine Sanctuary (GRNMS) is a 22 sq. mile (5700 ha) marine protected area approximately 17 nautical miles (31 km) east of the Georgia coast, and is part of the National Marine Sanctuary System. It is home to one of the largest "live bottom" reef systems in the southeast United States. Gray's Reef is currently experiencing changing environmental conditions, and climate projections to 2100 suggest that these changes will continue and likely accelerate. The sensitivity of marine species at Gray's Reef to these changes (i.e., vulnerability) and their ability to acclimate to these changes (i.e., resilience) will define the sustainability of the sanctuary as a viable marine habitat in coming decades. In November 2017, GRNMS convened an expert workshop to assess the climate vulnerability of nine key species that occur within the sanctuary, with participants identifying two additional species for post-workshop assessments. Participants were provided information about the current and projected climate conditions of the sanctuary and applied this to their knowledge of each species and its capacity to adapt to changing conditions. They used a modified version of the Commission for Environmental Cooperation's North American Marine Protected Area Rapid Vulnerability Assessment tool to transform this knowledge into a vulnerability score for each species. Once climate vulnerabilities were established, participants discussed possible adaptation strategies which, if implemented, might reduce vulnerability. This report summarizes the outcomes of the Gray's Reef Rapid Vulnerability Assessment workshop. Key findings were that top climate concerns included changes such as storm frequency and intensity, increasing water temperature, and ocean acidification. Top nonclimate stressors were identified as well, such as invasive lionfish, sedimentation, coastal development, and marine debris/anchor damage. Initial adaptation strategies that participants felt could be widely applicable, low cost, and efficacious included lionfish reduction efforts (e.g., traps, derbies), and establishing a rapid, post-storm damage assessment protocol.

Sponaugle, S., & Cowen, R. K. (2019). Coral Ecosystem Connectivity between Pulley Ridge and the Florida Keys. In *Mesophotic Coral Ecosystems.* Y. Loya, K. A. Puglise, & T. C. L. Bridge (Eds.), (pp. 897-907). Cham: Springer International Publishing https://doi.org/10.1007/978-3-319-92735-0_46

Mesophotic coral ecosystems (MCEs) have the potential to supply larvae to help sustain spatially discrete shallow-reef populations (Deep Reef Refugia Hypothesis); however, for this to be viable, mesophotic populations must be ecologically connected to shallow-reef populations. Three primary criteria for successful connectivity are: (1) robust populations of shallow-reef species must co-occur at mesophotic depths, (2) shallow and mesophotic habitats must be physically connected by currents, and (3) life history traits of organisms must enable successful delivery of viable larvae from mesophotic to shallow reefs. One such MCE, Pulley Ridge, is located on the west Florida shelf and supports populations of algae, sponges, corals, and fishes, some of which co-occur in mesophotic and shallow reefs. For organisms with short larval durations (hours to <10 days), such as many corals, Pulley Ridge is less likely

to function as a larval source for shallow reefs. Genetic differentiation among depth-stratified coral populations in the Florida Keys confirms this reduced connectivity. In comparison, a population of a model fish species, the bicolor damselfish, at Pulley Ridge invests more heavily in reproduction than their shallow-reef counterparts, and biophysical modeling demonstrates that they can seed downstream, shallow reefs. Thus, the degree to which Pulley Ridge can serve as a refuge varies by taxon. For many key reef species, such as corals, population connectivity may be insufficient for Pulley Ridge to serve as a regular larval source. However, for fishes, including the invasive lionfish, Pulley Ridge may already be serving as a source of larvae for shallow-reef populations.

Vandeperre, F., Parra, H., Pham, C. K., Machete, M., Santos, M., Bjorndal, K. A., & Bolten, A. B. (2019). Relative Abundance of Oceanic Juvenile Loggerhead Sea Turtles in Relation to Nest Production at Source Rookeries: Implications for Recruitment Dynamics. *Scientific Reports, 9*(1), 13019 https://doi.org/10.1038/s41598-019-49434-0

After hatching, juveniles of most sea turtle species undertake long migrations across ocean basins and remain in oceanic habitats for several years. Assessing population abundance and demographic parameters during this oceanic stage is challenging. Two long-recognized deficiencies in population assessment are (i) reliance on trends in numbers of nests or reproductive females at nesting beaches and (ii) ignorance of factors regulating recruitment to the early oceanic stage. To address these critical gaps, we examined 15 years of standardized loggerhead sighting data collected opportunistically by fisheries observers in the Azores archipelago. From 2001 to 2015, 429 loggerheads were sighted during 67,922 km of survey effort. We used a model-based approach to evaluate the influence of environmental factors and present the first estimates of relative abundance of oceanic-stage juvenile sea turtles. During this period, relative abundance of loggerheads in the Azores tracked annual nest abundance at source rookeries in Florida when adjusted for a 3-year lag. This concurrence of abundance patterns indicates that recruitment to the oceanic stage is more dependent on nest abundance at source rookeries than on stochastic processes derived from short term climatic variability, as previously believed.

2018

Atlantic Highly Migratory Species Management Division. (2018). *2017 Stock Assessment and Fishery Evaluation (SAFE) Report for Atlantic Highly Migratory Species.* NOAA Fisheries. Retrieved from https://www.fisheries.noaa.gov/resource/document/2017-stock-assessment-and-fishery-evaluation-safe-report-atlantic-highly

This 2017 Stock Assessment and Fisheries Evaluation (SAFE) Report is produced by the National Marine Fisheries Service (NMFS) Atlantic Highly Migratory Species (HMS) Management Division. It contains a review of the current status of Atlantic HMS stocks (tunas, swordfish, billfish, and sharks) and describes the year's accomplishments in managing Atlantic HMS. Atlantic HMS SAFE Reports provide the public with information on the latest developments in Atlantic HMS management and fulfill Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) requirements.

Feeley, M. W., Morley, D., Acosta, A., Barbera, P., Hunt, J., Switzer, T., & Burton, M. (2018). Spawning Migration Movements of Mutton Snapper in Tortugas, Florida: Spatial Dynamics Within a

Marine Reserve Network. *Fisheries Research, 204*, 209-223 https://doi.org/10.1016/j.fishres.2018.02.020

A marine reserve'seffectiveness for sustaining transient spawning reef fish populations is dependent on inclusion of fish spawning aggregations and consideration of the natural spatial boundaries of the populations themselves. Seasonal migrations of Mutton Snapper Lutjanus analis between protected nearshore areas and spawning grounds on Riley's Hump in Dry Tortugas, Florida, were assessed from 2008 to 2012 by acoustic telemetry. Individual fish showed synchronized reproductive migrations (up to 5 trips fish−1 yr−1) from resident habitats to spawning grounds swimming at an estimated 63 ± 18 cm s−1 (mean ± SD) over minimum linear distances up to 35.2 km. Migrations occurred from April to August, corresponding with the lunar cycle and an increase in water temperature from 25 to 30 °C. Fish arrived on spawning grounds on the full moon and stayed for 7 ± 2 d (mean ± SD). Observations of multiple spawning events made one to five days after the full moon in the late afternoon confirm these movements as spawning migrations. Functional migration areas (109.59 ± 61.01 km2; mean ± SD), which included estimates of staging/courtship/spawning area (4.51 ± 1.84 km2 [mean ± SD]) and home site area (2.50 ± 1.31 km2 [mean ± SD]), were combined to estimate the minimum catchment area of the population studied (291.3 km2). Although this study focuses on movements and habitat use of a single fish species in the Tortugas, the results are relevant to the design of marine reserve networks intended to protect and manage fishes that undergo transient spawning migrations in other locations as well.

Gleason, D. F., Harbin, L. R., Divine, L. M., & Matterson, K. O. (2018). The Role of Larval Supply and Competition in Controlling Recruitment of the Temperate Coral Oculina arbuscula. *Journal of Experimental Marine Biology and Ecology, 506*, 107-114 https://doi.org/10.1016/j.jembe.2018.06.006

Recruitment success in sessile benthic invertebrates that produce pelagic larvae is an emergent property of larval supply, settlement rates, and post-settlement survival. While intuitive that larval supply and settlement rates should be positively correlated, previous studies have demonstrated that many factors, such as competition for limited space on hard substrata, may decouple this relationship. Oculina arbuscula is a temperate, broadcast spawning coral and is the only structurally complex Scleractinian occurring on hard bottom reefs of the South Atlantic Bight (SAB), a region located in the North Atlantic Ocean off the southeastern coast of the U.S.A. Planula larvae of this species must settle on hard-bottom substrate that is densely colonized by a diversity of sessile benthic invertebrates, including sponges, bryozoans, and ascidians. To investigate the relative roles of larval supply and competition for space on the recruitment dynamics of O. arbuscula, settlement to and survival on 30 x 30 cm plots was monitored over 5 years on a reef off the coast of Georgia, U.S.A. Treatments consisted of 10 replicates of each of the following: 1) unmanipulated natural substrate, 2) natural substrate initially cleared of encrusting competitors such as sponges and tunicates, and 3) artificial substrate composed of concrete paving tiles. These plots were photographed 3-5 times per year between July 2004 and June 2009. These images showed that O. arbuscula recruits throughout the year in the SAB with a peak in September/October. While recruitment rates were higher than death rates in all treatments and resulted in a net gain of O. arbuscula colonies, recruitment to artificial substrate far-exceeded that found on natural surfaces. The high recruitment rates observed on artificial substrate ruled out the possibility that maintenance of O. arbuscula populations on natural surfaces is limited by larval supply. Competition with other sessile invertebrates, such as ascidians and sponges, also appeared to contribute to differences in recruitment among treatments, however, comparisons between cleared and unmanipulated control plots on natural substrate suggested that the competition effect was small. Based on these findings as well as anecdotal

observations suggesting that sediment accumulates less on the artificial substrate, the alternative hypothesis that O. arbuscula populations in this system are controlled by physical factors, especially sedimentation, is proposed and warrants further investigation.

Griffin, L. P., Brownscombe, J. W., Adams, A. J., Boucek, R. E., Finn, J. T., Heithaus, M. R., . . . Danylchuk, A. J. (2018). Keeping up with the Silver King: Using Cooperative Acoustic Telemetry Networks to Quantify the Movements of Atlantic Tarpon (Megalops atlanticus) in the Coastal Waters of the Southeastern United States. *Fisheries Research, 205*, 65-76 https://doi.org/10.1016/j.fishres.2018.04.008

Understanding the nature of migratory behaviors within animal populations is critical to develop and refine conservation and management plans. However, tracking migratory marine animals across life stages and over multiple years is inherently difficult to achieve, especially for highly migratory species. In this paper, we explore the use of acoustic telemetry to characterize the spatial ecology of Atlantic tarpon (Megalops atlanticus), elucidate the ecology of this poorly studied species, and ultimately inform conservation and management. Using the data from twenty-two acoustically tagged Atlantic tarpon, we found a diversity of tarpon migratory patterns, including spatial and temporal overlap for some individuals. We also reveal fine scale movements within specific ecosystems, as well as a range of distributions and connectivity across coastal waters of the southeastern United States of America. For tarpon with tracking durations greater than one month (n = 13), we found heterogeneous space use and migratory connectivity with some tarpon remaining close to their capture location while others migrated hundreds of kilometers. In addition, we were able to identify a northern and southern limit for one migratory tarpon that had detections spanning over 365 days. We share analyses on Atlantic tarpon data, including model-driven approaches and network analysis, to investigate movement strategies and space use, which may be pertinent to other studies involving highly migratory species. The project was a collaborative effort involving several acoustic telemetry networks which enabled the monitoring of broad- and fine-scale movements for extended periods of time that would normally be difficult to achieve with other monitoring techniques. Although challenges exist with applying acoustic telemetry to monitor highly migratory species, we also discuss its value in enabling researchers to assess movements and space use beyond the focal species, such as cross-ecosystem comparisons and multi-species interactions.

Loerzel, J., Fleming, C. S., & Gorstein, M. (2018). Ecosystem Services Valuation of the Central Georgia Coast, Including Sapelo Island National Estuarine Research Reserve and Gray's Reef National Marine Sanctuary https://doi.org/10.25923/r522-xv78

This report details the results of a survey effort conducted by the National Centers for Coastal Ocean Science, Hollings Marine Laboratory for coastal Georgia, which included the Sapelo Island National Estuarine Research Reserve and the Gray's Reef National Marine Sanctuary. The survey instrument was designed in collaboration with management staff to analyze the knowledge, attitudes, and preferences of social values associated with the area's ecosystem services for three distinct user groups of the Georgia coast: permanent residents, seasonal residents, and visitors. Components of the survey instrument addressed observed changes in abundance of key resources, and prioritization of management goals, among others. A participatory mapping component was included during which respondents allocated weights to any of 13 social value types and placed points on a map corresponding with those values. We received a total of 348 usable responses. We highlight interesting findings for

each group, and offer two potential uses of this information for the Sapelo Island National Estuarine Research Reserve and the Gray's Reef National Marine Sanctuary.

Munroe, D. M., Haidvogel, D., Caracappa, J. C., Klinck, J. M., Powell, E. N., Hofmann, E. E., . . . Hart, D. R. (2018). Modeling Larval Dispersal and Connectivity for Atlantic Sea Scallop (Placopecten Magellanicus) in the Middle Atlantic Bight. *Fisheries Research, 208*, 7-15 https://doi.org/10.1016/j.fishres.2018.06.020

Larval Atlantic sea scallops (Placopecten magellanicus) simulations in the Middle Atlantic Bight (MAB) from 2006 to 2012 were performed to investigate annual and inter-annual dispersal and connectivity patterns among stock regions. These simulations used a circulation model based on the Regional Ocean Modeling System (ROMS) and an individual-based larval model (IBM) that included larval behavior. The circulation model used realistic dynamical forcing (e.g., winds, tides, and open ocean boundary conditions), thermo-dynamical fluxes (e.g., solar radiations, sensible and latent heating), and hydrological forcing; the larval IBM included vertical swimming and sinking behaviour, temperature-dependent growth, and settlement. Simulated larvae that reach settlement size and suitable habitat in 45 days are considered 'successful', and two regions are considered 'connected' by larval dispersal when larvae successfully disperse from one region to the other. In general, simulated larval dispersal patterns varied seasonally (28% higher in September and October compared to May and June), among years (2007 through 2009 had 5% lower larval success during August and September compared to other years), and spatially, with larvae released from the northern regions like Long Island acting as a substantive larval source with 14% greater dispersal success and 15% greater connectivity with other regions than those released elsewhere. Over the seven years simulated, the MAB scallop stocks showed high rates of connectivity to regions to the south and more limited and variable connectivity to regions to the north. In species like sea scallops with limited adult mobility, larval dispersal supplies recruits, enables range expansion, and connects populations. Thus, appreciation of dispersal patterns are essential for fishery management of this economically valuable stock.

Ogburn, M. B., Bangley, C. W., Aguilar, R., Fisher, R. A., Curran, M. C., Webb, S. F., & Hines, A. H. (2018). Migratory Connectivity and Philopatry of Cownose Rays Rhinoptera bonasus Along the Atlantic Coast, USA. *Marine Ecology Progress Series, 602*, 197-211 https://doi.org/10.3354/meps12686

Migratory species link spatially separated ecosystems, and understanding their migrations is critical for conservation and management. The cownose ray Rhinoptera bonasus is a large-bodied batoid ray implicated in shellfish declines along the US Atlantic coast, but its migrations and habitat use remain poorly understood. We used passive acoustic telemetry to track tagged adult female (N = 27) and male (N = 9) rays released during summer and fall 2014-2016 in Maryland, Virginia, and Georgia. Twenty-three tags provided data for more than 1 yr. Individuals from all tagging locations overwintered in the same region offshore of Cape Canaveral, Florida, then returned in summer to the estuaries where tagging took place. Hidden Markov modeling identified 3 behavioral states (Resident, Ranging, Migratory), with ray movements generally classified as non-migratory (Resident and Ranging behavioral states) in summer and winter, and migratory (Migratory behavioral state) in spring and fall. Linear discriminant analysis suggested strong philopatry to tagging locations. This study provides the first full annual migration tracks for cownose rays along the US Atlantic coast, indicating that they migrate between summer pupping and mating habitats in estuaries south of Long Island, New York, and shared overwintering habitats off the east coast of Florida near Cape Canaveral. Our results highlight the value

of national-scale networks of acoustic telemetry arrays for identifying migratory patterns of highly mobile marine species.

South Carolina Department of Natural Resources. (2018). Marmap Contributions and Related Reports. Retrieved from http://www.scwaterlaw.sc.gov/marine/mrri/CoastalResearch/ReefFishSurvey/publicationsreports.html

The Reef Fish Survey creates, and contributes to many types of publications, including gray literature, as well as peer-reviewed literature which are published in scientific research journals. This is a list of references they have complied on the topic.

Stormer, D. G., & Juanes, F. (2018). Overwinter Habitat Use, Feeding Habits and Energetics of Juvenile Bluefish in the Northern Florida Coastal Ocean. *Estuaries and Coasts, 41*(5), 1422-1435 https://doi.org/10.1007/s12237-018-0370-2

Recruitment success for juvenile fishes that take part in seasonal migrations may be dependent on the environmental conditions during the first winter of life. Juvenile bluefish (Pomatomus saltatrix) in the USA migrate from mid-Atlantic waters during the fall to overwinter in the coastal ocean of Florida and return again in the spring. Little is known regarding the recruitment dynamics and feeding ecology of juvenile bluefish at the southern edge of the species US range, particularly during winter. We examined the cohort structure, feeding habits, and lipid content of juvenile bluefish during late fall and winter in the northern Florida coastal ocean. We found that three juvenile bluefish cohorts migrated to the area at distinct temporal and spatial intervals. Abundance of juvenile bluefish was greatest during January and was dominated by the summer-spawned cohort. We first collected fall-spawned fish in January, and this was the only cohort collected by March, indicating the possibility of local spawning from a resident bluefish population. Stomach content analysis revealed that all three juvenile bluefish cohorts used the northern Florida coastal ocean to forage during the winter, and striped anchovy (Anchoa hepsetus) was the primary prey. Feeding intensity of juvenile bluefish was greatest in December and January, and their lipid content increased throughout the winter. Juvenile bluefish recruited to the coastal shelf waters of northern Florida, where the region provided this popular sportfish with distinct overwintering resources.

The Nature Conservancy. (2018). *South Atlantic Regional Fish Monitoring of Restored Oyster Habitat Along the Southeastern US Coast.* Retrieved from https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/marine/sabma/Pages/Fish-Monitoring-Around-Reefs.aspx

In 2015, the Nature Conservancy initiated a three-year project to evaluate fish communities associated with restored oyster reefs in five locations the southeast United States. With primary funding support from Boeing, the Conservancy's project focused on developing and implementing a regional fish productivity monitoring protocol to document the connection between restored oyster reefs, important fish species, and the marine food web.

Varnerin, B. (2018). *An Investigation into the Physiological Impacts of Ocean Acidification on Recruits of the Temperate Coral, Oculina arbuscula.* Masters Thesis, Georgia Southern University. Retrieved from https://digitalcommons.georgiasouthern.edu/etd/1740

Ocean acidification is well-researched with respect to adult scleractinian corals, however information on whether adults and recruits of the same species respond similarly to this environmental stress is lacking. I investigated the responses to increased pCO2 of recruits of the temperate coral, Oculina arbuscula, whose adults are known to withstand high levels of pCO2 with no depression in calcification (up to 1000 ppm CO2). I addressed the hypothesis that O. arbuscula recruit health is not affected by increased pCO2 by exposing small colonies (5-12mm diameter) to 475, 711, and 1270 ppm CO2 for 75 days. Calcification rates were monitored throughout the experiment, while mortality, respiration rates, photosynthetic rates, zooxanthella densities, and soluble protein were determined at the end. As predicted, higher pCO2 did not impact survival, zooxanthella densities, or soluble protein. In contrast, both calcification rates and photosynthesis:respiration (P:R) ratios tended to be lower at higher pCO2. These results suggest that there is a size-dependent response to pCO2 within O. arbuscula, with recruits being unable to keep up with the increased energetic cost of calcification that occurs at higher pCO2. With the mean pCO2 increasing approximately 2.4% each year in the South Atlantic Bight (SAB), within the next 30 years O. arbuscula recruits are predicted to experience seasonal depressions in calcification rate driven by the overlying natural fluctuations in oceanic pCO2, and within 50 years recruits are anticipated to exhibit year-round depressions in calcification rate.

Wang, V., White, J., Arnott, S., & Scharf, F. (2018). Population Connectivity of Southern Flounder in the US South Atlantic Revealed by Otolith Chemical Analysis. *Marine Ecology Progress Series, 596*, 165-179 https://doi.org/10.3354/meps12576

Reconstructing the movements of fish among different environments and incorporating patterns of spatial population structure contribute to improved accuracy in the assessment of marine fishery resources. The southern flounder *Paralichthys lethostigma* is a valuable flatfish throughout its range in the US South Atlantic and Gulf of Mexico, but stock conservation and management is hindered by critical knowledge gaps related to patterns of movement and the level of mixing among populations. Identifying stock structure and connectivity can be challenging in species with complex life histories, and otolith geochemical signatures have been effectively used as natural markers to estimate population connectivity in migratory fishes. With this approach, we inferred the degree of exchange of southern flounder among broad US South Atlantic regions by predicting the nursery origins of adults captured in North Carolina and South Carolina estuaries. Baseline nursery profiles were first established by analyzing stable isotopes (δ13C, δ18O) and trace elements (Mg:Ca, Mn:Ca, Sr:Ca, Ba:Ca) sampled from juvenile southern flounder otoliths. Quadratic discriminant analysis discriminated among state-scale nursery regions (North Carolina, South Carolina, and Florida) with 72% cross-validation accuracy. Adult southern flounder from the same cohort were subsequently classified to the atlas of nursery signatures obtained from the juvenile fish using a maximum likelihood mixed stock analysis. Results revealed a lack of nursery-state fidelity and the potential for broad-scale movement of post-migratory adults along the US South Atlantic coast, which will contribute to the definition of appropriate spatial scales for management.

2017

Bacheler, N. M., Geraldi, N. R., Burton, M. L., Munoz, R. C., & Kellison, G. T. (2017). Comparing Relative Abundance, Lengths, and Habitat of Temperate Reef Fishes Using Simultaneous Underwater Visual Census, Video, and Trap Sampling. *Marine Ecology Progress Series, 574*, 141-155 https://doi.org/10.3354/meps12172

Unbiased counts of individuals or species are often impossible given the prevalence of cryptic or mobile species. We used 77 simultaneous multi-gear deployments to make inferences about relative abundance, diversity, length composition, and habitat of the reef fish community along the southeastern US Atlantic coast. In total, 117 taxa were observed by underwater visual census (UVC), stationary video, and chevron fish traps, with more taxa being observed by UVC (100) than video (82) or traps (20). Frequency of occurrence of focal species was similar among all sampling approaches for tomtate Haemulon aurolineatum and black sea bass Centropristis striata, higher for UVC and video compared to traps for red snapper Lutjanus campechanus, vermilion snapper Rhomboplites aurorubens, and gray triggerfish Balistes capriscus, and higher for UVC compared to video or traps for gray snapper L. griseus and lionfish Pterois spp. For 6 of 7 focal species, correlations of relative abundance among gears were strongest between UVC and video, but there was substantial variability among species. The number of recorded species between UVC and video was correlated (rho = 0.59), but relationships between traps and the other 2 methods were weaker. Lengths of fish visually estimated by UVC were similar to lengths of fish caught in traps, as were habitat characterizations from UVC and video. No gear provided a complete census for any species in our study, suggesting that analytical methods accounting for imperfect detection are necessary to make unbiased inferences about fish abundance.

Bell, J. E., & Williamson, J. E. (2017). Positive Indirect Interactions in Marine Herbivores and Algae. In V.D.C. Sheilds (Ed.) *Herbivores.* (Vol. 1, pp. 135-153) https://doi.org/10.5772/67343

There is an increasing interest in how nested positive indirect interactions involving at least three species maintain community structure. Recent research shows that positive indirect effects can strongly influence community structure, organisation and functioning. It is thus important to understand and identify positive indirect effects for the purpose of predicting system responses to certain perturbations. In order to investigate indirect effects, experimental manipulations must be carried out within the entire framework of the community of interest. Hence, often due to logistical difficulties, indirect effects, especially those that yield positive results, have been less studied. Here we present a synthesis of current information on patterns of positive indirect effects and review and compare recently conducted experimental studies in marine herbivores and algae.

Ceriani, S. A., Weishampel, J. F., Ehrhart, L. M., Mansfield, K. L., & Wunder, M. B. (2017). Foraging and Recruitment Hotspot Dynamics for the Largest Atlantic Loggerhead Turtle Rookery. *Scientific Reports, 7*(1), 16894 https://doi.org/10.1038/s41598-017-17206-3

Determining patterns of migratory connectivity for highly-mobile, wide-ranging species, such as sea turtles, is challenging. Here, we combined satellite telemetry and stable isotope analysis to estimate foraging locations for 749 individual loggerheads nesting along the east central Florida (USA) coast, the largest rookery for the Northwest Atlantic population. We aggregated individual results by year, identified seven foraging hotspots and tracked these summaries to describe the dynamics of inter-

annual contributions of these geographic areas to this rookery over a nine-year period. Using reproductive information for a subset of turtles (n = 513), we estimated hatchling yields associated with each hotspots. We found considerable inter-annual variability in the relative contribution of foraging areas to the nesting adults. Also reproductive success differed among foraging hotspots; females using southern foraging areas laid nests that produced more offspring in all but one year of the study. These analyses identified two high priority areas for future research and conservation efforts: the continental shelf adjacent to east central Florida and the Great Bahama Bank, which support higher numbers of foraging females that provide higher rates of hatchling production. The implementation of the continuous-surface approach to determine geographic origins of unknown migrants is applicable to other migratory species.

Conley, M. F., Anderson, M.G., Steinberg, N. & Barnett A. (2017). *South Atlantic Bight Marine Assessment: Species, Habitats and Ecosystems.* The Nature Conservancy, Eastern Conservation Science. Retrieved from https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/marine/sabma/sabma/Pages/default.aspx

Healthy coastal and marine habitats are vital to both people and natural communities. New and increasing activities in nearshore waters are increasing the need for spatial resource and use information to aid in decision-making. The South Atlantic Bight Marine Assessment (SABMA) builds on decades of marine research and data collection to improve understanding of critical habitats and their relationship with key species and oceanographic properties. The breadth of the assessment is large and required significant partner collaboration. Covering over half of the Atlantic seaboard from the mouth of the Chesapeake Bay to the Florida Keys (over 17,000 miles of coastline & 93 million acres), the project areas extends inland from the area of tidal influence seaward beyond the shallow continental shelf to the base of the U.S. portion of the continental slope. Over 30 technical experts from across the region engaged in review of the assessment to ensure validity of all products. The result is regional baseline spatial data on the distribution and status of seafloor habitats, coastal systems, marine mammals and sea turtles. Evaluation across resources enabled the identification of a conservation portfolio – areas of ecological importance. These products, when combined with ocean use and more localized resource data, contribute to the body of knowledge needed to help reduce potential conflicts between and among human uses and ecologically significant resources.

Farmer, N. A., Heyman, W. D., Karnauskas, M., Kobara, S., Smart, T. I., Ballenger, J. C., . . . Sedberry, G. R. (2017). Timing and Locations of Reef Fish Spawning Off the Southeastern United States. *PLOS ONE, 12*(3), e0172968 https://doi.org/10.1371/journal.pone.0172968

Managed reef fish in the Atlantic Ocean of the southeastern United States (SEUS) support a multi-billion dollar industry. There is a broad interest in locating and protecting spawning fish from harvest, to enhance productivity and reduce the potential for overfishing. We assessed spatiotemporal cues for spawning for six species from four reef fish families, using data on individual spawning condition collected by over three decades of regional fishery-independent reef fish surveys, combined with a series of predictors derived from bathymetric features. We quantified the size of spawning areas used by reef fish across many years and identified several multispecies spawning locations. We quantitatively identified cues for peak spawning and generated predictive maps for Gray Triggerfish (Balistes capriscus), White Grunt (Haemulon plumierii), Red Snapper (Lutjanus campechanus), Vermilion Snapper

(Rhomboplites aurorubens), Black Sea Bass (Centropristis striata), and Scamp (Mycteroperca phenax). For example, Red Snapper peak spawning was predicted in 24.7–29.0˚C water prior to the new moon at locations with high curvature in the 24–30 m depth range off northeast Florida during June and July. External validation using scientific and fisherydependent data collections strongly supported the predictive utility of our models. We identified locations where reconfiguration or expansion of existing marine protected areas would protect spawning reef fish. We recommend increased sampling off southern Florida (south of 27˚ N), during winter months, and in high-relief, high current habitats to improve our understanding of timing and location of reef fish spawning off the southeastern United States.

Geselbracht, L., R. Newton, & Greene, J. (2017). Marine Mammals and Sea Turtles of the South Atlantic Bight Marine Region. In *The South Atlantic Bight Marine Assessment: Species, Habitats and Ecosystems.*: The Nature Conservancy, Eastern Conservation Science Retrieved from http://nature.ly/marineSAtlanticBightERA

Marine mammals and sea turtles serve a number of important functions in the South Atlantic Bight ecosystem. They are pelagic and, in many cases, are highly migratory or wide-ranging. They serve as vital components of marine food webs as predators, planktivores, or herbivores, and are important conduits for the movement of carbon and nutrients between coastal habitats and the open ocean. These "charismatic megafauna" draw public attention, helping to educate people about the importance of our oceans to life on earth. In many cases, the marine mammal and sea turtle species occurring in the SAB region are endangered, threatened or vulnerable and require a concerted effort by humans to ensure their persistence into the future. A consequence of the large geographic ranges of many of these species is frequent opportunity to interact with humans. These interactions can include exposure to ship and boat traffic, fishing gear (active and derelict) and pollution (including marine debris), underwater noise, and the effects of climate change, which all may pose serious threats to these sensitive populations.

Glasgow, D. M. (2017). *Environmental Relationships and Predator-Prey Interactions within the Snapper-Grouper Complex in the Southeastern U.S. Atlantic – Implications for Fisheries Management.* (Doctoral dissertation), University of South Carolina, Retrieved from https://scholarcommons.sc.edu/etd/4458

Stock assessments indicate many valuable fish species are declining, or are considered overfished and/or are undergoing overfishing. Fisheries scientists and managers in the southeastern U.S. typically have utilized a single-species approach, and relied on catch per unit effort data derived from fishery-independent surveys to determine indices of abundance for economically important reef fish. However, catchability for these surveys vary for many reasons including environmental and predator-prey relationships. This research was developed to elucidate environmental influences on reef fish assemblages and distribution of reef-associated marine predators, and examine predator-prey dynamics that may influence relative abundance of large predators based on chevron traps and video data from the southeastern U.S. Atlantic. The first part of this study focused on fish assemblage structure association with different environmental gradients such as distance to shelf edge, depth, substrate vertical relief, substrate size, biotic class and % biotic cover. The second part of the study further detailed the association of Scamp, Gag, Yellowmouth Grouper, Red Grouper, Snowy Grouper and Red Snapper with month, latitude, depth, temperature, surface geologic class, biotic class, and percent biotic cover and revealed Red Snapper had a wider niche breadth than the groupers, while alternatively,

groupers exhibited greater habitat specificity. The final part of the study determined Gag, Red Grouper and Red Snapper showed a preference toward Tomtate and small Black Sea Bass when predation occurred within traps. However, statistical analyses determined selected prey species were not important drivers in the presence of the focal predator species within the traps or video observations. Based on observations during this study, predator-prey interactions may have more implications for indices based on video outside the traps for these focal predator species. Given environmental relationships and species interactions have implications for fisheries management, this study provides details that describe assemblage patterns across environmental gradients, determines habitat associations for economically and environmentally important groupers and Red Snapper, and determines the importance of predation regarding chevron traps. This information will be used to inform stock assessments and conservation management decisions to enhance fisheries sustainability.

Heinänen, S., Žydelis, R., Dorsch, M., Nehls, G., & Skov, H. (2017). High-Resolution Sea Duck Distribution Modeling: Relating Aerial and Ship Survey Data to Food Resources, Anthropogenic Pressures, and Topographic Variables. *The Condor, 119*(2), 175-190 https://doi.org/10.1650/condor-16-57.1

Anthropogenic developments in marine coastal zones potentially overlap with areas of conservation interest, including important areas for birds. Ideally, spatial patterns of species abundance should be considered at ecologically relevant spatial resolutions (high resolutions) to inform spatial planning and environmental assessments. Most planning so far, however, has relied on coarse-resolution distribution maps from atlas projects or models often based on limited datasets (few surveys), and relationships with environmental variables have rarely been taken into account, leaving many studies and recommendations vulnerable to criticism. We therefore combined the strengths of a detailed database of spatially explicit aerial and ship surveys with high-resolution environmental predictors and species distribution models to predict detailed density patterns for 3 sea duck species, as part of an environmental impact assessment (EIA) in the southern Baltic Sea. We also compared the results from 2 different survey platforms to assess potential differences. We related survey data for Common Eiders (Somateria mollissima), Long-tailed Ducks (Clangula hyemalis), and Common Scoters (Melanitta nigra) to topographic variables, food resources, and anthropogenic pressures using 2-step generalized additive models accounting for zero inflation, nonnormality, and nonlinearity. We accurately predicted distribution patterns (the area under the receiver operating characteristic curve [AUC]: 0.79–0.84) and abundances (Spearman's correlation: 0.36–0.62) at a resolution of 750 m. However, abundance predictions based on aerial survey data differed in magnitude in comparison with predictions from ship survey data, particularly for the frequently diving Long-tailed Duck. We suggest that the main source of the differing abundance estimates was differences in the input data collected using different survey platforms, rather than the modeling approach. A correction factor for birds missed during surveys due to diving activity would therefore increase the accuracy of abundance estimates. Our results show that it is possible to fit ecologically interpretable relationships between species and environmental variables, allowing for the creation of high-resolution predictions useful for management and conservation.

Kelly-Stormer, A., Shervette, V., Kolmos, K., Wyanski, D., Smart, T., McDonough, C., & Reichert, M. J. M. (2017). Gray Triggerfish Reproductive Biology, Age, and Growth Off the Atlantic Coast of the Southeastern USA. *Transactions of the American Fisheries Society, 146*(3), 523-538 https://doi.org/10.1080/00028487.2017.1281165

The Gray Triggerfish Balistes capriscus supports fisheries on both sides of the Atlantic Ocean. We utilized fishery-independent samples to assess the age structure, growth, sex ratio, size and age at maturity, spawning season, and spawning frequency of the Gray Triggerfish population off the southeastern U.S. Atlantic coast. From 1991 to 2012, 7,685 samples were collected, ranging in FL from 82 to 578 mm and ranging in age from 0 to 13 years. Our study provides key life history information for an exploited population and is the first to comprehensively describe age, growth, and reproduction for a Balistes species. We documented that the Gray Triggerfish is sexually dimorphic, with adult males attaining larger sizes at age and a larger maximum size than females. Sex-specific growth curves were fitted, yielding the following von Bertalanffy equations: FLt = 419[1 – e–0.54(t + 0.61)] for males and FLt = 352[1 – e–0.94(t + 0.22)] for females. This species is characterized by a medium size at maturity (the smallest mature female was 179 mm FL; the smallest mature male was 183 mm FL) and relatively early age at maturity (the youngest mature female and male were age 0). Some shifts in population attributes coincided with a period of increased fishing pressure. Due to tighter regulations on snapper and grouper fisheries, the Gray Triggerfish has become a more targeted species. Fisheries biologists and managers should continue to evaluate potential impacts and establish management regulations that consider the region-specific reproductive season, size and age at maturity, and sex-specific differences in growth documented in this study.

Korsman, B. M., Kimball, M. E., & Hernandez, F. J., Jr. (2017). Spatial and Temporal Variability in Ichthyoplankton Communities Ingressing through Two Adjacent Inlets Along the Southeastern US Atlantic Coast. *Hydrobiologia, 795*(1), 219-237 https://doi.org/10.1007/s10750-017-3131-5

Estuaries along the US east coast serve as essential nursery habitats for the early life history stages of many marine fishes. In the South Atlantic Bight (SAB), many studies have demonstrated the importance of these habitats for juveniles, but larval fish communities have received little attention, particularly around northeast Florida. To determine community structure, and seasonal distribution and abundance of larval fish in the Guana-Tolomato-Matanzas (GTM) estuary at its two inlets (St. Augustine and Matanzas), ichthyoplankton were sampled bi-weekly for one year at both inlets during nighttime spring flood tides. Samples were collected with a plankton net (1 m diameter, 1 mm mesh) suspended 1 m below the surface. Seventy-two taxa were collected, with four families comprising 85% of the collection: Sciaenidae (36.2%), Engraulidae (19.9%), Gobiidae (18.0%), and Gerreidae (10.7%). The two inlets differed in larval densities and taxonomic richness, although both were greatest during the summer. Spring and summer pulses in recruitment were observed for nearshore summer spawners. Marine offshore-spawned species exhibited peak recruitment in winter. The ichthyoplankton communities of the GTM estuary were most similar to those in southern SAB estuaries, and showed pronounced seasonal changes in composition, as is common in estuaries worldwide.

Marino, C. M., Pawlik, J. R., López-Legentil, S., & Erwin, P. M. (2017). Latitudinal Variation in the Microbiome of the Sponge *Ircinia campana* Correlates with Host Haplotype but Not Anti-Predatory Chemical Defense. *Marine Ecology Progress Series, 565*, 53-66 Retrieved from https://www.int-res.com/abstracts/meps/v565/p53-66/

Many marine sponges host diverse symbiotic microbial communities that have been implicated in the production of secondary metabolites. These metabolites may defend the host sponge from potential predators. Variability in symbiont communities across the range of the host sponge could alter levels of chemical defense. To investigate the relationship between symbiont composition and chemical defense,

the microbiomes and palatability of tissue samples from *Ircinia campana* were characterized from 5 sites along a latitudinal gradient spanning temperate (South Atlantic Bight, SAB) and tropical (Caribbean) regions. Terminal restriction fragment length polymorphism analysis and Illumina sequencing of 16S ribosomal RNA genes revealed that *Ircinia campana* from different locations contained significantly distinct microbiomes and exhibited a consistent relationship of lower symbiont similarity over greater geographic distance (i.e. distance-decay). However, crude organic extracts of all samples of *Ircinia campana* were unpalatable to assay fish *Thalassoma bifasciatum* in laboratory assays, indicating no difference in chemical defense across locations. Distinct haplotypes of *I. campana* were detected in populations from the SAB and Caribbean, correlating with the observed patterns of latitudinal variation in microbial symbiont communities. Our findings indicate that *I. campana* is chemically defended from fish predators across the range of the species and that latitudinal variation occurs in the microbiome of *I. campana,* driven by a combination of host-specific factors and region-specific environmental filtering of symbiont communities.

McVeigh, D. M., Eggleston, D. B., Todd, A. C., Young, C. M., & He, R. (2017). The Influence of Larval Migration and Dispersal Depth on Potential Larval Trajectories of a Deep-Sea Bivalve. *Deep Sea Research Part I: Oceanographic Research Papers, 127*, 57-64 https://doi.org/10.1016/j.dsr.2017.08.002

Many fundamental questions in marine ecology require an understanding of larval dispersal and connectivity, yet direct observations of larval trajectories are difficult or impossible to obtain. Although biophysical models provide an alternative approach, in the deep sea, essential biological parameters for these models have seldom been measured empirically. In this study, we used a biophysical model to explore the role of behaviorally mediated migration from two methane seep sites in the Gulf of Mexico on potential larval dispersal patterns and population connectivity of the deep-sea mussel "Bathymodiolus" childressi, a species for which some biological information is available. Three possible larval dispersal strategies were evaluated for larvae with a Planktonic Larval Duration (PLD) of 395 days: (1) demersal drift, (2) dispersal near the surface early in larval life followed by an extended demersal period before settlement, and (3) dispersal near the surface until just before settlement. Upward swimming speeds varied in the model based on the best data available. Average dispersal distances for simulated larvae varied between 16km and 1488km. Dispersal in the upper water column resulted in the greatest dispersal distance (1173km ± 2.00), followed by mixed dispersal depth (921km ± 2.00). Larvae originating in the Gulf of Mexico can potentially seed most known seep metapopulations on the Atlantic continental margin, whereas larvae drifting demersally cannot (237km ± 1.43). Depth of dispersal is therefore shown to be a critical parameter for models of deep-sea connectivity.

Samuel Furtner, Stephanie Gad, Isabella Marill, & Qian, A. (2017). *A Greater Gray: A Larval Connectivity Assessment of Gray's Reef National Marine Sanctuary.* Bren School of Environmental Science & Management. Retrieved from https://sanctuaries.noaa.gov/news/sep17/a-greater-gray-students-investigate-ecological-connectivity-in-sanctuaries.html

Situated off the coast of Savannah, Georgia under the direction of the National Oceanic and Atmosphere Administration (NOAA), the Gray's Reef National Marine Sanctuary is home to a thriving and diverse marine community. With commercial and recreational fishing pressure on fish species in the region, NOAA aims to identify areas in the region that, if protected, could build upon the benefits of the

sanctuary to preserve these economically important species. Using Marine Geospatial Ecology Tools (MGET), we identified potential new conservation areas by modeling ecological connectivity of larval dispersal to GRNMS. Four species were modeled to represent the diversity of fish in the region — red snapper, black sea bass, gag grouper, and scamp grouper. Model outputs mapped the expected regional sources of fish larvae throughout the Carolinian Ecoregion that ultimately supply new fish to GRNMS. Over 400 model runs were performed to examine connectivity in the peak spawning months from 2009-2015. Model runs over multiple years were aggregated to identify the sites that showed the highest larval contributions to GRNMS. The results suggest that the most efficient way to increase regional protection is a small expansion of the sanctuary and the creation of a connected protected area to the south. This study provides a framework for connecting protected sites in the region and provides a model for use in other settings within the National Marine Sanctuary system where the current level of protection is inadequate.

Skomal, G., Braun, C., Chisholm, J., & Thorrold, Sr. (2017). Movements of the White Shark *Carcharodon carcharias* in the North Atlantic Ocean. *Marine Ecology Progress Series, 580*, 1-16 https://doi.org/10.3354/meps12306

In the western North Atlantic, much of what is known about the movement ecology of the white shark Carcharodon carcharias is based on historical fisheries-dependent catch records, which portray a shelf-oriented species that moves north and south seasonally. In this study, we tagged 32 white sharks (16 females, 7 males, 9 unknown), ranging from 2.4 to 5.2 m total length, with satellitebased tags to investigate broad-scale movements in the North Atlantic. Based on 10427 days of tracking data, we found that white sharks are more broadly distributed, both horizontally and vertically, throughout the North Atlantic than previously understood, exhibiting an ontogenetic shift from near-coastal, shelf-oriented habitat to pelagic habitat with frequent excursions to mesopelagic depths. During the coastal phase, white sharks migrated seasonally from the northeast shelf in the summer to overwintering habitat off the southeastern US and the Gulf of Mexico, spending 95% of their time at <50 m depth. During the pelagic phase, subadult and adult white sharks exhibited wide-ranging movements during the fall, winter, and spring into the broader Atlantic over a 30° latitudinal range and as far east as the Azores. These sharks moved daily to depths of up to 1128 m, spending significant time at specific mesopelagic depth zones through a temperature range of 1.6 to 30.4°C. We believe these movements are associated with offshore foraging facilitated by the thermal physiology of the species. Our findings extend the known essential habitat for the white shark in the North Atlantic beyond existing protection, with implications for future conservation.

2016

Bacheler, N. M., Schobernd, C. M., Harter, S. L., David, A. W., Sedberry, G. R., & Kellison, G. T. (2016). No Evidence of Increased Demersal Fish Abundance Six Years after Creation of Marine Protected Areas Along the Southeast United States Atlantic Coast. *Bulletin of Marine Science, 92*(4), 447-471 https://doi.org/10.5343/bms.2016.1053

Marine protected areas (MPAs) have been used widely as a conservation and fisheries management tool to protect fish and habitats. We used a time series (20012014) of underwater videos from submersibles and remotely operated vehicles to determine whether a series of MPAs established in early 2009 along the southeast United States Atlantic coast has increased the number of fish species, density of fished

species, or the density of Rhomboplites aurorubens (Cuvier, 1829) compared to adjacent, non-reserve areas. We used univariate and multivariate approaches at two spatial scales (region-wide and MPA-specific) to test for a change in the number or density of fish species inside compared to outside MPAs. Overall, 185 fish taxa were observed from 1021 video transects across all years of the study. We did not observe a higher number of species, density of fished species, or density of R. aurorubens inside compared to outside MPAs, either after region-wide standardization using generalized additive models or for nominal analyses focusing on two (Edisto or North Florida) MPAs. Using non metric multidimensional scaling and analysis of similarity, we did not observe any change in community structure occurring inside the MPAs that was not simultaneously occurring outside the MPAs, both at the region-wide or MPA-level scale. We did not detect unique changes to the fish community inside MPAs after their creation, which could be due to low statistical power, not enough data post-MPA creation, low compliance rates, or suboptimal MPA shape and size, or some combination thereof. Given their current relatively low abundances, the sampling effort required to effectively assess potential MPA effects for most grouper species is well beyond current or historical levels of sampling.

Bacheler, N. M., Schobernd, Z. H., Berrane, D. J., Schobernd, C. M., Mitchell, W. A., Teer, B. Z., . . . Glasgow, D. M. (2016). Spatial Distribution of Reef Fish Species Along the Southeast US Atlantic Coast Inferred from Underwater Video Survey Data. *PLOS ONE, 11*(9) https://doi.org/10.1371/journal.pone.0162653

Marine fish abundance and distribution often varies across spatial scales for a variety of reasons, and this variability has significant ecological and management consequences. We quantified the distribution of reef-associated fish species along the southeast United States Atlantic coast using underwater video survey samples (N = 4,855 in 2011–2014) to elucidate variability within species across space, depths, and habitats, as well as describe broad-scale patterns in species richness. Thirty-two species were seen at least 10 times on video, and the most commonly observed species were red porgy (Pagrus pagrus; 41.4% of videos), gray triggerfish (Balistes capriscus; 31.0%), black sea bass (Centropristis striata; 29.1%), vermilion snapper (Rhomboplites aurorubens; 27.7%), and red snapper (Lutjanus campechanus; 22.6%). Using generalized additive models, we found that most species were non-randomly distributed across space, depths, and habitats. Most rare species were observed along the continental shelf break, except for goliath grouper (Epinephelus itajara), which was found on the continental shelf in Florida and Georgia. We also observed higher numbers of species in shelf-break habitats from southern North Carolina to Georgia, and fewer in shallower water and at the northern and southern ends of the southeast United States Atlantic coast. Our study provides the first broad-scale description of the spatial distribution of reef fish in the region to be based on fishery-independent data, reinforces the utility of underwater video to survey reef fish, and can help improve the management of reef fish in the SEUS, for example, by improving indices of abundance.

Bacheler, N. M., & Smart, T. I. (2016). Multi-Decadal Decline in Reef Fish Abundance and Species Richness in the Southeast USA Assessed by Standardized Trap Catches. *Marine Biology, 163*(2), 1-17 https://doi.org/10.1007/s00227-015-2774-x

Reef fish species naturally fluctuate in abundance over various temporal and spatial scales, but recent broad-scale declines in abundance have been observed worldwide and attributed to various anthropogenic influences. We used 25 years of fishery-independent trap data (N = 11,237 trap hauls) to examine the spatial and temporal variability in temperate reef fish abundance along the southeast coast

of the USA, a relatively understudied region with many economically important reef fish species. Overall, 441,298 individuals from 118 species were caught in the trap survey. Number of species and total number of individuals caught in the trap survey declined over the 25 years, but when separated, nontargeted fish species declined more than fishery-targeted species. For instance, traps caught a median of 18 nontargeted individuals and a median of 2-3 nontargeted reef fish species in the early 1990s, but by the 2010s, traps caught a median of fewer than three nontargeted individuals and a median of one nontarget species. Using generalized additive models, we found that the catch of fishery-targeted and nontargeted species was positively related to bottom water temperature, while depth influenced nontargeted and fishery-targeted species in opposite ways. The substantial and consistent decline in nontargeted fish species suggests that more research and management attention should be given to these often ignored species. These results suggest that the temperate reef fish community in the southeast USA is influenced by more than just fishing, perhaps including invasive species (e.g., lionfish Pterois volitans), decadal-scale environmental variability, or climate change.

Ballew, N. G., Bacheler, N. M., Kellison, G. T., & Schueller, A. M. (2016). Invasive Lionfish Reduce Native Fish Abundance on a Regional Scale. *Scientific Reports, 6*(1), 32169 https://doi.org/10.1038/srep32169

Invasive lionfish pose an unprecedented threat to biodiversity and fisheries throughout Atlantic waters off of the southeastern United States, the Caribbean, and the Gulf of Mexico. Here, we employ a spatially replicated Before-After-Control-Impact analysis with temporal pairing to quantify for the first time the impact of the lionfish invasion on native fish abundance across a broad regional scale and over the entire duration of the lionfish invasion (1990–2014). Our results suggest that 1) lionfish-impacted areas off of the southeastern United States are most prevalent off-shore near the continental shelfbreak but are also common near-shore and 2) in impacted areas, lionfish have reduced tomtate (a native forage fish) abundance by 45% since the invasion began. Tomtate served as a model native fish species in our analysis, and as such, it is likely that the lionfish invasion has had similar impacts on other species, some of which may be of economic importance. Barring the development of a control strategy that reverses the lionfish invasion, the abundance of lionfish in the Atlantic, Caribbean, and Gulf of Mexico will likely remain at or above current levels. Consequently, the effect of lionfish on native fish abundance will likely continue for the foreseeable future.

Freeman, C. J., Easson, C. G., & Baker, D. M. (2016). Niche Structure of Marine Sponges from Temperate Hard-Bottom Habitats within Gray's Reef National Marine Sanctuary. *Journal of the Marine Biological Association of the United Kingdom, 96*(2), 559-565 https://doi.org/10.1017/S0025315415000363

Many species of marine sponges on tropical reefs host abundant and diverse symbiont communities capable of varied metabolic pathways. While such communities may confer a nutritional benefit to some hosts (termed High Microbial Abundance (HMA) sponges), other sympatric species host only sparse symbiont communities (termed Low Microbial Abundance (LMA) sponges) and obtain a majority of their C and N from local sources. Sponge communities are widespread across large latitudinal gradients, however, and recent evidence suggests that these symbioses may also extend beyond the tropics. We investigated the role that symbionts play in the ecology of sponges from the temperate, hard-bottom reefs of Gray's Reef National Marine Sanctuary by calculating the niche size (as standard ellipse area (SEAc)) and assessing the relative placement of five HMA and four LMA sponge species within bivariate

(δ13C and δ15N) isotopic space. Although photosymbiont abundance was low across most of these species, sponges were widespread across isotopic niche space, implying that microbial metabolism confers an ecological benefit to temperate sponges by expanding host metabolic capability. To examine how these associations vary across a latitudinal gradient, we also compared the relative placement of temperate and tropical conspecifics within isotopic space. Surprisingly, shifts in sponge δ13C and δ15N values between these regions suggest a reduced reliance on symbiont-derived nutrients in temperate sponges compared with their tropical conspecifics. Despite this, symbiotic sponges in temperate systems likely have a competitive advantage, allowing them to grow and compete for space within these habitats.

Merten, W., Appeldoorn, R., & Hammond, D. (2016). Movement Dynamics of Dolphinfish (*Coryphaena hippurus*) in the Northeastern Caribbean Sea: Evidence of Seasonal Re-Entry into Domestic and International Fisheries Throughout the Western Central Atlantic. *Fisheries Research, 175*, 24-34 https://doi.org/10.1016/j.fishres.2015.10.021

Distinct spatial variation and fisheries exchange routes for dolphinfish (Cotyphaena hippurus) were resolved relative to the northeastern Caribbean Sea and U.S. east coast using conventional (n = 742; mean +/- SD cm FL: 70.5 +/- 15.2 cm FL) and pop-up satellite archival tags (n = 7; 117.6 +/- 11.7 cm FL) from 2008 to 2014. All dolphinfish released in the northeastern Caribbean Sea moved westward (274.42 +/- 21.06), but slower in the tropical Atlantic than Caribbean Sea, with a maximum straight-line distance recorded between San Juan, Puerto Rico, and Charleston, South Carolina (1917.49 km); an 180-day geolocation track was obtained connecting the South Atlantic Bight to the northern limits of the Mona Passage. Two recaptures occurred within the Mona Passage from San Juan, Puerto Rico, and St. John, United States Virgin Islands, providing the first evidence that dolphinfish may cross the Greater Antilles island chain between the Atlantic Ocean and Caribbean Sea in both directions during their migration. To investigate this further, fish movements were compared to surface drifter tracks (n=196) in the region. Entry of drifters into the Caribbean Sea from the Atlantic Ocean occurred through the northern Lesser Antilles, the Anegada Passage, and the Mona Passage; both passages were observed to be an entry and exit. Results suggest domestic and international fisheries exchanges occur annually between the United States and Caribbean island nations (Antigua and Barbuda, Anguilla, St. Kitts, United States Virgin Islands, Puerto Rico, Hispaniola, The Bahamas, Cuba, Bermuda), with return migration directed towards the Yucatan Channel/Loop Current (south of the Greater Antilles) or Straits of Florida/Gulf Stream (north). Understanding dolphinfish movements and regional connectivity among exclusive economic zones of northern Caribbean islands and the United States is critical for accurate assessments of fishing mortality, spawning biomass and stock health, and given the regional connectivity, management must be consistent between jurisdictions.

Miller, A. S., Shepherd, G. R., & Fratantoni, P. S. (2016). Offshore Habitat Preference of Overwintering Juvenile and Adult Black Sea Bass, *Centropristis striata*, and the Relationship to Year-Class Success. *PLOS ONE, 11*(1), e0147627 https://doi.org/10.1371/journal.pone.0147627

Black sea bass (Centropristis striata) migrations are believed to play a role in overwinter survival and connectivity between juvenile and adult populations. This study investigated oceanographic drivers of winter habitat choice and regional differences between populations of juvenile and adult black sea bass. Trends in cohort strength, as a result of juvenile survival, were also identified. Oceanographic and fisheries survey data were analyzed using generalized additive models. Among the oceanographic

variables investigated, salinity was the main driver in habitat selection with an optimal range of 33–35 practical salinity units (PSU) for both juveniles and adults. Preferred temperature ranges varied between juveniles and adults, but held a similar minimum preference of >8°C. Salinity and temperature ranges also differed by regions north and south of Hudson Canyon. Shelf water volume had less of an effect than temperature or salinity, but showed an overall negative relationship with survey catch. The effect of winter conditions on juvenile abundance was also observed across state and federal survey index trends. A lack of correlation observed among surveys in the fall paired with a strong correlation in the spring identifies the winter period as a factor determining year-class strength of new recruits to the population. A rank order analysis of spring indices identified three of the largest year classes occurring during years with reduced shelf water volumes, warmer winter shelf waters, and a 34 PSU isohaline aligned farther inshore. While greater catches of black sea bass in the northwest Atlantic Ocean remain south of Hudson Canyon, the species' range has expanded north in recent years.

Varo-Cruz, N., Bermejo, J. A., Calabuig, P., Cejudo, D., Godley, B. J., xf, . . . Hawkes, L. A. (2016). New Findings About the Spatial and Temporal Use of the Eastern Atlantic Ocean by Large Juvenile Loggerhead Turtles. *Diversity and Distributions, 22*(3/4), 481-492 Retrieved from http://www.jstor.org/stable/24817668

Aims: Effective conservation of threatened or endangered species requires a robust understanding of their spatio-temporal distribution. Although a huge amount is known about the movements of Atlantic adult sea turtles, much less is known about juvenile turtles, and much of the life history model is therefore inferred. We set out to describe the spatio-temporal distribution of juvenile loggerheads turtles found around the Canary Islands. Location: Eastern North Atlantic Ocean. Methods: Between 1999 and 2012, we satellite-tracked 24 healthy large juvenile loggerhead turtles (mean straight carapace length = 47.4 cm, range = 34.6-54.5 cm) captured in the waters around the Canary Islands. We describe their regional distribution, identify high-use areas and create a model for habitat suitability using minimum convex polygons, density rasters and ensemble ecological niche modelling, integrated with physical and biological environmental data. Results: Turtles used a huge oceanic area (2.5 million km2) with particularly high usage around the Canary Islands, Spain, Portugal, Morocco and Western Sahara. In spring and summer, turtles generally moved further north towards the Iberian Peninsula. Ecological niche modelling identified sea surface temperature as the most important contributory variable to the habitat models. We also recorded three juvenile turtles making westward migrations away from the eastern Atlantic Ocean, presumably back towards their original natal beaches near sexual maturity. Main conclusions: The results of the present study provide insight into a significant knowledge gap on the spatio-temporal distribution of large juvenile loggerhead turtles in the eastern Atlantic Ocean. The data highlight that turtles occupy a vast open oceanic area, which hampers the ability of static conservation approaches to afford effective protection. However, ensemble ecological niche modelling highlights key suitable habitat for juvenile loggerhead turtles, which could be used in dynamic conservation protection.

Zhang, X., Munroe, D., Haidvogel, D., & Powell, E. N. (2016). Atlantic Surfclam Connectivity within the Middle Atlantic Bight: Mechanisms Underlying Variation in Larval Transport and Settlement. *Estuarine, Coastal and Shelf Science, 173*, 65-78 https://doi.org/10.1016/j.ecss.2016.02.019

Larval transport and settlement have been shown in various studies to be essential in determining population abundance and connectivity for benthic invertebrates. This transport is influenced by both

the physical environment and biological behavior. The Atlantic surfclam, Spisula solidissima, is a commercially important benthic invertebrate fishery species along the U.S northeastern coast. In this study, a physical circulation model is coupled to a surfclam larval model to investigate the dynamics of larval transport and settlement within the Middle Atlantic Bight (MAB) shelf in 2006. The main physical mechanisms causing variability in larval transport and settlement are also examined. Model results show that surfclam larvae released from July to early October experience relatively larger settlement rates, due to higher average temperatures experienced by larvae. Larval along-shore transport exhibits a mean down-coast pattern following the coastal current from the northeast to the southwest, with most high-frequency (period of 2–10 days) variations caused by fluctuations in the along-shore surface wind stress, and with seasonal variations speculated to be driven mainly by changes in the across-shelf density gradient. Larval across-shelf movement is highly correlated with the along-shore surface wind stress mediated by coastal upwelling and downwelling episodes, but the correlation is further dependent on the vertical distribution of the larvae, particularly their position relative to the thermocline. Most surfclam larvae released from the Middle Atlantic shelf stay below the thermocline and experience a net onshore transport during the summer-stratified season when upwelling-favorable wind forcing dominates. A proposed critical value of water temperature at the thermocline successfully regulates the observed patterns of vertical distribution of surfclam larvae and their across-shelf movement off the New Jersey and South Virginia shelves; that is, when the water temperature at the thermocline is above the critical value (19.0 °C), surfclam larvae tend to escape the warm surface layer to concentrate below the thermocline and follow the across-shelf movement of bottom water, and vice versa. These results provide an important insight into the general mechanism of how physical environmental factors interact with biological behavior of the larvae to influence larval transport, connectivity and population dynamics, and also indicate the potential impact of large-scale climate change on benthic species and coastal ecosystems.

2015

Bacheler, N. M., & Ballenger, J. C. (2015). Spatial and Temporal Patterns of Black Sea Bass Sizes and Catches in the Southeastern United States Inferred from Spatially Explicit Nonlinear Models. *Marine and Coastal Fisheries, 7*(1), 523-536 https://doi.org/10.1080/19425120.2015.1095826

Temporal and spatial variability in abundance often results from the effects of environmental and landscape variables interacting over multiple spatial scales, and understanding the complex interplay among these variables is key to elucidating the drivers of a species' population dynamics. We used a spatially explicit, variable-coefficient, generalized additive modeling approach with 24 years of fishery-independent trap data (N = 11,726 samples) to elucidate the spatiotemporal dynamics of size and size-specific CPUE of Black Sea Bass Centropristis striata along the southeastern Atlantic coast of the United States. Black Sea Bass catch exhibited complex spatial and temporal dynamics that were influenced by environmental, landscape, and sampling effects. Black Sea Bass were more commonly caught inshore than offshore, but were significantly smaller inshore and southward and larger offshore and northward in the study area. Moreover, the spatial distribution of Black Sea Bass changed as abundance varied within and among sampling seasons. Standardized mean length of Black Sea Bass also increased by more than 20% over the study period, from 230 mm TL in the early 1990s to 280 mm TL after 2010. These results elucidate the spatial and temporal dynamics of Black Sea Bass, inform population structure and indices of abundance, and provide an analytical framework that can be easily adapted to other species and systems.

Green, A. L., Maypa, A. P., Almany, G. R., Rhodes, K. L., Weeks, R., Abesamis, R. A., . . . White, A. T. (2015). Larval Dispersal and Movement Patterns of Coral Reef Fishes, and Implications for Marine Reserve Network Design. *Biological Reviews, 90*(4), 1215-1247 https://doi.org/10.1111/brv.12155

Well-designed and effectively managed networks ofmarine reserves can be effective tools for both fisheries management and biodiversity conservation. Connectivity, the demographic linking of local populations through the dispersal of individuals as larvae, juveniles or adults, is a key ecological factor to consider in marine reserve design, since it has important implications for the persistence ofmetapopulations and their recovery from disturbance. For marine reserves to protect biodiversity and enhance populations of species in fished areas, they must be able to sustain focal species (particularly fishery species) within their boundaries, and be spaced such that they can function as mutually replenishing networks whilst providing recruitment subsidies to fished areas. Thus the configuration (size, spacing and location) of individual reserves within a network should be informed by larval dispersal and movement patterns of the species for which protection is required. In the past, empirical data regarding larval dispersal and movement patterns of adults and juveniles of many tropical marine species have been unavailable or inaccessible to practitioners responsible for marine reserve design. Recent empirical studies using new technologies have also provided fresh insights into movement patterns ofmany species and redefined our understanding of connectivity among populations through larval dispersal. Our review ofmovement patterns of 34 families (210 species) of coral reef fishes demonstrates that movement patterns (home ranges, ontogenetic shifts and spawning migrations) vary among and within species, and are influenced by a range of factors (e.g. size, sex, behaviour, density, habitat characteristics, season, tide and time of day). Some species move <0.1–0.5 km (e.g. damselfishes, butterflyfishes and angelfishes), <0.5–3 km (e.g. most parrotfishes, goatfishes and surgeonfishes) or 3–10 km (e.g. large parrotfishes and wrasses), while others move tens to hundreds (e.g. some groupers, emperors, snappers and jacks) or thousands ofkilometres (e.g. some sharks and tuna). Larval dispersal distances tend to be <5–15 km, and self-recruitment is common. Synthesising this information allows us, for the first time, to provide species, specific advice on the size, spacing and location ofmarine reserves in tropical marine ecosystems to maximise benefits for conservation and fisheries management for a range of taxa. We recommend that: (i) marine reserves should be more than twice the size ofthe home range offocal species (in all directions), thus marine reserves ofvarious sizes will be required depending on which species require protection, how far they move, and if other effective protection is in place outside reserves; (ii) reserve spacing should be <15 km, with smaller reserves spaced more closely; and (iii) marine reserves should include habitats that are critical to the life history of focal species (e.g. home ranges, nursery grounds, migration corridors and spawning aggregations), and be located to accommodate movement patterns among these. We also provide practical advice for practitioners on how to use this information to design, evaluate and monitor the effectiveness ofmarine reserve networks within broader ecological, socioeconomic and management contexts.

Hammerschlag, N., Broderick, A. C., Coker, J. W., Coyne, M. S., Dodd, M., Frick, M. G., . . . Hawkes, L. A. (2015). Evaluating the Landscape of Fear between Apex Predatory Sharks and Mobile Sea Turtles Across a Large Dynamic Seascape. *Ecology, 96*(8), 2117-2126 https://doi.org/10.1890/14-2113.1

The "landscape of fear" model has been proposed as a unifying concept in ecology, describing, in part, how animals behave and move about in their environment. The basic model predicts that as an animal's landscape changes from low to high risk of prédation, prey species will alter their behavior to risk avoidance. However, studies investigating and evaluating the landscape of fear model across large spatial scales (tens to hundreds of thousands of square kilometers) in dynamic, open, aquatic systems involving apex predators and highly mobile prey are lacking. To address this knowledge gap, we investigated predatorprey relationships between tiger sharks (Galeocerdo cuvier) and loggerhead turtles (Caretta caretta) in the North Atlantic Ocean. This included the use of satellite tracking to examine shark and turtle distributions as well as their surfacing behaviors under varying levels of home range overlap. Our findings revealed patterns that deviated from our a priori predictions based on the landscape of fear model. Specifically, turtles did not alter their surfacing behaviors to risk avoidance when overlap in shark-turtle core home range was high. However, in areas of high overlap with turtles, sharks exhibited modified surfacing behaviors that may enhance prédation opportunity. We suggest that turtles may be an important factor in determining shark distribution, whereas for turtles, other life history trade-offs may play a larger role in defining their habitat use. We propose that these findings are a result of both biotic and physically driven factors that independently or synergistically affect predator-prey interactions in this system. These results have implications for evolutionary biology, community ecology, and wildlife conservation. Further, given the difficulty in studying highly migratory marine species, our approach and conclusions may be applied to the study of other predatorprey systems.

Qian, H., Li, Y., He, R., & Eggleston, D. B. (2015). Connectivity in the Intra-American Seas and Implications for Potential Larval Transport. *Coral Reefs, 34*(2), 403-417 https://doi.org/10.1007/s00338-014-1244-0

A major challenge in marine ecology is to describe patterns of larval dispersal and population connectivity, as well as their underlying processes. We re-assessed broad-scale population connectivity with a focus on the 18 coral reef hot spots in the Intra-American Seas described in Roberts (Science 278:1454–1457, 1997), by including seasonal and inter-annual variability in potential larval dispersal. While overall dispersal patterns were in agreement with previous findings, further statistical analyses show that dispersal patterns driven by mean circulation initially described by Roberts (Science 278:1454–1457, 1997) can significantly underestimate particle connectivity envelopes. The results from this study indicate that seasonal and inter-annual variability in circulation are crucial in modulating both dispersal distance and directional anisotropy of virtual larvae over most coral reef sites and that certain larval hotspots are likely more strongly connected than originally thought. Improved larval dispersal transport envelopes can enhance the accuracy of probability estimates which, in turn, may help to explain episodic larval settlement in certain times and places, and guide spatial management such as marine protected areas.

2014

Pittman, S. J., Monaco, M. E., Friedlander, A. M., Legare, B., Nemeth, R. S., Kendall, M. S., . . . Caldow, C. (2014). Fish with Chips: Tracking Reef Fish Movements to Evaluate Size and Connectivity of Caribbean Marine Protected Areas. PLOS ONE, 9(5), e96028 https://doi.org/10.1371/journal.pone.0096028

Coral reefs and associated fish populations have experienced rapid decline in the Caribbean region and marine protected areas (MPAs) have been widely implemented to address this decline. The performance of no-take MPAs (i.e., marine reserves) for protecting and rebuilding fish populations is influenced by the movement of animals within and across their boundaries. Very little is known about Caribbean reef fish movements creating a critical knowledge gap that can impede effective MPA design, performance and evaluation. Using miniature implanted acoustic transmitters and a fixed acoustic receiver array, we address three key questions: How far can reef fish move? Does connectivity exist between adjacent MPAs? Does existing MPA size match the spatial scale of reef fish movements? We show that many reef fishes are capable of traveling far greater distances and in shorter duration than was previously known. Across the Puerto Rican Shelf, more than half of our 163 tagged fish (18 species of 10 families) moved distances greater than 1 km with three fish moving more than 10 km in a single day and a quarter spending time outside of MPAs. We provide direct evidence of ecological connectivity across a network of MPAs, including estimated movements of more than 40 km connecting a nearshore MPA with a shelf-edge spawning aggregation. Most tagged fish showed high fidelity to MPAs, but also spent time outside MPAs, potentially contributing to spillover. Three-quarters of our fish were capable of traveling distances that would take them beyond the protection offered by at least 40-64% of the existing eastern Caribbean MPAs. We recommend that key species movement patterns be used to inform and evaluate MPA functionality and design, particularly size and shape. A re-scaling of our perception of Caribbean reef fish mobility and habitat use is imperative, with important implications for ecology and management effectiveness.

Poirson, B. (2014). *Sessile Invertebrate Colonization on Rocky Outcrops at Gray's Reef National Marine Sanctuary*. Masters Thesis, Western Washington University. Retrieved from https://digitalcommons.georgiasouthern.edu/etd/1103

Documenting patterns of sessile invertebrate community development is important for predicting recovery patterns after disturbance and designing effective marine reserves. In the South Atlantic Bight, invertebrate assemblages can differ significantly from one rocky outcrop to another, but the factors driving these differences are not well understood. I tracked community development for fourteen months at four rocky outcrops at Gray's Reef National Marine Sanctuary (GRNMS) to address the predictions that (i) developing sessile invertebrate communities in this system do not exhibit a predictable pattern of succession and (ii) recolonization patterns for small patches of open space that become available are influenced by the composition of the invertebrate community in the immediate vicinity. Community development was followed for 14 months on paving tiles (30 x 30 cm) deployed in July 2012 by photographing these tiles, along with the adjacent natural community, each month through September 2013. Species composition, percent cover, and diversity were determined each month. Sessile invertebrate taxa colonizing tiles were similar across all four sites in the first three months after deployment, but diverged over time. At all sites, developing communities exhibited lower percent cover and diversity than their adjacent existing communities over the fourteen months of the study, but analyses of similarities (ANOSIM) did provide evidence of convergence over the long term. These results indicate that succession of sessile invertebrates is not a predictable process in this system and that the extant community plays a role in deciding the final outcome of species re-establishment. Thus, differences in invertebrate community structure among rocky outcrops likely persist in this system because the extant community influences recruitment.

2013

Farmer, N. A., & Karnauskas, M. (2013). Spatial Distribution and Conservation of Speckled Hind and Warsaw Grouper in the Atlantic Ocean Off the Southeastern U.S. *PLOS ONE, 8*(11) https://doi.org/10.1371/journal.pone.0078682

There is broad interest in the development of efficient marine protected areas (MPAs) to reduce bycatch and end overfishing of speckled hind (Epinephelus drummondhayi) and warsaw grouper (Hyporthodus nigritus) in the Atlantic Ocean off the southeastern U.S. We assimilated decades of data from many fishery-dependent, fishery-independent, and anecdotal sources to describe the spatial distribution of these data limited stocks. A spatial classification model was developed to categorize depth-grids based on the distribution of speckled hind and warsaw grouper point observations and identified benthic habitats. Logistic regression analysis was used to develop a quantitative model to predict the spatial distribution of speckled hind and warsaw grouper as a function of depth, latitude, and habitat. Models, controlling for sampling gear effects, were selected based on AIC and 10-fold cross validation. The best-fitting model for warsaw grouper included latitude and depth to explain 10.8% of the variability in probability of detection, with a false prediction rate of 28–33%. The best-fitting model for speckled hind, per cross-validation, included latitude and depth to explain 36.8% of the variability in probability of detection, with a false prediction rate of 25–27%. The best-fitting speckled hind model, per AIC, also included habitat, but had false prediction rates up to 36%. Speckled hind and warsaw grouper habitats followed a shelf-edge hardbottom ridge from North Carolina to southeast Florida, with speckled hind more common to the north and warsaw grouper more common to the south. The proportion of habitat classifications and model-estimated stock contained within established and proposed MPAs was computed. Existing MPAs covered 10% of probable shelf-edge habitats for speckled hind and warsaw grouper, protecting 3–8% of speckled hind and 8% of warsaw grouper stocks. Proposed MPAs could add 24% more probable shelf-edge habitat, and protect an additional 14–29% of speckled hind and 20% of warsaw grouper stocks.

Griffin, D. B., Murphy, S. R., Frick, M. G., Broderick, A. C., Coker, J. W., Coyne, M. S., . . . Witt, M. J. (2013). Foraging Habitats and Migration Corridors Utilized by a Recovering Subpopulation of Adult Female Loggerhead Sea Turtles: Implications for Conservation. *Marine Biology, 160*(12), 3071-3086 https://doi.org/10.1007/s00227-013-2296-3

From 1998 to 2008, 68 adult female loggerhead sea turtles (Caretta caretta) were instrumented with platform transmitter terminals at nesting beaches in Georgia, North Carolina (NC) and South Carolina (SC) on the East Coast of the United States of America (30A degrees 48'N, 81A degrees 28'W to 33A degrees 51'N, 77A degrees 59'W). The majority of post-nesting loggerheads (N = 42, 62 %) migrated to foraging habitats in the Mid-Atlantic Bight during May-October, with a subsequent migration occurring during November-March to foraging habitats south of Cape Hatteras, NC. Nine (13 %) loggerheads initially foraged in the near-shore, coastal areas of the South Atlantic Bight, but moved to offshore habitats-closer to the Gulf Stream-during November-March, while fourteen (21 %) loggerheads remained in foraging areas along the mid-continental shelf off of the eastern coast of Florida and/or continued southward to Florida Bay and the Bahamas. The present study delineates important, post-nesting foraging habitats and migration corridors where loggerheads may interact with commercial fisheries-providing managers opportunities to develop and implement optimally effective conservation actions for the recovery of this threatened species.

Scott, J. A., Dodd, M. G., & Castleberry, S. B. (2013). Assessment of Management Scenarios to Reduce Loggerhead Turtle Interactions with Shrimp Trawlers in Georgia. *Marine and Coastal Fisheries, 5*(1), 281-290 https://doi.org/10.1080/19425120.2013.829143

Recovery of loggerhead turtle Caretta caretta populations depends on many factors, including reducing anthropogenic mortality of adult turtles. Shrimp trawls are considered a major source of mortality for adult loggerhead turtles despite the mandatory use of turtle excluder devices. We modeled scenarios for reducing the likelihood of interaction between nesting adult loggerhead turtles and shrimp trawlers operating off the coast of Georgia during the nesting season (May–August). We used satellite telemetry and aerial surveys to describe the distribution patterns of nesting adult female turtles (2004–2005; n = 22) and shrimp trawls (1999–2005), respectively, across waters adjacent to the Georgia shoreline. Adult female turtles and shrimp trawlers both occupied state waters extensively during the nesting season. Turtles tended to have long, narrow home ranges that were located parallel to shore and that overlapped with the shrimp trawl distribution, which showed a slight grouping around deep channels. We modeled the efficacy of fleet reductions and spatial closures (accounting for fleet redistribution) in reducing shrimp trawler activity around loggerhead turtles. A comparison of spatial closures indicated that a large closure of state waters (~200 km2) east ofSapelo and Blackbeard islands would reduce mean trawler activity levels in turtle home ranges.We also found that fleet reductions of50% or more reduced potential interactions between turtles and trawlers. Although spatial closures produced a net total reduction in turtle–trawler interactions, fleet reductions yielded a reduction in such interactions across the study area. We recommend that to reduce loggerhead turtle–trawler interactions, state agencies should consider a limited-entry system or some other means to limit the number of vessels operating within state waters.

South Atlantic Information Resources: Data Search and Literature Synthesis. (2013). US Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region OCS Study BOEM 2013-01157. New Orleans, LA. Retrieved from https://www.boem.gov/ESPIS/5/5296.pdf

No abstract available.

Staudinger, M. D., Juanes, F., Salmon, B., & Teffer, A. K. (2013). The Distribution, Diversity, and Importance of Cephalopods in Top Predator Diets from Offshore Habitats of the Northwest Atlantic Ocean. *Deep-Sea Research Part II-Topical Studies in Oceanography, 95*, 182-192 https://doi.org/10.1016/j.dsr2.2012.06.004

Large pelagic predators were used as biological samplers to gain information on cephalopod diversity, abundance, distribution, and their role as prey in the Northwest Atlantic Ocean. Fish predators were caught by recreational anglers in offshore waters of New England (NE; 2007-2010), the Mid-Atlantic Bight (MAB; 2009-2010) and the South Atlantic Bight (SAB; 2010-2011). In total, 2362 cephalopods, including 22 species of squid and 4 octopods, were identified in the diets of 13 species of predatory fishes. Cephalopod body sizes were obtained for 1973 specimens through direct measurement of mantle lengths (ML) or estimated using lower rostral/hood lengths of lower beaks. Cephalopod diversity (number of species) was highest in predator diets from the SAB (N=19), intermediate in NE (N=18), and lowest in the MAB (N=9); however, differences may reflect unequal sampling effort among regions. The most important cephalopods across predator diets by number and frequency of occurrence were from

the families Ommastrephidae, Argonautidae, Loliginidae, and Histioteuthidae. Shortfin squid (Illex illecebrosus) and paper nautilus (Argonauta sp.) were the most recurrent species identified across spatiotemporal scales; size distributions of these two species varied significantly among regions, and the largest individuals on average were found in the MAB. Results demonstrate that although pelagic predators consumed a broad range of cephalopod species, octopods and squids from the families Argonautidae and Ommastrephidae dominated the collective diets of numerous pelagic teleosts and elasmobranchs, and play a key role in offshore food-webs of the Northwest Atlantic Ocean. This study emphasizes the value of using predators as biological samplers to gain information on cephalopod biogeography, and as a potential approach to track ecosystem changes in this region due to environmental and anthropogenic stressors.

2012

Arendt, M. D., Segars, A. L., Byrd, J. I., Boynton, J., Schwenter, J. A., Whitaker, J. D., & Parker, L. (2012). Migration, Distribution, and Diving Behavior of Adult Male Loggerhead Sea Turtles (*Caretta caretta*) Following Dispersal from a Major Breeding Aggregation in the Western North Atlantic. *Marine Biology, 159*(1), 113-125 https://doi.org/10.1007/s00227-011-1826-0

Sixteen satellite-tagged adult male loggerhead sea turtles (Caretta caretta) dispersed widely from an aggregation near Port Canaveral, Florida, USA (28°230N, -80°320W) after breeding. Northbound males migrated further (990 ± 303 km) than southbound males (577 ± 168 km) and transited more rapidly (median initial dive duration = 6 (IQR = 4–16) versus 19 (IQR = 10–31) min, respectively).. Migration occurred along a depth corridor (20–40 m) except where constricted by a narrow continental shelf width. Males foraged in areas 27 ± 41 km2 day-1 at locations\1–80 km from shore for 100.1 ± 60.6 days, with variability in foraging patterns not explained by turtle size or geography. Post-breeding dispersal patterns were similar to patterns reported for adult female loggerhead sea turtles in this region and adult male loggerhead sea turtles elsewhere in the northern hemisphere; however, foraging ground distributions were most similar to adult female loggerhead sea turtles in this region.

Galuardi, B., & Lutcavage, M. (2012). Dispersal Routes and Habitat Utilization of Juvenile Atlantic Bluefin Tuna, *Thunnus thynnus*, Tracked with Mini PSAT and Archival Tags. *PLOS ONE, 7*(5) https://doi.org/10.1371/journal.pone.0037829

Between 2005 and 2009, we deployed 58 miniature pop-up satellite archival tags (PSAT) and 132 implanted archival tags on juvenile Atlantic bluefin tuna (age 2–5) in the northwest Atlantic Ocean. Data returned from these efforts (n = 26 PSATs, 1 archival tag) revealed their dispersal routes, horizontal and vertical movements and habitat utilization. All of the tagged bluefin tuna remained in the northwest Atlantic for the duration observed, and in summer months exhibited core-use of coastal seas extending from Maryland to Cape Cod, MA, (USA) out to the shelf break. Their winter distributions were more spatially disaggregated, ranging south to the South Atlantic Bight, northern Bahamas and Gulf Stream. Vertical habitat patterns showed that juvenile bluefin tuna mainly occupied shallow depths (mean = 5–12 m, sd = 15–23.7 m) and relatively warm water masses in summer (mean = 17.9–20.9°C, sd = 4.2–2.6°C) and had deeper and more variable depth patterns in winter (mean = 41–58 m, sd = 48.9–62.2 m). Our tagging results reveal annual dispersal patterns, behavior and oceanographic associations of juvenile Atlantic bluefin tuna that were only surmised in earlier studies. Fishery independent profiling

from electronic tagging also provide spatially and temporally explicit information for evaluating dispersals rates, population structure and fisheries catch patterns.

Putman, N. F., Scott, R., Verley, P., Marsh, R., & Hays, G. C. (2012). Natal Site and Offshore Swimming Influence Fitness and Long-Distance Ocean Transport in Young Sea Turtles. *Marine Biology, 159*(10), 2117-2126 https://doi.org/10.1007/s00227-012-1995-5

Although long-distance transport of marine organisms is constrained by numerous oceanic and biological factors, some species have evolved life-histories reliant on such movements. We examine the factors that promote long-distance transport in a transoceanic migrant, young loggerhead sea turtles (Caretta caretta), from the southeastern U.S. Empirical data from near-surface buoys and simulations in two ocean circulation models indicated that passive drifters are often retained for long periods shoreward of oceanic fronts that delineate coastal and offshore waters. Further simulations revealed that offshore swimming aided newly hatched turtles in moving past fronts and increased turtles' probability of survival, reaching distant foraging grounds, and encountering favorable temperatures. Swimming was most beneficial in regions that were more favorable under scenarios assuming passive drift. These results have broad implications for understanding the movement processes of many marine species, highlighting likely retention of more planktonic species and potential for dispersal in more nektonic species.

Putman, N. F., Verley, P., Shay, T. J., & Lohmann, K. J. (2012). Simulating Transoceanic Migrations of Young Loggerhead Sea Turtles: Merging Magnetic Navigation Behavior with an Ocean Circulation Model. *Journal of Experimental Biology, 215*(11), 1863-1870 https://doi.org/10.1242/jeb.067587

Young loggerhead sea turtles (Caretta caretta) from eastern Florida, USA, undertake a transoceanic migration in which they gradually circle the Sargasso Sea before returning to the North American coast. Loggerheads possess a 'magnetic map' in which regional magnetic fields elicit changes in swimming direction along the migratory pathway. In some geographic areas, however, ocean currents move more rapidly than young turtles can swim. Thus, the degree to which turtles can control their migratory movements has remained unclear. In this study, the movements of young turtles were simulated within a high-resolution ocean circulation model using several different behavioral scenarios, including one in which turtles drifted passively and others in which turtles swam briefly in accordance with experimentally derived data on magnetic navigation. Results revealed that small amounts of oriented swimming in response to regional magnetic fields profoundly affected migratory routes and endpoints. Turtles that engaged in directed swimming for as little as 1–3 h per day were 43–187% more likely than passive drifters to reach the Azores, a productive foraging area frequented by Florida loggerheads. They were also more likely to remain within warm-water currents favorable for growth and survival, avoid areas on the perimeter of the migratory route where predation risk and thermal conditions pose threats, and successfully return to the open-sea migratory route if carried into coastal areas. These findings imply that even weakly swimming marine animals may be able to exert strong effects on their migratory trajectories and open-sea distributions through simple navigation responses and minimal swimming.

Scott, R., Hodgson, D. J., Witt, M. J., Coyne, M. S., Adnyana, W., Blumenthal, J. M., . . . Godley, B. J. (2012). Global Analysis of Satellite Tracking Data Shows That Adult Green Turtles Are Significantly Aggregated in Marine Protected Areas. *Global Ecology and Biogeography, 21*(11), 1053-1061 https://doi.org/10.1111/j.1466-8238.2011.00757.x

Aim: Tracking technologies are often proposed as a method to elucidate the complex migratory life histories ofmigratory marine vertebrates, allowing spatially explicit threats to be identified and mitigated. We conducted a global analysis of foraging areas ofadult green turtles (Chelonia mydas) subject to satellite tracking (n = 145) and the conservation designation of these areas according to International Union for Conservation of Nature criteria. Location: The green turtle has a largely circumtropical distribution, with adults migrating up to thousands of kilometres between nesting beaches and foraging areas, typically in neritic seagrass or algal beds. Methods: We undertook an assessment of satellite tracking projects that followed the movements of green turtles in tropical and subtropical habitats. This approach was facilitated by the use of the Satellite Tracking and Analysis Tool (http://www.seaturtle.org) and the integration of publicly available data on Marine Protected Areas (MPAs). Results: We show that turtles aggregate in designated MPAs far more than would be expected by chance when considered globally (35% of all turtles were located within MPAs) or separately by ocean basin (Atlantic 67%, Indian 34%, Mediterranean 19%, Pacific 16%). Furthermore, we show that the size, level ofprotection and time of establishment of MPAs affects the likelihood of MPAs containing foraging turtles, highlighting the importance of large, well-established reserves.
Main conclusions: Our findings constitute compelling evidence of the worldwide effectiveness of extant MPAs in circumscribing important foraging habitats for a marine megavertebrate.

2011

Able, K. W., Allen, D. M., Bath-martin, G., Hare, J. A., Hoss, D. E., Marancik, K. E., . . . Wenner, C. (2011). Life History and Habitat Use of the Speckled Worm Eel, *Myrophis punctatus*, Along the East Coast of the United States. *Environmental Biology of Fishes, 92*(2), 237-259 https://doi.org/10.1007/s10641-011-9837-8

Many species of fishes along the east coast of the United States have complex life histories, especially those that move over hundreds of kilometers across ocean and estuarine habitats. To further unravel the life history of one of these, the speckled worm eel, Myrophis punctatus we examined samples from extensive time series and discrete samples collected in the ocean and estuaries between Florida and Massachusetts. We now surmise spawning occurs between fall and early winter in the ocean south of Cape Hatteras, North Carolina and in the vicinity of the Bahamas. The pelagic leptocephalus larvae (10-80 mm Total Length [TL]) are transported north in the Gulf Stream and across the continental shelf to arrive at estuarine inlets at ages of 53 - 110 days. Their estuarine immigration and abundance varies along the east coast, with higher levels occurring at inlets in South Carolina (North Inlet), and North Carolina (Beaufort Inlet), during the winter and early spring. Much lower abundances occur in New Jersey (Little Egg Inlet) in winter and spring and again in the summer. These ingressing individuals were euryodontic leptocephali and metamorphic stages and were shrinking to lengths of 76-52 mm TL as these stages progressed. Metamorphic individuals and glass eels subsequently settle and burrow in estuarine sediments, as do all subsequent stages, and thereby become relatively unavailable to many sampling gears. In estuaries they attained sizes up to 440 mm TL. Later, they presumably enter the ocean to spawn because that is where the smallest larvae are found.

Auster, P. J., David Grenda, Jeff Godfrey, Eric Heupel, Auscavitch, S., & Mangiafico, J. (2011). Behavioral Observations of Lilliputian Piscivores: Young-of-Year *Sphyraena barracuda* at Offshore Sub-Tropical Reefs (NW Atlantic Ocean). *Southeastern Naturalist, 10*(3), 563-569 https://doi.org/10.2307/41262937

Direct observations were made in June 2009 and 2010 of newly recruited young-of-year (YOY) Sphyraena barracuda (Great Barracuda; 50-80 mm total length) occuring on "live bottom" sub-tropical reefs off the southeast US at depths of 18-25 m. Counts of YOY fish from roving diver surveys along multiple reefs with under-cut ledges ranged from 0-122 individuals, indicating patchy distributions at the scale of individual reefs. Individual fish occured in groups of 2-20+, primarily along the undercut side of ledges, where dense schools of Haemulon aurolineatum (Tomtate), Decapterus punctatus (Round Scad), Decapterus macarellus (Mackeral Scad), Stenotomus chrysops (Scup), and Atherinid sp. (silverside) were concentrated. Groups of YOY Great Barracuda attacked, captured and consumed YOY Tomtate and Silverside that occured in schools in the water column adjacent to (just above the sediment- water interface) and directly above the undercut edge of the reefs. Prey reacted during attacks by reducing nearest neighbor distances and retreating to the reef edge, where they were subsequently attacked by the demersal piscivores Centropristis striata (Black Sea Bass), Centropristis ocyurus (Bank Sea Bass), and Mycteroperca phenax (Scamp Grouper). That groups of YOY piscivores, at sizes close to settlement, can assume such a functional role in regards to driving such species interactions suggests greater attention should be given to the roles played by the wider diversity of YOY piscivores recruiting to reef communities.

Divine, L. M. (2011). *Effects of Sediment on Growth and Survival of Various Juvenile Morphologies of the Scleractinian Coral, Ocunlina arbusucula (Verrill).* Thesis, Master of Science in Biology, Georgia Southern University. Retrieved from https://digitalcommons.georgiasouthern.edu/etd/750

Sedimentation can play an important role in shaping tropical and temperate benthic marine communities. Here, I quantified sedimentation rates on a hard-bottom reef in the South Atlantic Bight (SAB) off the coast of Georgia, USA and assessed its effects on a conspicuous member of the benthic community: the scleractinian coral, Oculina arbuscula. I addressed the predictions that: 1) inorganic and organic sedimentation rates vary in relation to wind speed and wave height in the SAB, 2) the ability of juvenile O. arbuscula to shed sediment depends on skeletal morphology, and 3) inorganic sedimentation reduces growth and survival of encrusting O. arbuscula juveniles more than those with a branching morphology. The first prediction was tested by quantifying sedimentation rates from July 2008-October 2010 at J-Y Reef, a hard bottom reef at 18-20 m depth ~32 km off the coast of Sapelo Island, GA. Collected sediments were divided into inorganic and organic fractions and compared with wave height and wind speed from the region. Results showed that organic material comprised ~3% of total sediment. Inorganic sediments consistently exceeded 50 mg cm-2 day-1 and were positively correlated with wave height and wind speed. The second prediction was investigated by documenting passive and active sediment shedding abilities in juvenile O. arbuscula with morphologies ranging from encrusting to branching. Laboratory experiments showed that juveniles with greater branching morphology exhibited better passive sediment shedding ability under both low (30 mg cm-2) and high (100 mg cm-2) sediment regimes. However, this morphological advantage was nullified when active sediment shedding mechanisms were included. The third prediction was tested by investigating the relationship between inorganic sedimentation and growth and survival of O. arbuscula juveniles settled on artificial recruitment tiles. Mortality of coral recruits was positively correlated with sedimentation. Juveniles with

a branching morphology survived best under sediment stress. Collectively, these results provide evidence that sedimentation can affect the population structure of O. arbuscula via mortality at the juvenile stage and that developing a branched morphology early in life provides a selective advantage for countering the negative impacts imposed by the high sediment loads present on Georgia offshore reefs.

Harding, J. M., Walton, W. J., Trapani, C. M., Frick, M. G., & Mann, R. (2011). Sea Turtles as Potential Dispersal Vectors for Non-Indigenous Species: The Veined Rapa Whelk as an Epibiont of Loggerhead Sea Turtles. *Southeastern Naturalist, 10*(2), 233-244 https://doi.org/10.1656/058.010.0204

We present the first record of Rapana venosa (Veined Rapa Whelk) as an epibiont of Caretta caretta (Loggerhead Sea Turtle) and the first observation of rapa whelks in the South Atlantic Bight, USA. Veined Rapa Whelks are invasive shellfish predators. The only known North American population of Veined Rapa Whelks is in the southern Chesapeake Bay. Collections of Veined Rapa Whelks as epibionts on Loggerhead Sea Turtles from Norfolk, VA and Wassaw Island, GA present a previously undescribed vector for whelk range expansion to widely separated coastal habitats. In October 2008, a live juvenile Loggerhead stranded near Norfolk, VA with a Veined Rapa Whelk attached to its carapace. Since May 2005, a total of eight Loggerheads with Veined Rapa Whelks as epibionts have been observed nesting on Wassaw Island, GA. The shell lengths of the two smallest Wassaw Island whelks (1.9 and 2.6 mm) indicate that the whelks settled from the plankton 24-48 hr immediately prior to collection in Georgia. This time frame is not commensurate with turtle migration from Chesapeake Bay to Wassaw Island and indicates a whelk source that is geographically distinct from the Chesapeake Bay. Rapa whelk use of Loggerhead carapaces as settlement and juvenile habitat is of serious concern given the observed potential for coastal and oceanic migrations by turtles to facilitate Veined Rapa Whelk dispersal.

Hawkes, L. A., Matthew J. Witt, Annette C. Broderick, John W. Coker, Michael S. Coyne, Mark Dodd, . . . Godley, B. J. (2011). Home on the Range: Spatial Ecology of Loggerhead Turtles in Atlantic Waters of the USA. *Diversity and Distributions, 17*(4), 624-640 https://doi.org/10.2307/41242807

Aim: Although satellite tracking has yielded much information regarding th migrations and habitat use of threatened marine species, relatively little has be published about the environmental niche for loggerhead sea turtles Caretta caret in north-west Atlantic waters. Location: North Carolina, South Carolina and Georgia, USA. Methods: We tracked 68 adult female turtles between 1998 and 2008, one of the largest sample sizes to date, for 372.2 ± 210.4 days (mean ± SD). Results: We identified two strategies: (1) 'seasonal' migrations between summer and winter coastal areas (n = 47), although some turtles made oceanic excursions (n = 4) and (2) occupation of more southerly 'year-round' ranges (n = 18). Seasonal turtles occupied summer home ranges of 645.1 km2 (median, n = 42; using ot-hulls) predominantly north of 35 ° latitude and winter home ranges of 339.0 km2 (n = 24) in a relatively small area on the narrow shelf off North Carolina. We tracked some of these turtles through successive summer (n = 8) and winter (n = 3) seasons, showing inter-annual home range repeatability to within 14.5 km of summer areas and 10.3 km of winter areas. For year-round turtles, home ranges were 1889.9 km2. Turtles should be tracked for at least 80 days to reliably estimate the home range size in seasonal habitats. The equivalent minimum duration for 'year-round' turtles is more complex to derive. We define an environmental envelope of the distribution of North American loggerhead turtles: warm

waters (between 18.2 and 29.2 °C) on the coastal shelf (in depths of 3.0-89.0 m). Main conclusions: Our findings show that adult female loggerhead turtles show predictable, repeatable home range behaviour and do not generally leave waters of the USA, nor the continental shelf (< 200m depth). These data offer insights for future marine management, particularly if they were combined with those from the other management units in the US

Stratton, M. (2011). *An Ecosystem Perspective: Temporal Analysis of the Reef Fish Assemblage in Southeast U.S. Atlantic Continental Shelf Waters.* Master's Thesis, College of Charleston. Retrieved from https://pqdtopen.proquest.com/pubnum/1500247.html?FMT=AI

Of the myriad species inhabiting live-bottom reefs off the southeast U.S. Atlantic coast, many are economically valuable finfish species in the snapper-grouper management complex. The majority of these species are managed based on single-species (SS) assessment models, which do not parameterize important variables such as interspecific trophic interactions and environmental impacts (among others). These shortcomings of SS assessments, along with the overexploited status of multiple stocks in the complex and the inherent multi-species nature of the fishery, lend cause for more holistic assessment and management approaches for this fishery. Towards this goal, the current study applied ecosystem indicators to monitor the status of the reef fish assemblage from Cape Lookout, NC to Cape Canaveral, FL (13−60 m depth). Utilizing a 20-year dataset (1990−2009) from a fishery-independent baited trap survey, temporal analysis (all species combined) revealed a consistent increase in mean fish size but an overall decrease in the number of fish and total biomass (i.e. there are now fewer, but larger fish in the system). Changes in metrics describing the biomass-size spectrum also indicate temporal shifts in the distribution of fish biomass towards larger size classes. While overall reef fish biomass has decreased, the percentage of community biomass comprised of especially marketable species ("targeted" stocks) has increased. Collective results from size- and production-based indicators are consistent with concomitant fisherydependent trends, which show a decrease in commercial harvest of reef fishes since 1990 (primarily due to implemented size and catch restrictions). Importantly, temporal decreases in overall biomass highlight the necessity to consider gear selectivity when interpreting time series. Mean δ15N (a trophic level proxy), rarefied annual species richness, and annual species heterogeneity (Simpson's index-1) showed no overall change from 1990−2009. Future exploratory assessments of reef fishes should emphasize aggregate species approaches, a concept that has already materialized in management regulations.

2010

Fautin, D., Dalton, P., Incze, L. S., Leong, J.-A. C., Pautzke, C., Rosenberg, A., . . . Wolff, N. (2010). An Overview of Marine Biodiversity in United States Waters. *5*(8), e11914 https://doi.org/10.1371/journal.pone.0011914

Marine biodiversity of the United States (U.S.) is extensively documented, but data assembled by the United States National Committee for the Census ofMarine Life demonstrate that even the most complete taxonomic inventories are based on records scattered in space and time. The best-known taxa are those of commercial importance. Body size is directly correlated with knowledge of a species, and knowledge also diminishes with distance from shore and depth. Measures of biodiversity other than species diversity, such as ecosystem and genetic diversity, are poorly documented. Threats to marine biodiversity in the U.S. are the same as those for most of the world: overexploitation of living resources;

reduced water quality; coastal development; shipping; invasive species; rising temperature and concentrations ofcarbon dioxide in the surface ocean, and other changes that may be consequences of global change, including shifting currents; increased number and size of hypoxic or anoxic areas; and increased number and duration of harmful algal blooms. More information must be obtained through field and laboratory research and monitoring that involve innovative sampling techniques (such as genetics and acoustics), but data that already exist must be made accessible. And all data must have a temporal component so trends can be identified. As data are compiled, techniques must be developed to make certain that scales are compatible, to combine and reconcile data collected for various purposes with disparate gear, and to automate taxonomic changes. Information on biotic and abiotic elements of the environment must be interactively linked. Impediments to assembling existing data and collecting new data on marine biodiversity include logistical problems as well as shortages in finances and taxonomic expertise.

Fiore, C. L., & Jutte, P. C. (2010). Characterization of Macrofaunal Assemblages Associated with Sponges and Tunicates Collected Off the Southeastern United States. *Invertebrate Biology, 129*(2), 105-120 https://doi.org/10.1111/j.1744-7410.2010.00184.x

Sponges can serve as hosts to invertebrate assemblages that live and reproduce within them. Sponges also constitute a major part of the benthic epifaunal community on the continental shelf of the southeastern United States; however, little is known about these sponges and the assemblages they harbor. In this study, the associated fauna from a variety of sponges and one species of tunicate collected by submersible from the continental shelf and slope of the southeastern United States at depths in the range 18-875 m were examined. Seventeen sponges, comprising eight species (Ircinia campana, Topsentia sp., Geodia sp., Characella sp., Erylus sp., Apylsina archeri, Cliona sp., and Pheronema carpenteri), and three tunicate colonies (Didemnidae) were fully dissected and all associated organisms were identified and counted. Additionally, the sponges Pheronema annae (951 m) and P. carpenteri (770 m) represent new records for the region. The diversity (H') and density of associates varied considerably among hosts; the densities of associates ranged 0.4-11,684 per 1 L of host volume. Polychaete worms were the most common organisms found, with one species, Haplosyllis spongicola, being especially abundant in I. campana, Topsentia sp., and Cliona sp. The amphipods Ericthonius punctatus and Leucothoe cf. spinicarpa, as well as decapods such as snapping shrimp (Synalpheus sp.) and crabs (e.g., Pilumnus floridana, Micropanope urinator), were also common. The number of symbiont taxa did not significantly increase as the sponge size increased. However, weak positive trends were found between the diversity of associates and increasing canal diameter. Sponges and tunicates were judged to represent legitimate ecological communities harboring a complete food web as well as gravid and juvenile individuals.

Hale, S. S. (2010). Biogeographical Patterns of Marine Benthic Macroinvertebrates Along the Atlantic Coast of the Northeastern USA. *Estuaries and Coasts, 33*(5), 1039-1053 https://doi.org/10.1007/s12237-010-9332-z

The biogeography of marine benthic macroinvertebrates of US Atlantic estuaries and inshore coastal areas from Delaware Bay north to Passamaquoddy Bay was studied to compare recent data with historical biogeographic studies, define physical-chemical factors affecting species' distributions, and provide information for calibrating benthic indices of environmental condition. Five years (2000-2004) of data from 614 non-polluted, soft-bottom stations from the National Coastal Assessment were analyzed.

Multi-dimensional scaling done on Bray-Curtis similarity matrices of species' relative abundance (547 species) suggested seven subregions: two based on salinity (oligohaline, mesohaline) and five based on latitude. Species' distribution patterns for stations with salinities ≥18 (n=558) were strongly influenced by latitude; Cape Cod was a clear faunal transition zone (R=0.92, p<0.001). Conversely, for stations with salinities <18 (n=56), salinity was the more important factor. An ordination of abiotic variables (temperature, salinity, sediment percent silt-clay, depth) correlated well with the ordination of species' relative abundance data (R=0.77, p<0.001). The first split of a multivariate regression tree was by a summer bottom temperature of 20°C at Cape Cod. Salinity and percent silt-clay led to further splits. These results support the existence of Virginian and Transhatteran biogeographic provinces. They constitute a baseline for addressing broad-scale and long-term issues such as global climate change, species invasions, and conservation planning.

Muñoz, R. C., Whitfield, P. E., & Buckel, C. A. (2010). *Summary Report to Gray's Reef National Marine Sanctuary: Fish and Habitat Community Assessments, August 18-21, 2010.* Center for Coastal Fisheries and Habitat Research. Retrieved from https://graysreef.noaa.gov/science/publications/pub_current.html

Gray's Reef National Marine Sanctuary (GRNMS) is located 16 miles offshore of Sapelo Island, Georgia, in the South Atlantic Bight (SAB), where it protects 22 square miles of live-bottom habitat. NOAA is proposing to establish a research area in GRNMS to increase the opportunity to scientifically discriminate between natural and human-induced change to living sanctuary resources. One goal proposed for evaluation with the research area is to determine the effect of bottom fishing on benthic fish populations. To this end, in August 2010 we conducted benthic habitat and fish community surveys of six sites located within the proposed research area and six sites located outside the research area. At each site, we measured structural ledge characteristics (e.g., height, undercut height), determined benthic habitat biota with a series of stationary photoquadrats, and censused the conspicuous and cryptic fish communities with a combination of linear band transects and stationary quadrats. Overall, no significant differences in conspicuous fishes, cryptic/juvenile prey fishes, or habitat community structure were seen between management zones. However, robust comparisons between management zones were not possible nor expected given the lack of statistical power from the low samples sizes of this preliminary study. The dominant members of the fish community that we observed were consistent with previous studies from GRNMS spanning nearly 25 years, suggesting stability in the species composition of the top five to ten most abundant species on the live-bottom reefs. Our results provide a detailed census of live-bottom fish and benthic community structure that offer information as to the stability of the populations and also a template for additional comprehensive sampling scheduled for Spring/Summer 2011. We include a brief discussion and comparison of potential sampling methods for benthic habitat and fishes that may be useful when selecting protocols for future comprehensive sampling. Once accomplished, the planned increase in sample size of 20-48 medium to high relief sites per management zone will provide an ample pre-implementation baseline for live-bottom areas inside and outside the research area, anticipated for 2011.

Piecuch, C., Rossby, H. T., & Rynearson, T. (2010). Connecting High-Chlorophyll Regions in the North Atlantic: A Lagrangian Look at the Biogeographic Connectivity of Marine Plankton. *Eos Transactions AGU, Ocean Science Meeting Supplement* (26) Retrieved from https://abstractsearch.agu.org/meetings/2010/OS/IT25F-01.html

Recent population genetic studies of marine eukaryotes have revealed rich spatial and temporal patterns of diversity, indicating that a combination of differential selection and geographic isolation may influence the fine-scale biogeography of marine plankton. Critically, the physical mechanisms driving the observed patterns of genetic diversity are not well understood. At present, the role of surface-ocean fluid transport in physically connecting marine planktonic populations separated by space and time largely has remained unexplored. Here, we investigated Lagrangian drifter trajectories between high-chlorophyll regions of the North Atlantic Ocean to examine regional physical connectivity. Our drifter data set comprised 940 drifter-years of trajectory measurements taken by 1100 WOCE holey sock drogues from 1989-2008. The northwest North Atlantic was divided into a network of 14 geographic regions from the South Atlantic Bight to Iceland. Interregional connectivity was determined using transit time spectra, which measure the probability of transit from one region to another as a function of time. Transit time spectra were used to explore the transport of hypothetical phytoplankton cells between regions both forward and backward in time on timescales <= 1 year. Preliminary results provide probabilistic insight into the nature of surface-ocean material exchange in the North Atlantic. For example, the shelf break of eastern North America from Cape Hatteras to the Flemish Cap was observed to be an asymmetric barrier to transport, restricting flow from the open ocean onto the continental shelf, and the North Atlantic Current (40-51) was apparent as a considerable barrier to meridional transport. From a population dynamic perspective, these calculations can provide baseline estimates for interregional immigration and emigration rates. On-going analyses involve partitioning the drifter dataset into seasonal components to resolve seasonal variability in transit time spectra. This approach complements contemporary population genetic studies of marine plankton, illuminating transit times and magnitudes, identifying potential dispersal barriers, and identifying the origins and destinations of plankton cells before and after blooms.

Putman, N. F., Bane, J. M., & Lohmann, K. J. (2010). Sea Turtle Nesting Distributions and Oceanographic Constraints on Hatchling Migration. *Proceedings B, 277*(1700), 3631-3637 https://doi.org/10.1098/rspb.2010.1088

Patterns of abundance across a species's reproductive range are influenced by ecological and environmental factors that affect the survival of offspring. For marine animals whose offspring must migrate long distances, natural selection may favour reproduction in areas near ocean currents that facilitate migratory movements. Similarly, selection may act against the use of potential reproductive areas from which offspring have difficulty emigrating. As a first step towards investigating this conceptual framework, we analysed loggerhead sea turtle (Caretta caretta) nest abundance along the southeastern US coast as a function of distance to the Gulf Stream System (GSS), the ocean current to which hatchlings in this region migrate. Results indicate that nest density increases as distance to the GSS decreases. Distance to the GSS can account for at least 90 per cent of spatial variation in regional nest density. Even at smaller spatial scales, where local beach conditions presumably exert strong effects, at least 38 per cent of the variance is explained by distance from the GSS. These findings suggest that proximity to favourable ocean currents strongly influences sea turtle nesting distributions. Similar factors may influence patterns of abundance across the reproductive ranges of diverse marine animals, such as penguins, eels, salmon and seals.

T. Dale Bishop, Harlan L. Miller III, Randal L. Walker, Dorset H. Hurley, Menken, T., & Tilburg, C. E. (2010). Blue Crab (*Callinectes sapidus* Rathbun, 1896) Settlement at Three Georgia (USA) Estuarine Sites. *Estuaries and Coasts, 33*(3), 688-698 https://doi.org/10.1007/sl2237-009-9259-4

The blue crab, Callinectes sapidus Rathbun, 1896, represents the second most important fishery for coastal Georgia; yet, little is known about environmental forces that affect planktonic postlarval settlement in the region. Here, we describe a study to examine the physical mechanisms responsible for blue crab settlement in the extensive salt marsh system of coastal Georgia. Bottom and surface samplers were placed at three sites along a salinity gradient from a low-salinity site in the Altamaha River to a high-salinity area of the Duplin River, Sapelo Island, GA, USA during 2005. Megalopae and juvenile monitoring occurred from July through December. The majority of both megalopae (86.8%) and juvenile (89.3%) blue crabs were recovered in bottom samplers at the low-salinity Altamaha River site during August and early September. Few megalopae were collected at the surface of the Altamaha River or at the two higher-salinity sites in the Duplin and North Rivers. Downwelling winds were unable to explain all settlement events; however, winds with an onshore component regularly preceded settlement events. The use of a multiple-regiression model revealed a lagged relationship (r=0.5461, lag=0-2 days) between wind events, temeprature, salinity, maximum tidal height and settlement.

2008

Fraser, S. B., & Sedberry, G. R. (2008). Reef Morphology and Invertebrate Distribution at Continental Shelf Edge Reefs in the South Atlantic Bight. *Southeastern Naturalist, 7*(2), 191-206 https://doi.org/10.1656/1528-7092(2008)7[191:Rmaida]2.0.Co;2

Video footage recorded from 14 submersible dives on the continental shelf edge was used to describe and categorize reef morphology and quantify density and number of morphotypes of large sponges and corals. Significant variation in number of morphotypes and density of three dominant species among temperature classes, depth classes, and reef morphology categories was tested using a multiple response permutation procedure. The greatest densities of Ircinia campana, Stichopathes sp., and Muricea pendula, and the largest numbers of morphotypes were found between 18.1 and 21.0 degrees C and at depths between 51.0 and 60.9 m. Among reef morphology types, those that contained unconsolidated sediments such as "sand" and "large boulders with sand" exhibited the lowest densities and richness of morphotypes, while "block-shaped boulders," "buried block-shaped boulders," and "low-relief bioeroded" reefs had the greatest densities and largest numbers of coral and sponge morphotypes. Rocky reefs along the shelf edge with rough texture, complexity, and relief provide favorable conditions for epibenthic invertebrates. The warming and stabilizing effect of the Gulf Stream along the continental shelf edge allows some sessile macrofauna to inhabit deeper waters and more northern latitudes.

2007

Epperly, S. P., Braun-McNeill, J., & Richards, P. M. (2007). Trends in Catch Rates of Sea Turtles in North Carolina, USA. *Endangered Species Research, 3*, 283-293 https://doi.org/10.3354/esr00054

Sea turtles captured in pound nets during the autumn and early winter in the Pamlico Albermarle Estuarine Complex, North Carolina, USA, were sampled 1995–1997 and 2001–2003 to monitor trends in catch rates during their autumn emigration from the temperate sounds. Juvenile loggerhead turtles Caretta caretta were the most frequent species encountered, followed by green turtles Chelonia mydas and Kemp's ridley turtles Lepidochelys kempii. Several different subpopulations with origins throughout

the western North Atlantic were represented on these foraging grounds. The catch rates of loggerhead turtles increased significantly at a rate of 13% yr–1. Despite annual increases in the major contributing nesting beach populations in excess of 10% yr–1, we did not detect a trend in catch rates for either green or Kemp's ridley turtles, perhaps due to low statistical power. There was a significant increase in size of loggerhead turtles over time. We also detected a significant difference in annual size distributions of green and Kemp's ridley sea turtles, but there was no discernable pattern. We conclude that long-term studies on the sea turtles' foraging grounds, at multiple sites, are needed to monitor the status of sea turtle populations.

Love, J. W., & Chase, P. D. (2007). Marine Fish Diversity and Composition in the Mid-Atlantic and South Atlantic Bights. *Southeastern Naturalist, 6*(4), 705-714 Retrieved from http://www.jstor.org/stable/20203957

We sampled fishes from nearshore, continental shelf (≈30 m) to shelf-slope, deep-water habitats (≈100 m) in the Mid-Atlantic Bight (MAB) and South Atlantic Bight (SAB) during winter (2005) to explore compositional differences among temperatures and depths. Trawl surveys conducted by the National Marine Fisheries Service do not typically sample winter fish assemblages concurrently from both the MAB and SAB, although increased concern over changes in distribution of species such as Pterois volitans (Lionfish) may warrant such studies. We collected 41 families and 68 species of fish, and found that temperature and depth influenced their distribution. More species were collected in the SAB where temperature was 10 °C higher. At nearshore sites of SAB, we collected reef fishes (Chaetodontidae; Fistulariidae) and Stenotomus chrysops (Scup). At deep water sites of SAB, we collected Ophichthidae, Acropomatidae, and Scorpaenidae. Assemblages of the MAB were dominated by Squalus acanthias (Spiny Dogfish), particularly at nearshore sites. Pomatomus saltatrix (Bluefish) and Scomber scombrus (Atlantic Mackerel) were also abundant in the MAB. Our results highlight distributions of some fish species during winter. However, more data are necessary for understanding macroecological patterns of marine fish distribution in the northwestern Atlantic Ocean, especially as they relate to the interactive effects of temperature and depth on populations.

2006

Hyland, J., Cooksey, C., Balthis, W. L., Fulton, M., Bearden, D., McFall, G., & Kendall, M. (2006). The Soft-Bottom Macrobenthos of Gray's Reef National Marine Sanctuary and Nearby Shelf Waters Off the Coast of Georgia, USA. *330*(1), 307-326 https://doi.org/10.1016/j.jembe.2005.12.036

As part of an ongoing ecological assessment of the Gray's Reef National Marine Sanctuary (GRNMS), a 58-km2 marine protected area 32 km off the coast of Georgia, USA, surveys of benthic macroinfaunal communities, contaminant levels in sediments and biota, and general habitat conditions were conducted during 2000–2002 at 20 stations within the sanctuary and along three cross-shelf transects in nearby shelf waters. Macroinfaunal community structure and composition exhibited distinct cross-shelf patterns associated with sediment granulometry, depth and possibly other factors related to shoreline proximity (e.g., erosional effects, recruitment of estuarine species). Finer-scale spatial patterns ofbenthic fauna among stations within the sanctuary appear to be related to proximity to live-bottom habitat and other features of seafloor structure (e.g., rippled vs. flat sand). Population densities ofdominant fauna within the sanctuary also varied considerably among years, resulting in shifts in the ranking of dominants at most stations. Chemical contaminants generally were at low background

concentrations below probable bioeffect levels and thus are not a likely cause of the observed spatial patterns of benthic fauna. However, trace concentrations of pesticides, PCBs, and PAHs were detectable in sediments and biota throughout the study area, demonstrating that chemicals originating from human activities are capable of reaching the offshore sanctuary environment, possibly from atmospheric deposition or cross-shelf transport of materials outwelled through coastal sounds. Highly diverse infaunal assemblages also were observed within the sanctuary and nearby sites ofsimilar depth, suggesting that the sanctuary is an important reservoir ofmarine biodiversity. Results of this study should be useful in addressing long-term science and management needs of the GRNMS and in furthering our understanding of broader ecological patterns and dynamics of the surrounding South Atlantic Bight (SAB) ecosystem.

Lindberg, W. J., Frazer, T. K., Portier, K. M., Vose, F., Loftin, J., Murie, D. J., . . . Hart, M. K. (2006). Density-Dependent Habitat Selection and Performance by a Large Mobile Reef Fish. *Ecological Applications, 16*(2), 731-746 Retrieved from http://www.jstor.org/stable/40061692

Many exploited reef fish are vulnerable to overfishing because they concentrate over hard-bottom patchy habitats. How mobile reef fish use patchy habitat, and the potential consequences on demographic parameters, must be known for spatially explicit population dynamics modeling, for discriminating essential fish habitat (EFH), and for effectively planning conservation measures (e.g., marine protected areas, stock enhancement, and artificial reefs). Gag, Mycteroperca microlepis, is an ecologically and economically important warm-temperate grouper in the southeastern United States, with behavioral and life history traits conducive to large-scale field experiments. The Suwannee Regional Reef System (SRRS) was built of standard habitat units (SHUs) in 1991-1993 to manipulate and control habitat patchiness and intrinsic habitat quality, and thereby test predictions from habitat selection theory. Colonization of the SRRS by gag over the first six years showed significant interactions of SHU size, spacing, and reef age; with trajectories modeled using a quadratic function for closely spaced SHUs (25 m) and a linear model for widely spaced SHUs (225 m), with larger SHUs (16 standardized cubes) accumulating significantly more gag faster than smaller 4-cube SHUs (mean = 72.5 gag/16-cube SHU at 225-m spacing by year 6, compared to 24.2 gag/4-cube SHU for same spacing and reef age). Residency times (mean = 9.8 mo), indicative of choice and measured by ultrasonic telemetry (1995-1998), showed significant interaction of SHU size and spacing consistent with colonization trajectories. Average relative weight $(W_{\rm{r}})$ and incremental growth were greater on smaller than larger SHUs (mean $W_{\rm{r}}$= 104.2 vs. 97.7; incremental growth differed by 15%), contrary to patterns of abundance and residency. Experimental manipulation of shelter on a subset of SRRS sites (2000-2001) confirmed our hypothesis that shelter limits local densities of gag, which, in turn, regulates their growth and condition. Density-dependent habitat selection for shelter and individual growth dynamics were therefore interdependent ecological processes that help to explain how patchy reef habitat sustains gag production. Moreover, gag selected shelter at the expense of maximizing their growth. Thus, mobile reef fishes could experience density-dependent effects on growth, survival, and/or reproduction (i.e., demographic parameters) despite reduced stock sizes as a consequence of fishing.

Walsh, H. J., Marancik, K. E., & Hare, J. A. (2006). Juvenile Fish Assemblages Collected on Unconsolidated Sediments of the Southeast United States Continental Shelf. *Fishery Bulletin, 104*(2), 256-277 Retrieved from https://spo.nmfs.noaa.gov/content/juvenile-fish-assemblages-collected-unconsolidated-sediments-southeast-united-states

Patterns were investigated in juvenile fish use of unconsolidated sediments on the southeast United States continental shelf off Georgia. Juvenile fish and environmental data were sampled at ten stations along a 110-km cross-shelf transect, including four stations surrounding Gray's Reef National Marine Sanctuary (Grays Reef NMFS). Cross-shelf stations were sampled approximately quarterly from spring 2000 to winter 2002. Additional stations were sampled on three transects inshore of Gray's Reef NMS and four transects offshore of the Sanctuary during three cruises to investigate along-shelf patterns in the juvenile fish assemblages. Samples were collected in beam trawls, and 121 juvenile taxa, of which 33 were reef-associated species, were identified. Correspondence analysis on untransformed juvenile fish abundance indicated a cross-shelf gradient in assemblages, and the station groupings and assemblages varied seasonally. During the spring, fall, and winter, three cross-shelf regions were identified: inner-shelf, mid-shelf, and outer-shelf regions. In the summer, the shelf consisted of a single-juvenile fish assemblage. Water depth was the primary environmental variable correlated with cross-shelf assemblages. However, salinity, density, and water column stratification also correlated with the distribution of assemblages during the spring, fall, and winter, and along with temperature likely influenced the distribution of juvenile fish. No along-shelf spatial patterns were found in the juvenile fish assemblages, but the along-shelf dimension sampled was small (similar to 60 km). Our results revealed that a number of commercially and recreationally important species used unconsolidated sediments on the shelf off Georgia as juvenile habitat. We conclude that management efforts would be improved through a greater recognition of the importance of these habitats to fish production and the interconnectedness of multiple habitats in the southeast U.S. continental shelf ecosystem.

2005

Brooke, S., & Young, C. M. (2005). Embryogenesis and Larval Biology of the Ahermatypic Scleractinian *Oculina varicosa*. *146*(4), 665-675 https://doi.org/10.1007/s00227-004-1481-9

The ivory tree coral Oculina varicosa (Leseur, 1820) is an ahermatypic branching scleractinian that colonizes limestone ledges at depths of 6–100 m along the Atlantic coast of Florida. This paper describes the development of embryos and larvae from shallow-water O. varicosa, collected at 6–8 m depth in July 1999 off Fort Pierce, Florida (27°32.542 N; 79°58.732 W). The effect of temperature on embryogenesis, larval survival, and larval swimming speed were examined in the laboratory. Ontogenetic changes in geotaxis and phototaxis were also investigated. Embryos developed via spiral cleavage from small (100 lm), negatively buoyant eggs. Ciliated larvae developed after 6–9 h at 25°C. Embryogenesis ceased at 10◦C, was inhibited at 17°C, and progressed normally at 25°C and 30°C. Larval survival, however, was high across the full range of experimental temperatures (11–31°C), although mortality increased in the warmest treatments (26°Cand 31°C). Larval swimming speed was highest at 25°C, and lower at the temperature extremes (5°Cand 35°C). An ontogenetic change in geotaxis was observed; newly ciliated larvae swam to the water surface and remained there for approximately 18 h, after which they swam briefly throughout the water column, then became demersal. Early larvae showed no response to light stimulation, but at 14 and 23 days larvae appeared to exhibit negatively phototactic behavior. Although low temperatures inhibited the development of O. varicosa embryos, the larvae survived temperature extremes for extended periods of time. Ontogenetic changes in larval behavior may ensure that competent larvae are close to the benthos to facilitate settlement. Previous experiments on survival, swimming speeds, and observations on behavior of O. varicosa larvae from deep-water adults indicate that there is no difference between larvae of the deep and shallow populations.

Marancik, K. E., Clough, L. M., & Hare, J. A. (2005). Cross-Shelf and Seasonal Variation in Larval Fish Assemblages on the Southeast United States Continental Shelf Off the Coast of Georgia. *Fishery Bulletin, 103*(1), 108-129 Retrieved from https://spo.nmfs.noaa.gov/content/cross-shelf-and-seasonal-variation-larval-fish-assemblages-southeast-united-states

Seasonal and cross-shelf patterns were investigated in larval fish assemblages on the continental shelf off the coast of Georgia. The influence of environmental factors on larval distributions also was examined, and larval transport processes on the shelf were considered. Ichthyoplankton and environmental data were collected approximately every other month from spring 2000 to winter 2002. Ten stations were repeatedly sampled along a 110-km cross-shelf transect, including four stations in the vicinity of Gray's Reef National Marine Sanctuary. Correspondence analysis (CA) on untransformed community data identified two seasonal (warm weather [spring, summer, and fall] and winter) and three cross-shelf larval assemblages (inner-, mid-, and outer-shelf). Five environmental factors (temperature, salinity, density, depth of the water column, and stratification) were related to larval cross-shelf distribution. Specifically, increased water column stratification was associated with the outer-shelf assemblage in spring, summer, and fall. The inner shelf assemblage was associated with generally lower temperatures and lower salinities in the spring and summer and higher salinities in the winter. The three cross-shelf regions indicated by the three assemblages coincided with the location of three primary water masses on the shelf. However, taxa occurring together within an assemblage were transported to different parts of the shelf, thus, transport across the continental shelf off the coast of Georgia cannot be explained solely by two-dimensional physical factors.

2002

Braun-McNeill, J., & Epperly, S. P. (2002). Spatial and Temporal Distribution of Sea Turtles in the Western North Atlantic and the U.S. Gulf of Mexico from Marine Recreational Fishery Statistics Survey (MRFSS). *Marine Fisheries Review, 64*(4), 50-56 Retrieved from http://spo.nwr.noaa.gov/mfr644/mfr6444.pdf

Limited data exist on sea turtle (Cheloniidae and Dermochelydae) distributions and seasonal patterns of movement, knowledge which can aid conservation managers in their efforts to protect sea turtles from potentially harmful human interaction (National Research Council, 1990). Systematic surveys (aerial, shipboard, strandings), in addition to opportunistic sightings by fishery observers and the general public, have been used to gather these important distributional data.

Carpenter, K. E. (Ed.) (2002). *The Living Marine Resources of the Western Central Atlantic. Volume 1: Introduction, Molluscs, Crustaceans, Hagfishes, Sharks, Batoid Fishes, and Chimaeras.* Rome: Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/3/y4160e/y4160e00.htm

This 3 volume field guide covers the species of interest to fisheries of the major marine resource groups exploited in the Western Central Atlantic. The area of coverage includes FAO Fishing Area 31. The marine resource groups included are the bivalves, gastropods, cephalopods, stomatopods, shrimps, lobsters, crabs, hagfishes, sharks, batoid fishes, chimaeras, bony fishes, sea turtles, and marine mammals. The introductory chapter outlines the environmental, ecological, and biogeographical factors influencing the marine biota, and the basic components of the fisheries in the Western Central Atlantic.

Within the field guide, the sections on the resource groups are arranged phylogenetically according to higher taxonomic levels such as class, order, and family. Each resource group is introduced by general remarks on the group, an illustrated section on technical terms and measurements, and a key or guide to orders or families. Each family generally has an account summarizing family diagnostic characters, biological and fisheries information, notes on similar families occurring in the area, a key to species, a checklist of species and a short list of relevant literature. Families that are less important to fisheries include an abbreviated family account and no detailed species information. Species in the important families are treated in detail (arranged alphabetically by genus and species) and include the species name, frequent synonyms and names of similar species, an illustration, FAO common name(s), diagnostic characters, biology and fisheries information, notes on geographical distribution, and a distribution map. For less important species, abbreviated accounts are used. Generally, this includes the species name, FAO common name(s), an illustration, a distribution map, and notes on biology, fisheries, and distribution. The final volume concludes with an index of scientific and common names.

Whitfield, P. E., Gardner, T., Vives, S. P., Gilligan, M. R., Courtenay, W. R., Ray, G. C., & Hare, J. A. (2002). Biological Invasion of the Indo-Pacific Lionfish *Pterois volitans* Along the Atlantic Coast of North America. *Marine Ecology Progress Series, 235*, 289-297 https://doi.org/10.3354/meps235289

The occurrence of lionfish Pterois volitans is reported from the western Atlantic Ocean. Adults were collected off the coasts of North Carolina, Georgia and Florida, and juveniles were collected along the shore of Long Island, New York. They have also been found around Bermuda. Lionfish are indigenous to tropical waters of the western Pacific and their occurrence along the east coast of the United States represents a human-induced introduction. Distribution of adults suggests lionfish are surviving in the western Atlantic and capture of juveniles provides putative evidence of reproduction. The most likely pathway of introduction is aquarium releases, but introduction via ballast water cannot be ruled out. The ecosystem of the southeastern United States continental shelf is already undergoing change: reef fish communities are becoming more tropical and many fish species are overfished, These ongoing changes, along with limited information regarding the biology of P. volitans, make predictions of long-term effects of the introduction difficult. This discovery represents the first, apparently successful introduction, of a marine fish from the western Pacific to Atlantic coastal waters of the United States.

2001

Sedberry, G. R., & Loefer, J. K. (2001). Satellite Telemetry Tracking of Swordfish, *Xiphias gladius* Off the Eastern United States. *Marine Biology, 139*(2), 355-360 Retrieved from https://link.springer.com/article/10.1007/s002270100593

Swordfish (Xiphias gladius) were tagged with satellite "pop-off" tags that release from the fish after a preprogrammed time, float to the sea surface, and transmit present position and archived temperature data. Swordfish were tagged on the "Charleston Bump," a topographic feature on the Blake Plateau east of South Carolina and Georgia. This feature is an important swordfishing ground and may be a spawning and nursery area. Swordfish were tagged in spring of 2000 to determine movements in relation to the Charleston Bump, and tags were programmed to pop off the fish at 30 days (n = 10 tags), 60 days (n = 10), and 90 days (n = 9). Although four swordfish were found in the vicinity of the Charleston Bump up to 90 days after tagging, most moved considerable distances to the east and northeast and were subsequently located in association with offshore seamounts, submarine canyons of the Middle Atlantic

Bight, and with thermal fronts of the northern wall of the Gulf Stream. The longest minimum (i.e., straight-line) distance tracked was 2,497 kin, and maximum speed inferred from tracking was 34 km/day. Seawater temperature data archived by the tags reflected diel vertical migrations in swordfish.

1998

Kellison, G. T., & Sedberry, G. R. (1998). The Effects of Artificial Reef Vertical Profile and Hole Diameter on Fishes Off South Carolina. *Bulletin of Marine Science, 62*(3), 763-780 Retrieved from https://www.ingentaconnect.com/content/umrsmas/bullmar/1998/00000062/00000003/art00005

Attraction of demersal finfish to six artificial reef designs off Charleston, South Carolina, was studied using a SCUBA visual census technique. The experiment was designed to examine the effect of (1) increased vertical profile and (2) hole diameter on the recruitment and retention of demersal finfish to each of the six artificial reef designs. Increased vertical profile was accomplished through the addition of fish aggregation devices (FADs) to half of the benthic artificial reef units, which were concurrently equipped with large diameter holes (25.4 cm diameter), small diameter holes (12.7 cm diameter), or no holes. Mean abundances of demersal finfish individuals were significantly greater on FAD units than on units lacking FADs. Hole diameter was only occasionally a significant factor affecting mean total number of demersal individuals and species and did not significantly affect estimated average total lengths of species present. Hole presence (both hole diameters) had a positive significant affect on mean numbers of demersal individuals and species. The dominant species observed on the reefs included Decapterus punctatus, Stenotomus chrysops, Centropristis striata, Monacanthus hispidus, and Haemulon aurolineatum. Early observations of the unit designs have already prompted the South Carolina Marine Artificial Reef Program to deploy artificial reef units of the same design in a permitted reef site.

1991

Hopkinson, C., Fallon, R., Jansson, B. O., & Schubauer, J. (1991). Community Metabolism and Nutrient Cycling at Gray's Reef, a Hard Bottom Habitat in the Georgia Bight. *Marine Ecology Press Series, 73*, 105-120 https://doi.org/10.3354/meps073105

Benthic and pelagic metabolism and nutrient fluxes were measured during summer on a hard bottom on the continental shelf of the Georgia Bight, USA. Internal pools of organic matter and nutrients in the sediments and water column were also measured and compared with physical transport associated with ocean currents. Gray's Reef is a heterogeneous system cons~sting of a mosaic of bare sand regions, hard bottom regions thinly veneered with shifting sands, and exposed rock outcrops. Sediment organic carbon content increased from < 0.2 % of dry weight in sandy regions to an epifaunal biomass >77 g C m-' on rock outcrops. Sponges and corals accounted for a large percentage of macrofaunal biomass when sands were shallow. Benthic metabolism and nutrient regeneration were positively related to the spatial distribution of epifaunal biomass. In regions of high epifaunal biomass respiration exceeded 133 mg C m-' d-' and nutrient flux amounted to 23 mm01 inorganic N, 1.8 mm01 inorganic P, and 24 and 0.4 mm01 m-'d-' dissolved organic N and P, respectively. The benthic community of Gray's Reef was markedly heterotrophic, consuming almost twice as much organic matter as was produced on the bottom (production:respiration = 0.52.1). Community respiration in the water column exceeded by ca 30 % a fairly high level of pelagic primary production of 2.15 g C m-* d-' The overall Gray's Reef system was

heterotrophic and strongly dependent on allochthonous organic carbon for support of almost one third of its total respiratory requirements (production : respiration = 0.68.1). A large percentage (> 50 %) of system biomass and respiration was attributable to filter-feeding organisms which are largely ungrazed, including corals and sponges. A net effect of this hard bottom system was the capture and removal of organic matter produced in the water column. As most of the macrofauna is ungrazed, this organic matter becomes unavailable for support of food chains leading to the production of commercially important fishes. We present some thoughts on the relationship between hard bottoms, in general, and the anomalously low level of fishery production in the Georgia Bight as a whole.

1987

Hales, L. S. (1987). Distribution, Abundance, Reproduction, Food-Habits, Age, and Growth of Round Scad, *Decapterus-punctatus*, in the South-Atlantic Bight. *Fishery Bulletin, 85*(2), 251-268 Retrieved from https://spo.nmfs.noaa.gov/content/distribution-abundance-reproduction-food-habits-age-and-growth-round-scad-decapterus

Five years ofbottom trawling indicated that round scad were abundant and widely distributed throughout the South Atlantic Bight in summer and fall, but less abundant and restricted to deeper (28-110 mI. warmer (>15°C) waters in winter and spring. Adults and juveniles were spatially segregated, with adults dominating catches in inner and outer shelf regions and juveniles dominating mid shelf regions year round. Catches over sponge-coral habitat were significantly greater than catches over sand bottom in winter. whereas catches over the two bottom types were similar in other seasons. This seasonal change in distribution may relate to higher productivity and temperature stability of live bottom habitats. Stomach contents indicated that round scad are diurnally feeding zooplanktivores; diets changed seasonally and increased in prey diversity with growth. Round scad spawn repeatedly from March through September. Daily growth analysis revealed that both sexes mature in 4-5 months at approximately 11 em fork length. The life span ofround scad could not be determined because the growth record ofotoliths of most adults was irregular.

1986

Wenner, C. A., Roumillat, W. A., & Waltz, C. W. (1986). Contributions to the Life History of Black Sea Bass, *Centropristis striata*, Off the Southeastern United States. *Fishery Bulletin, 84*(3), 723-741 Retrieved from https://dc.statelibrary.sc.gov/handle/10827/10550

Ages of black sea bass, Centropristis striata , from the South Atlantic Bight were determined from otoliths. The von Bertalanffy growth equation derived from back-calculated mean standard lengths at age was lt = 341 (1 - e super(-0.2309(t + 0.3010))), where t is age in years and lt = standard length at age. The oldest fish was age 10. Centropristis striata is a protogynous hermaphrodite that undergoes sex succession at ages 1 through 8. The major spawning period is from March to May, and a minor spawn occurs in September-October. Mature males and females were encountered at age 1. Fecundity estimates ranged from 17,000 in a 108 mm SL female to 1,050,000 in a 438 mm SL fish, and were significantly related to length, weight, and age.

1984

Barans, C. A., & Henry, V. J. (1984). A Description of the Shelf Edge Groundfish Habitat Along the Southeastern United States. *Northeast Gulf Science, 7*(1) https://doi.org/10.18785/negs.0701.05

The rocky outcrops at the shelf edge along the southeastern United States provide a diverse and complex series of subhabitats inhabited by groundfish of both commercial and recreational importance. Reef morphology ranged from rounded outcrops of relatively low relief (less than 0.5 m) to steep scarps with as much as 15m relief. Ground· fish species composition and density of a community off Charleston, S. C. were deter· mined by counts from underwater television. More precise quantitative estimates of subhabitat area, greater replicate abundance sampling within discrete subhabitats and the incorporation of information on groundfish behavioral response to environmental factors and sampling techniques are necessary prior to realistic estimates of regional habitat carrying capacity and/or estimating absolute groundfish abundance.

1979

Center for Natural Areas (1979). *A Summary and Analysis of Environmental Information on the Continental Shelf and Blake Plateau from Cape Hatteras to Cape Canaveral (1977) : Summary and Synthesis* (Vol. 1). Produced for the Bureau of Land Management. South Gardiner, ME.

A 12-month study by the Center for Natural Areas (CNA) was conducted to collect and analyze published, unpublished, and raw data as well as ongoing research programs from 1974 to present, relative to the marine environment of the outer continental shelf (OCS) and the Blake Plateau from Cape Hatteras, North Carolina to Cape Canaveral, Florida. The report is to be used to assess adequacy of the regional data base, and may be used in the design of environmental studies that the Bureau of Land Management (BLM) will direct in an attempt to assess and predict the possible effects of oil and gas development on the marine life and environment. During the course of the project, 28 scientists contacted representatives from the federal, state and local governmental; private industry; and academic sectors and developed a list of bibliographic references including over 2500 citations. The following list shows the major topics inventoried and presented in the report: Marine Geology, Chemistry, Phytoplankton, Zooplankton, Neuston, Nekton, Commercial Fisheries, Sport Fisheries, Marine Benthic Flora, Marine Mammals, Marine Birds, Marine Turtles, Endangered or Threatened Species, Microbiology, OCS Uses, Unique or Endangered Environments, Toxicity and Health Studies. The report in three volumes is approximately 3500 pages in length with over 600 illustrations and 375 tables. Volume I contains the text for each topic; Volume II contains the master bibliography, index and acknowledgements; and Volume III contains various appendices.