Strategic Habitat Area validation and implementation plan development

Executive summary

Through previous CHPPs, DMF used a conservation planning tool that incorporated spatial analysis and subject matter expert input to identify a network of high-quality habitat areas in coastal watersheds, referred to as Strategic Habitat Areas (SHAs). SHA nominations for the four CHPP regions were completed in 2017, and field sampling was conducted in two regions (Regions 3 and 4) to verify that the habitat condition and biological productivity of nominated areas were high. Results from the field survey validate that nominated areas support a higher abundance of diverse fish populations. In combination with findings that Strategic Habitat Areas have a more diverse estuarine landscape, a higher area of structured habitats, and less alteration than areas outside of SHAs, the results of this validation study further support the designation of the nominated Strategic Habitat Areas. These results will be combined with additional analysis of DMF independent sampling data in a future issue paper that presents validation of Strategic Habitat Areas statewide and proposes designation options to the Marine Fisheries Commission. Strategic Habitat Area management options will then be developed through stakeholder engagement and collaboration with state, federal, and private partners and presented in another issue paper to rulemaking commissions and external partners.

Introduction

Early in the development of the first Coastal Habitat Protection Plan (CHPP), the CHPP Steering Committee identified the need to prioritize conserving areas that were most critical for fishery production and in need of protection. The second goal of the original CHPP was to “Identify, designate, and protect Strategic Habitat Areas (SHA).” (Street et al. 2005) Strategic Habitat Areas were defined as “locations of individual fish habitats or systems of habitats that provide exceptional habitat functions or that are particularly at risk due to imminent threats, vulnerability, or rarity" (15A NCAC O3I .0101 (4)(h), (Street et al. 2005, Deaton et al. 2010, NCDEQ 2016). To prioritize areas to protect, CHPP staff applied the understanding that ecosystems with diverse arrays of interconnected habitats can function better and provide more services compared to discrete isolated patches of habitats (Preston et al. 2025). Choosing areas representative of the entire ecosystem can help protect habitats necessary for various life stages to support fisheries.

The process to identify Strategic Habitat Areas was established in 2006 under the guidance of a committee of scientists and natural resource managers with a wide scope of expertise in fisheries and coastal habitats (Deaton et al. 2006). The committee developed a scientifically based process for identifying candidate areas for designation using biological data and the consensus of a regional expert panel, with a target of designating approximately 20% of the area of natural resource targets in each of the four CHPP regions as Strategic Habitat Areas (NRC 2001).

The desired areas would have high biodiversity and ecological function, be relatively unaltered, have strong landscape connections between structured habitats, and need protection (Figure 1). Management options would be site specific – SHAs with exceptional ecological function would be priority locations for protection, while areas experiencing threats that risk diminishing their ability to support coastal fisheries would be candidates for restoration or enhancement.

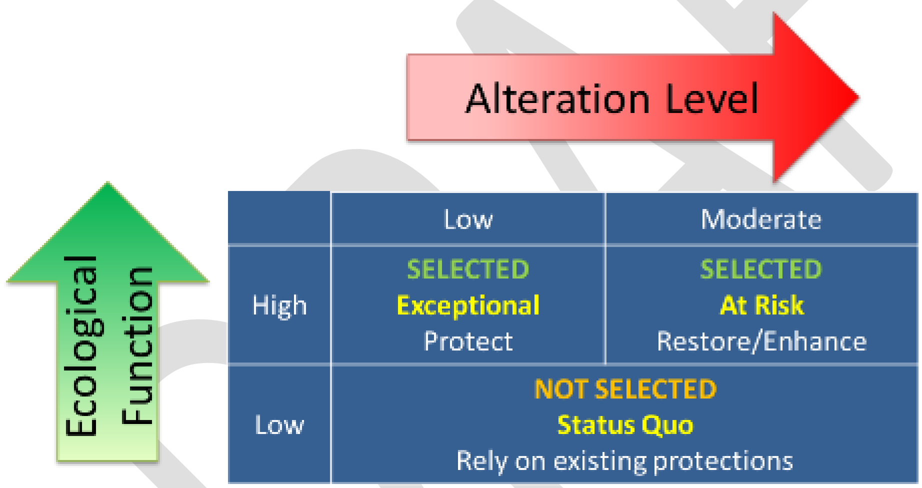

Figure 1. Selection criteria for Strategic Habitat Areas based on level of ecological function and habitat alteration level and the resulting management strategies (e.g., protect, restore/enhance) based on these gradients.

The SHA identification process consists of three main phases, each of which requires input from a regional advisory committee. The first phase in the SHA process is to identify priority species and habitats and build a GIS database of existing biological and anthropogenic use data for the region. For each region, the DMF Management Review Team (now the Directors Advisory Team) selected the priority and/or traditional fisheries for the area based on their importance to both the recreational and commercial fishing industries in the region.

DMF staff assembled the available data, which was reviewed by the regional advisory committee to ensure that it had sufficient spatial coverage and relevance to be included.

Then the committee examined the priority fish species for the region and recommended representation levels of each habitat (natural resource target) that should be included in the final SHA network. The committee also recommended how to rank alteration factors to calculate and map an alteration index for the region. The second phase of the process was to run the site selection software Marxan (Game and Grantham 2008, Ball et al. 2009) to select initial areas that met the established criteria for selection.

Once the Marxan modeling was complete, in the third phase an expert committee reviewed selections and used corroborating information and their own ecological knowledge to modify the boundaries of the SHAs and derive a final network of SHA nominations. Final SHA nominations incorporate expert scientific knowledge to consider additional biological information and socio-economic factors that may not have been included in the Marxan inputs.

Nominations were then peer-reviewed, sent for public comment, and presented to the Marine Fisheries Commission. For additional details about the specific data layers, prioritization, and expert decision-making process, see the Strategic Habitat Area nomination report for each region.

Region overviews

Four regional analyses were done to identify SHAs in coastal waters for each CHPP region. Region 1 (Albemarle Sound System), Region 2 (Pamlico Sound system), Region 3 (White Oak River Basin), Region 4 (Cape Fear River Basin) were completed in 2009, 2011, 2014, 2019 respectively.

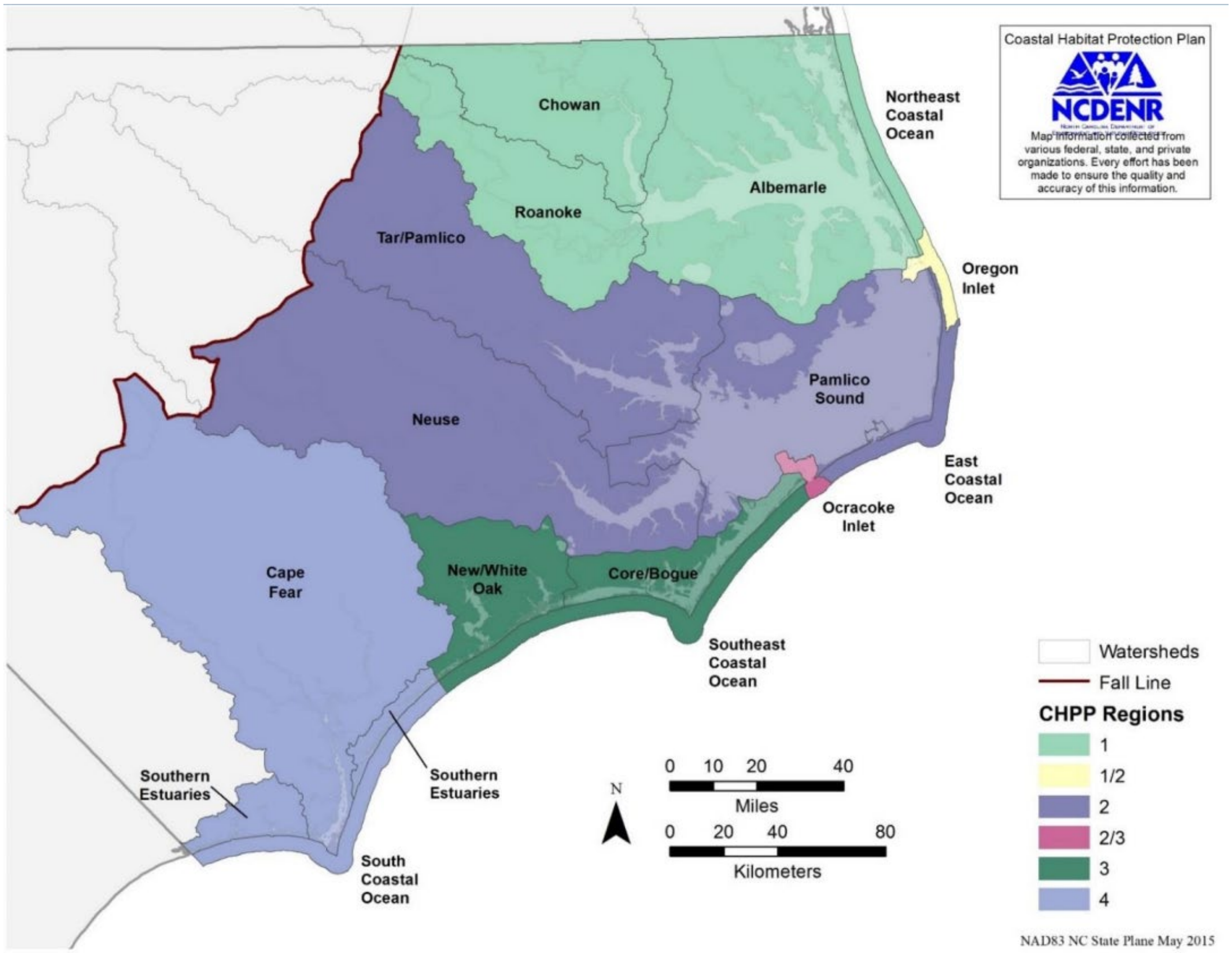

Figure 2. Map of CHPP regions and watersheds. Oregon Inlet is counted toward both regions 1 and 2, and Ocracoke Inlet is counted toward both regions 2 and 3.

Table 1. Characterization of nominated Strategic Habitat Areas broken down by number of units, area, and proportion of region (%).

Region	SHA Units	Area (a)	Area (%)
1	20	490315	20
2	67	322843	26
3	48	134547	19
4	43	74451	21

Albemarle Sound System (Region 1)

Region 1 includes the waters and adjacent wetlands draining into and out of Albemarle Sound through Oregon Inlet to the adjoining coastal ocean (NCDMF 2009). It includes the sounds and tributaries of the Albemarle, Currituck, Roanoke, and Croatan Sounds, as well as the nearshore ocean.

Most of the Albemarle Sound system is lined with bottomland hardwood wetland forests. The eastern sounds are lined with brackish marsh and support SAV habitat and scattered areas of shell bottom habitat. Because Oregon Inlet is the only inlet in the northern portion of the Albemarle-Pamlico system, it is a critical fish corridor. Priority species included the traditional fisheries of blue crab, river herring, and striped bass. SHA nominations included 20 areas that make up 490,315 acres or 20% of the region.

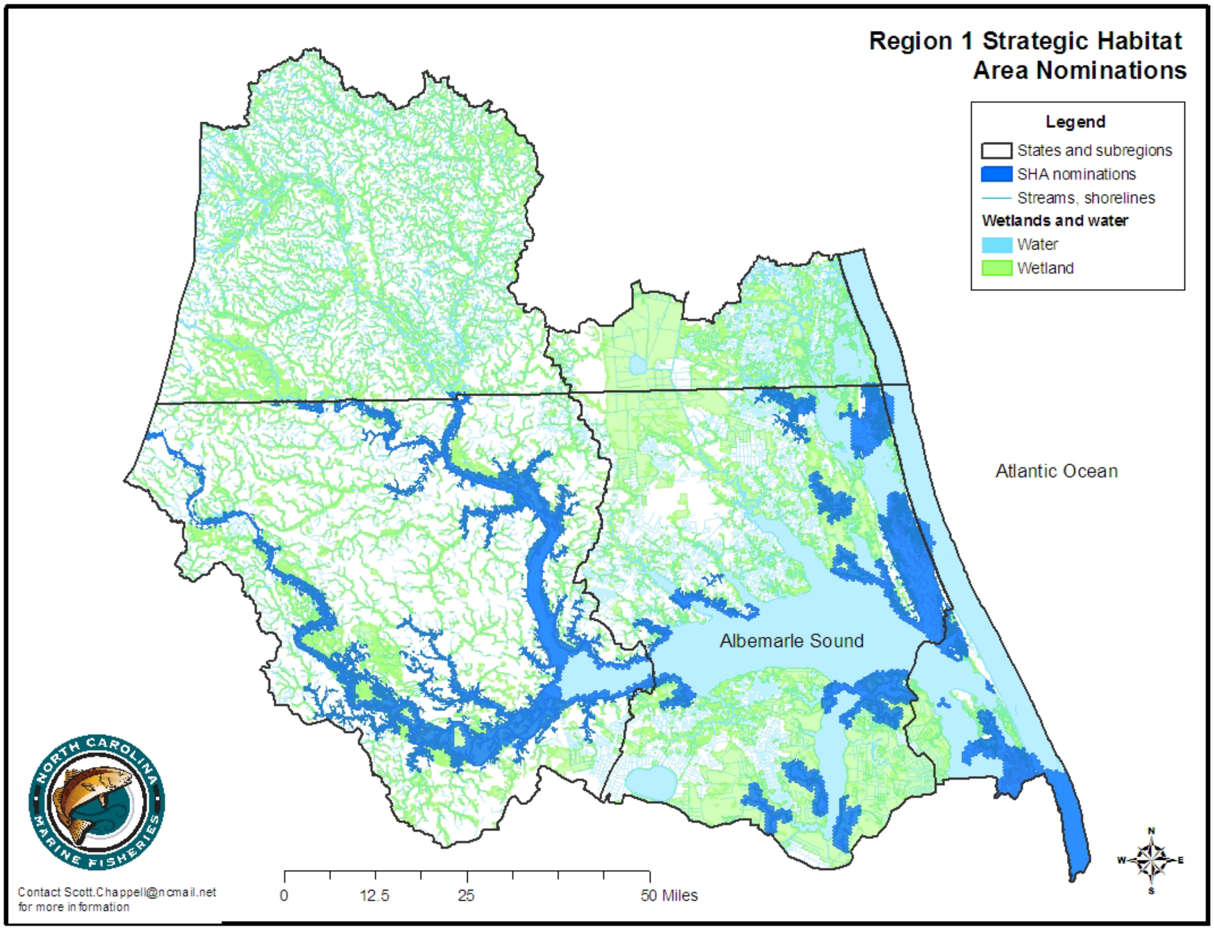

Figure 3. Nominated Strategic Habitat Areas within CHPP Region 1.

Pamlico Sound System (Region 2)

Region 2 includes the waters and adjacent wetlands draining into and out of Pamlico Sound through both Oregon and Ocracoke Inlets to the adjoining coastal ocean (NCDMF 2011). It comprises the sounds and tributaries of Pamlico Sound and the Tar-Pamlico and Neuse rivers up to the fall line separating Coastal Plains and Piedmont physiographic regions. The boundaries of the study area were based on the CHPP subregions of Pamlico Sound, Tar-Pamlico River, Neuse River, adjacent coastal ocean, Oregon Inlet and Ocracoke Inlet (Deaton et al. 2010).

Habitat features that contribute to the integrity and exceptional productivity of the Pamlico Sound system include extensive SAV beds behind the Outer Banks and along the rivers, intertidal and subtidal oyster rocks, and Primary Nursery Areas. Priority species include blue crab, Eastern Oyster, Red Drum, shrimp, Southern Flounder, and Spotted Seatrout. 67 discrete areas have been nominated in Region 2 that make up 322,843 acres or 26% of the region.

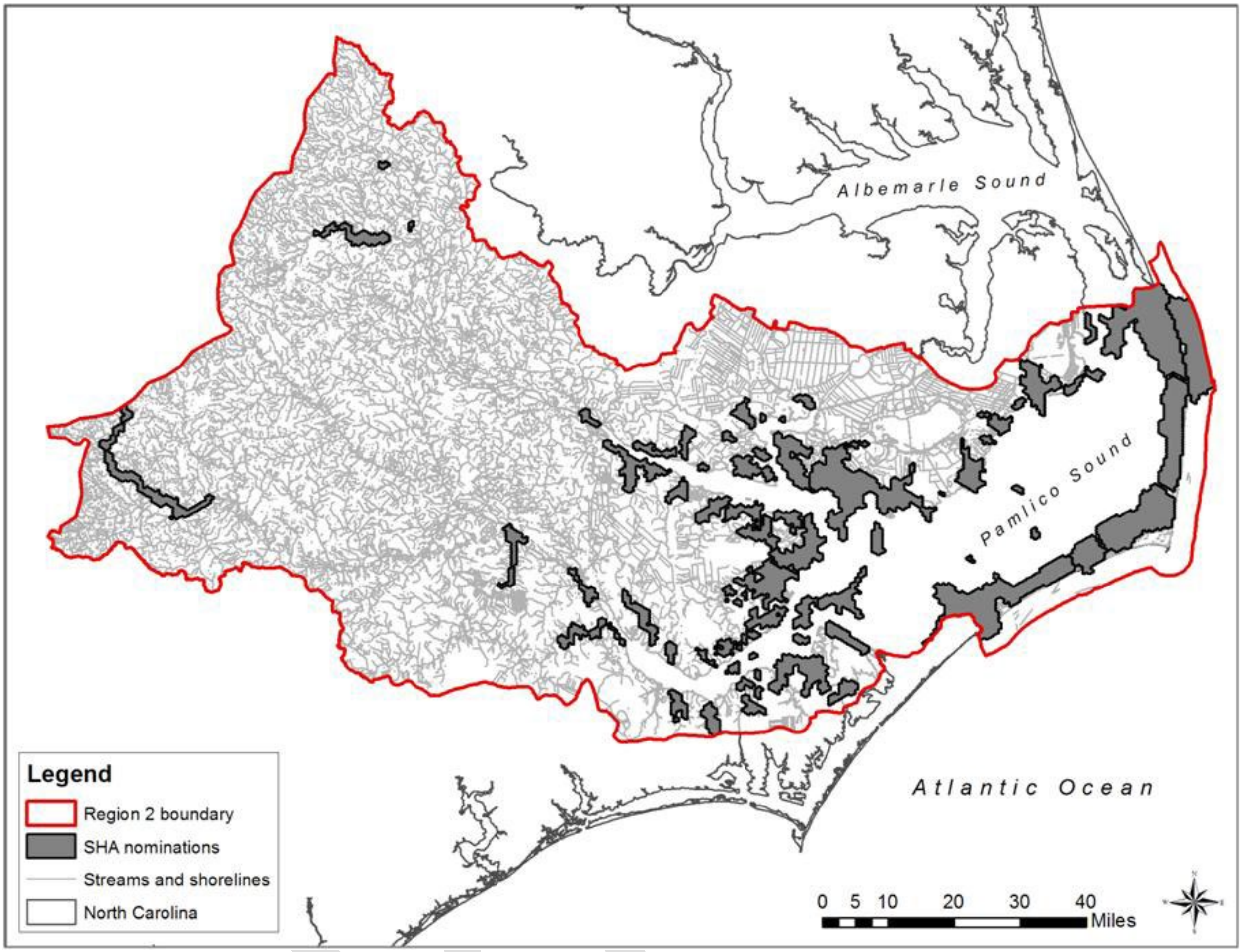

Figure 4. Nominated Strategic Habitat Areas within CHPP Region 2.

White Oak River Basin (Region 3)

Region 3 includes waters in Carteret and Onslow counties, as well as a small amount of Jones and Craven counties, and the entire watershed is contained within the White Oak River Basin (Jensen et al. 2014). This region lacks extensive riverine systems and consists primarily of estuarine waters and small to moderate sized sounds such as Core, Bogue, and Stump sounds. New River is the largest river.

Submerged Aquatic Vegetation (SAV) and wetlands (marsh and forest) are extensive, and intertidal and subtidal oyster reefs and ocean hard bottom are also present. Oyster, clam, Bay Scallop, Blue Crab, shrimp, Southern Flounder, Red Drum, Spotted Seatrout, Weakfish, and Spot were determined to be priority fishery species in this region, and an important nursery area for gag grouper and black sea bass. There were 48 discrete SHA units selected within region 3, comprising 134,547 acres or 19% of the region.

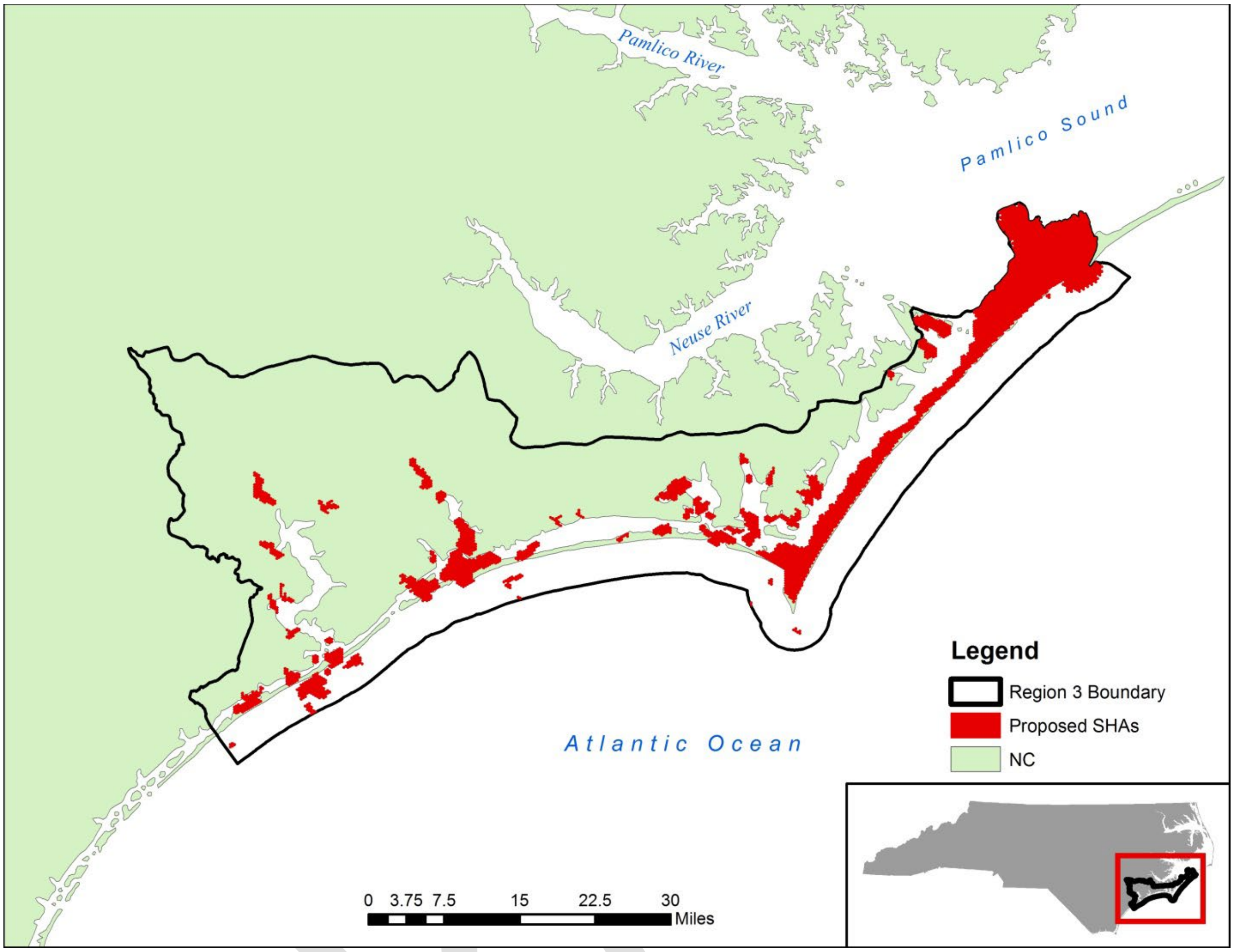

Figure 5. Nominated Strategic Habitat Areas within CHPP Region 3.

Cape Fear River Basin (Region 4)

Region 4 is the southernmost region and includes riverine and estuarine waters in Pender, New Hanover, and Brunswick counties, as well as portions of Duplin, Sampson, Bladen, and Cumberland counties (Knight and Deaton 2018). It includes the Cape Fear River system upstream to approximately Lillington, the historical anadromous fish spawning grounds of Smiley Falls (approximate fall line).

The estuarine waters include multiple small tidal creeks and sounds, and extensive intertidal oyster reefs and marsh habitats. Relatively small areas of SAV occur in the northern portion of the region. The priority fisheries species of the Cape Fear River Basin include Eastern Oyster, Hard Clam, Blue Crab, shrimp, Bay Scallop, Southern Flounder, Red Drum, Spotted Seatrout, kingfishes, and Spot. The Cape Fear River system is vital to anadromous species, including Striped Bass, American shad, River Herring, and sturgeon, that migrate upstream for spawning; while the nearshore provides important habitat for gag grouper, black sea bass, sheepshead, and mackerels. There were 43 discrete SHAs selected within Region 4 comprising 74,451 acres or 21% of the area's waterbodies.

Figure 6. Nominated Strategic Habitat Areas within CHPP Region 4.

Strategic Habitat Area Validation (region 3 and 4)

Origin

While it is assumed that areas nominated as SHAs are beneficial to fish populations, DMF staff sought to further validate this assumption. Previous and ongoing research has provided additional scientific understanding of the relationship between nekton, habitat, and alteration (Peterson et al. 2000; Wyda et al. 2002; Lowe and Peterson 2014), informing the establishment of a validation program (DMF Program 215) to verify habitat conditions and fish productivity of SHAs. The objective of the study was to verify habitat condition and biological productivity by conducting extensive field sampling of target fish species in three fish habitats inside and outside of SHAs.

Methods

Sampling design

A stratified random sampling design was established for Region 3 and 4. The sampling universe consisted of 1 nmi^2 grids and was modified for boat access. For each sampling year approximately sixteen proportionally allocated SHA and reference sites outside of SHA boundaries were randomly selected to sample from February 15 -November 15. The time window was chosen to follow the timing of the Juvenile Trawl Survey (Program 120) and Fisheries Independent Assessment (Program 915). Within Region 3, 252 sites were sampled in 2018-2019, however, sampling was limited in September 2018 due to Hurricane Florence. Within Region 4, 126 sites were sampled in 2020-2021, with a suspension of sampling from March 26th until June 2nd, 2020, for the COVID-19 Pandemic. In Region 4, the sampling grid was downstream of Lyon Thorofare on the Cape Fear River and Cowpen Branch on the Northeast Cape Fear River. Sampling difficulties resulted in the exclusion of 16 SHAs in that area. Full details of sampling gear and techniques can be found in the NC DMF Program 215 program documentation (NC DMF 2018)

Nekton sampling

Fish sampling was conducted using Breder traps, gill nets and bottom trawls. An otter trawl was towed for 1 minute in duration across 75 yards. Four Breder traps were set, alternating orientation from perpendicular and parallel from the habitat edge. A scientific gill net (2", 3", 4", 5" stretched mesh panels) was set within 100 ft of shore where water depth is roughly 3 ft at MLW. Breder traps and gill nets were set at low tide and soak for at least three and four hours, respectively. All collected fish were identified to species level and counted. Target species were measured and weighed, and total biomass of all fish was recorded.

Mean standardized catch (MGMS) was calculated to create an index to represent the total catch of the three gear types (Gibson-Reinemer et al. 2017). Catch per unit effort was also calculated to conduct community level analyses for each gear type.

Habitat Characteristics

At each sampling location, the types of structured habitats present were recorded (marsh, SAV, shell). Habitat characteristics were quantified for habitat present using three haphazard 1/4m^2 quadrats. For marsh quadrats, shoot densities of *Spartina spp.* and *Juncus spp.* were counted and all other species present within the quadrat were recorded. In addition, the stem height of the tallest and three random shoots were measured. In shell habitats, the point intercept method was used (n=16) to calculate percent cover of live oysters. All biota in the quadrat was recorded. To quantify the oyster density, a smaller 1/16 m^2 quadrat was used and a subsample of 30 oysters was measured. To quantify SAV, the point intercept method was used (n=16 intercepts) to measure the cover (%) of SAV in the quadrat. All species present in the quadrat were recorded, and the shoot height of the tallest and three random shoots were measured.

The area of all structured habitats was calculated within each sampling grid. Shell bottom area was calculated from DMF's Estuarine Benthic Habitat Mapping Program's shell bottom maps, produced from 1990 to 2019. NOAA Coastal Change Analysis Program (CCAP) land cover data from 2016 were used to quantify wetlands extent ((National Oceanic and Atmospheric Administration, Office for Coastal Management 2016)). The NC DEQ SAV "mosaic" dataset, which outlines a historical extent of SAV habitat from aerial surveys conducted from 1981-2021, was used to calculate SAV area.

Alteration

At each sampling location the extent of hardened shoreline and eroded edge, and presence of shoreline basins, marinas and/or boat ramps, rock or wood structures perpendicular to shore, low profile (riprap) or wood structure parallel to shore, and vertical structures (i.e. bulkheads) was recorded.

Analysis

Since the sampling of the two regions did not occur at the same time, all statistical analyses were conducted within regions, so inferences between regions are limited to qualitative observations. All analyses were performed in R version 4.6.0 (R Core Team, 2026).

A permutational analysis of variance (PERMANOVA) was used to test differences in community composition between SHA treatments. The PERMANOVA used Bray-Curtis distances and 1,000 permutations, and was run using the 'vegan' package in R. A non-metric multidimensional scaling (NMDS) ordination was used to visualize community composition between SHA and non-SHA sites for each region. SIMPER analysis was used to identify which species contributed the most to dissimilarities. Hill-Shannon diversity index (Kempton 1979) species richness, and a rank-abundance curve were calculated to examine the biodiversity of the nekton species.

Because of the variance in species present, most variables violated the assumptions of ANOVA (non-normal distribution and unequal variances) so differences among groups were tested using the non-parametric Kruskal–Wallis test. Kruskal-Wallis tests were used to test differences between designated SHA and undesignated sites (reference, or "non-SHA," sites) for each region independently for habitat metrics. Pearson Chi-squared tests were used to compare the frequency of habitat presence and alteration frequency between Strategic Habitat Areas and reference sites.

Results

Habitat Metrics

Analysis of the Region 3 and 4 habitat data confirm greater overall extent of the habitats investigated in this study (wetlands, shell bottom, and SAV) in the SHA sites compared to the non-SHA sites (Figure 7). SHAs had a significantly greater area of structured habitats in in Region 3 with 1,074,587±79,487 acres in SHAs and 568,885± 82,752 acres in non-SHAs ($\chi^2(1) = 18.596$, $p < 0.001$) and Region 4 with 1,402,093± 82,953 acres in SHAs and 637,418± 79,487 acres in non-SHAs ($\chi^2(1) = 29.510$, $p < 0.001$).

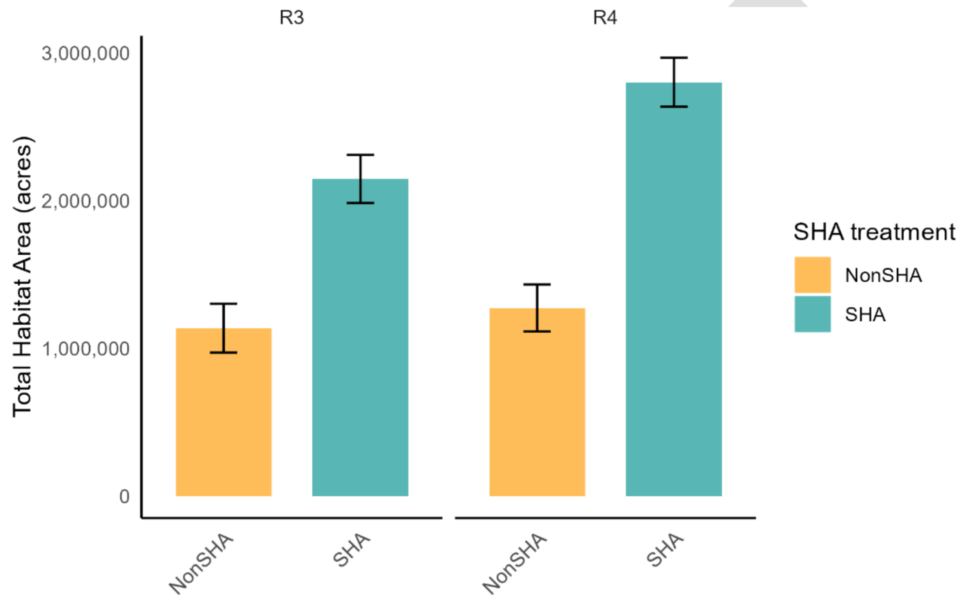

Figure 7. Total habitat area (acres) of structured habitats (SAV, oyster, wetlands) in sampling grids inside (SHA) and outside of Strategic Habitat Areas (non-SHA). Error bars represent ±1 standard error.

SHAs were also more likely to have multiple types of habitats present than reference sites. When looking at the average number of habitats at each sampling location, SHAs had a higher number of habitats (marsh, oyster, SAV) within the same landscape (Figure 8). In Region 3, SHAs had an average of 1.9 habitats present, while non-SHAs had only 1.4 habitats present on average ($\chi^2(1) = 18.596$, $p > 0.001$). Although the two regions were not statistically compared, the difference between reference sites and SHAs was greater in Region 4. On average, SHA sites had 2.2 habitats present and non-SHA reference sites had only 1.4 habitats present ($\chi^2(1) = 429.510$, $p > 0.001$). When examining the frequency of habitat presence, marsh habitats were present at nearly the same frequency in all SHA and reference sites. Oyster reefs occurred more frequently in SHAs than non-SHAs in both regions, but Region 4 had a higher frequency (Region 3, $\chi^2(1) = 10.297$, $p = 0.001$; Region 4 ,

$\chi^2(1) = 22.766$, $p > 0.001$). There was no significant difference in the frequency of SAV in Region 3, although SAV was higher in SHAs. In Region 4, SAV was only present in SHA sites ($\chi^2(1) = 10.242$, $p > 0.001$).

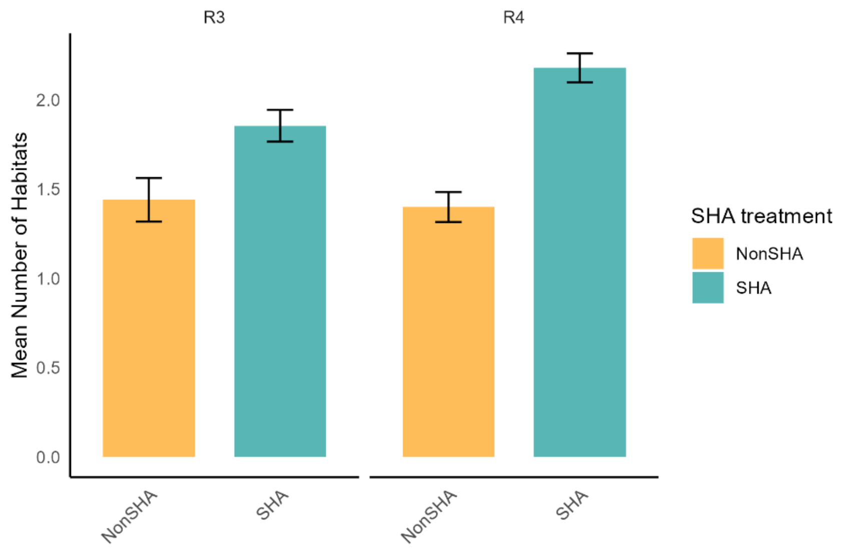

Figure 8. The mean number of structured habitats (marsh, oyster, SAV) found in Strategic Habitat Areas and reference sites. Error bars represent ±1 standard error.

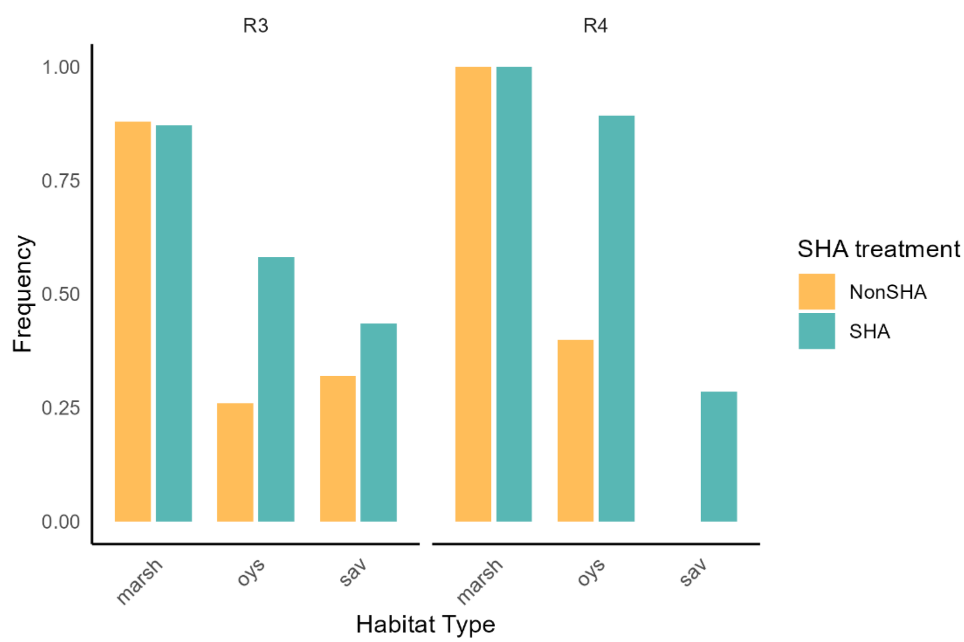

Figure 9. Frequency of structured habitats (salt marsh, oyster reef, SAV) in Strategic Habitat Areas and reference sites outside of Strategic Habitat Areas.

There is evidence that habitats in Strategic Habitat Areas were higher quality. In marsh habitats, *Spartina alterniflora* stem density (shoots / 0.25 m^2) was higher in SHAs than non-

SHAs (Figure 10; Region 3, $\chi^2(1) = 30.1$, $p < 0.001$; Region 4, $\chi^2(1) = 42.8$, $p < 0.001$). Oyster reefs had a higher live oyster cover (%) in SHAs than reference sites (Figure 11; Region 3, $\chi^2(1) = 4.883$, $p = 0.027$; Region 4, $\chi^2(1) = 14.090$, $p < 0.001$). SAV percent cover had the same pattern as habitat occurrence, with no difference between SHAs and reference sites in Region 3 (Figure 12; $\chi^2(1) = 0.973$, $p = 0.324$). Since SAV was absent from reference sites in Region 4, we could not test for statistical differences.

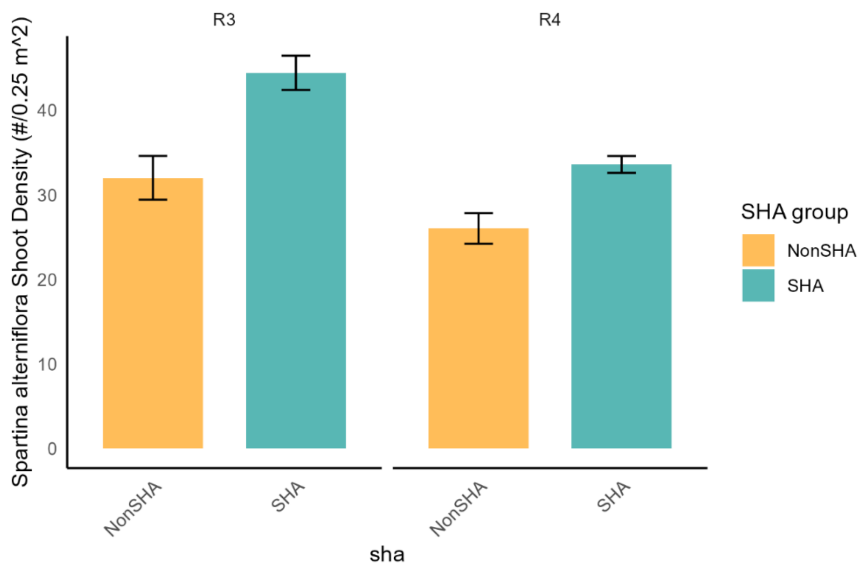

Figure 10. Spartina alterniflora shoot density (#/0.25 m^2) in Strategic Habitat Areas and reference sites. *Error bars represent ±1 standard error.*

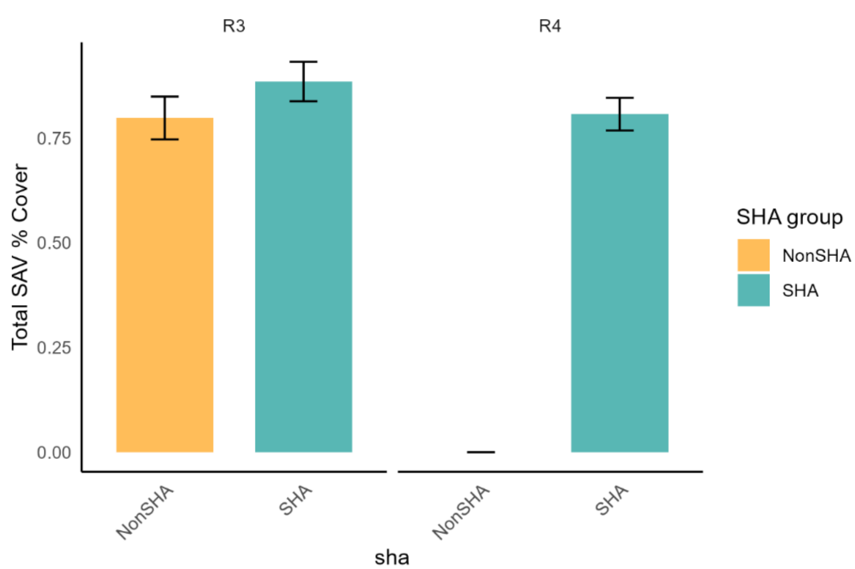

Figure 11. Percent cover of submerged aquatic vegetation in Strategic Habitat Areas and reference sites. Error bars represent ±1 standard error.

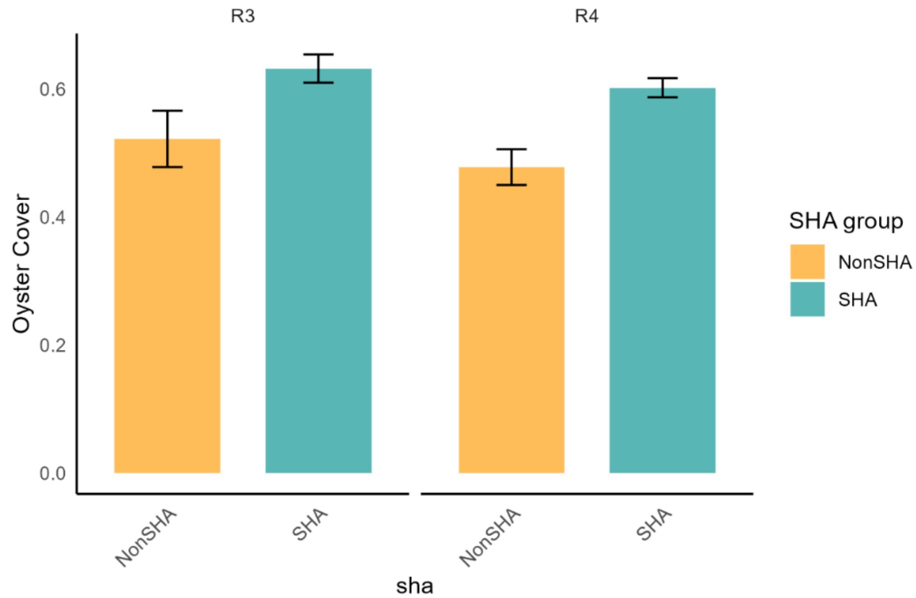

Figure 12. Percent cover of live oysters on oyster reefs in Strategic Habitat Areas and reference sites. Error bars represent ±1 standard error.

Nekton community

When examining the total multi-gear meal standardized catch, there were only differences between SHA and reference catch in Region 4 (Figure 13, $\chi^2(1) = 4.342$, $p = 0.037$). Strategic Habitat Areas had a higher abundance of nekton for mean-standardized catch as well as each individual gear. No statistical difference was found in the total abundance of nekton in Region 3 across all gear types ($\chi^2(1) = 1.113$, $p = 0.291$).

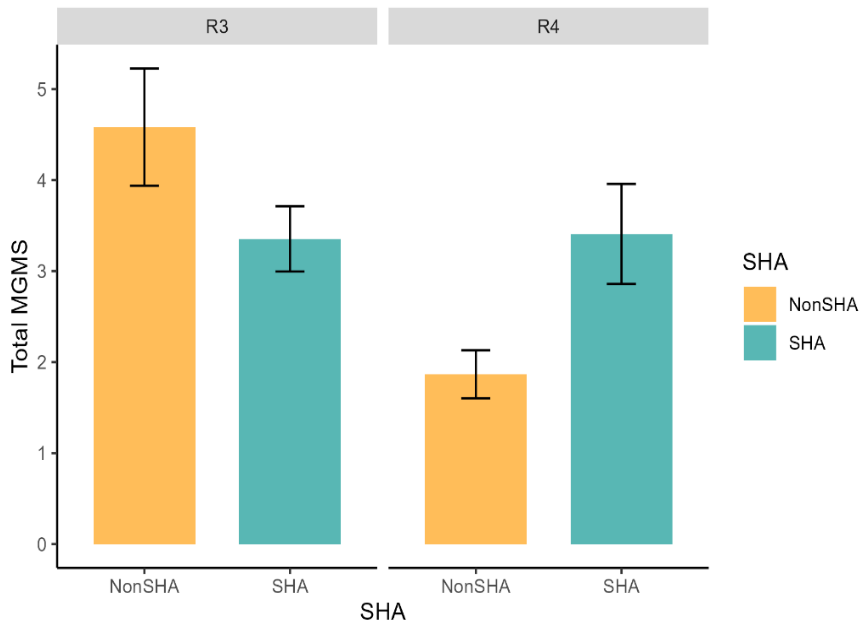

Figure 13. The total multi-gear mean standardization for Strategic Habitat Areas in Region 3 and 4. Error bars represent ±1 standard error.

Biodiversity

Overall, communities in SHAs had a higher species richness, and had a higher abundance of rare species. The difference in species richness was significant in Region 4 (Figure 14, $\chi^2(1) = 4.122$, $p = 0.042$). When examining the Shannon-Hill biodiversity of nekton measured in the multi-gear mean standardization index, there were no statistical differences between groups, but some patterns were present when examining each gear independently. When examining the trawl nekton, there was a higher diversity in the SHA sites than non-SHA reference sites ($\chi^2(1) = 4.324$, $p = 0.038$) in Region 3 (Figure 15). The opposite, however, was observed in Region 4, with higher diversity in the non-SHA sites than SHA sites ($\chi^2(1) = 5.418$, $p = 0.020$). No differences were found in Region 3 trap samples, but there was a higher diversity in SHA samples relative to diversity in the reference sites in Region 4 (Figure 16; $\chi^2(1) = 5.150$, $p = 0.023$).

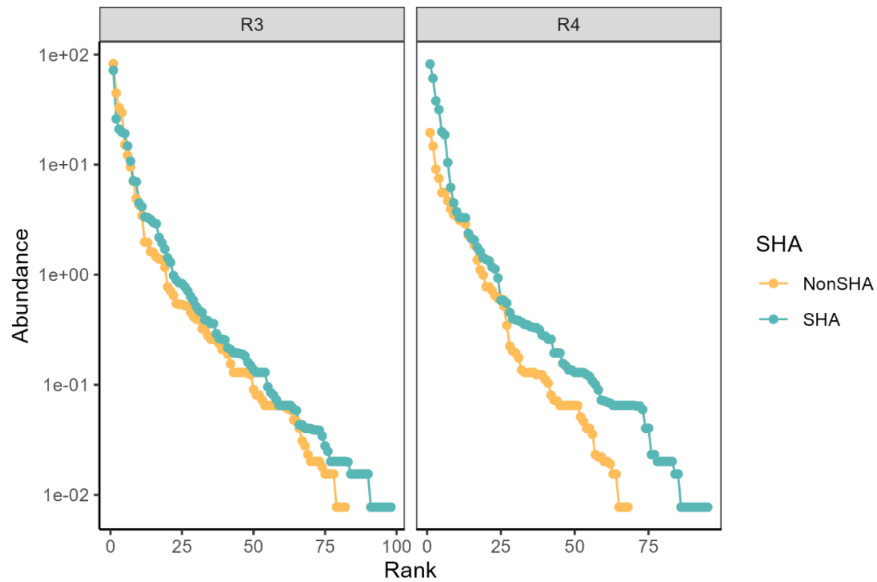

Figure 14. Species rank abundance curves for nekton multi-gear mean standardized catch in SHA and non-SHA sites in the White Oak (Region 3) and Cape Fear (Region 4) River regions.

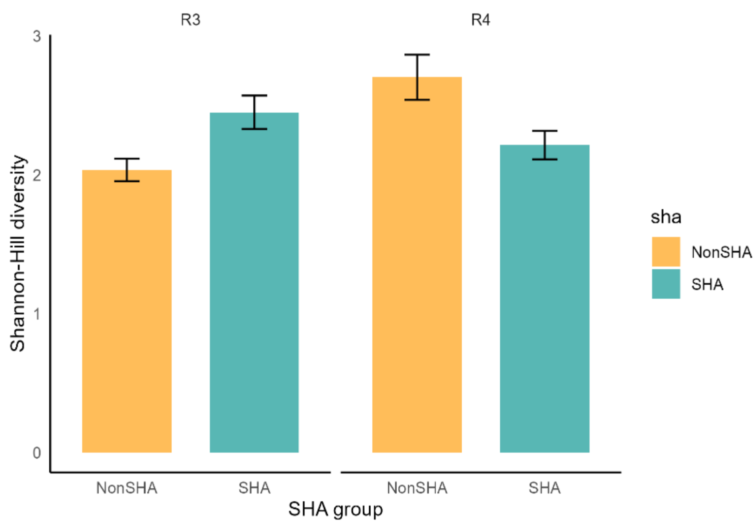

Figure 15. The Shannon-Hill Diversity index for nekton from trawl sampling in Strategic Habitat Areas and non-SHA reference sites. Error bars represent ±1 standard error.

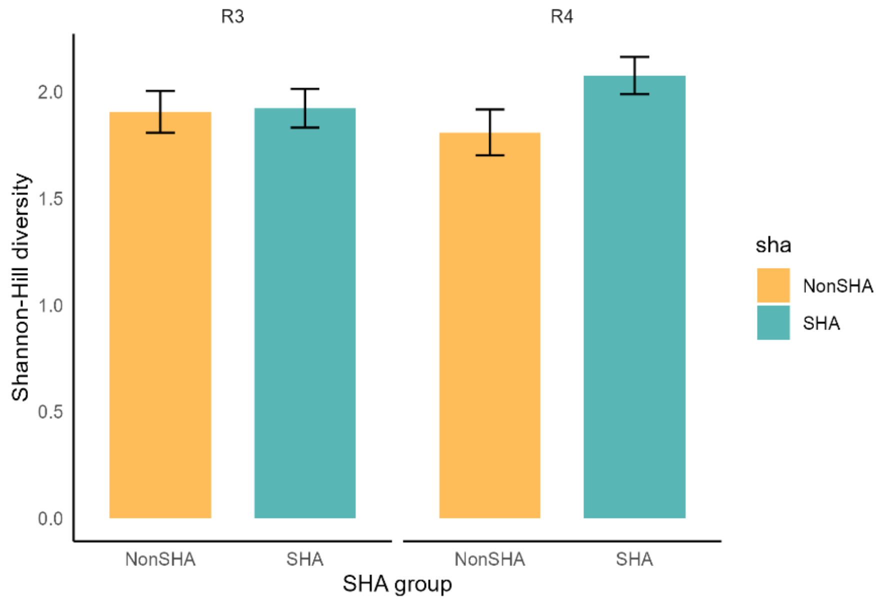

Figure 16. Shannon-Hill diversity index for nekton trap samples in Strategic Habitat Areas and non-SHA reference sites. Error bars represent ±1 standard error.

Community Analysis

Community analyses were not appropriate for the multi-gear mean standardization index or when examining most gear types due to high stress (stress > 0.2) and low squared correlation coefficient (r^2). The 2-dimensional NMDS of trawl catch per unit effort in both regions had an appropriate stress (Region 3 stress = 0.129, Region 4 stress = 0.110) and Region 3 trawl data had a significantly different community in SHA sites than reference sites (Figure 17, PERNAMOVA: Region 3 pseudo-F = 3.400, R^2 = 0.014, p = 0.014). Trawl community composition was not statically significant in Region 4 (pseudo-F = 1.767, R^2 = 0.008, p = 0.117).

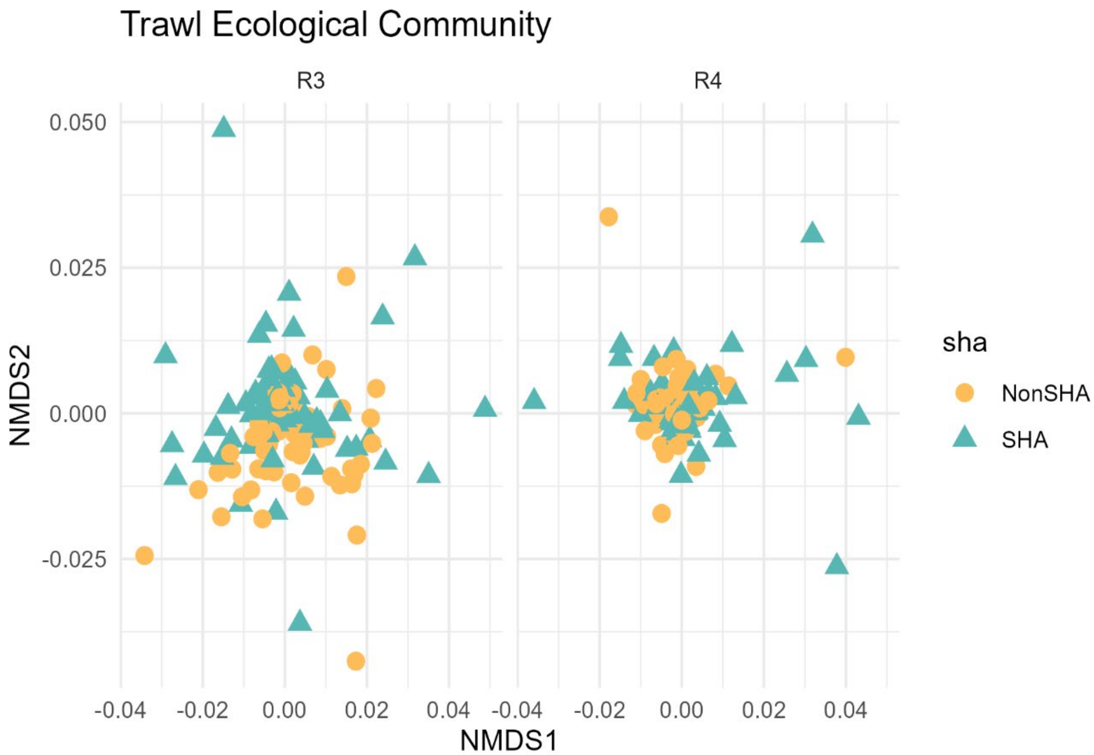

Figure 17. NMDS for community composition in trawl samples across Region 3 and 4 in SHA and non-SHA sites.

Alteration

Habitat alterations were observed more in non-SHA sites; however, frequency also varied between regions. Culverts were only found at one sampling location across both regions, in a non-SHA site in Region 3. There are no differences between the frequency of channeling at sites between treatments, but Region 4 was found to have higher channelization than Region 3. Region 4 also had higher frequency of bridges in non-SHA sites than SHA sites ($\chi^2(1) = 9.110$, $p = 0.003$).

Non-SHA sites had more eroded edge than SHAs. In Region 3, non-SHAs were overrepresented in the frequency of higher categories of eroded edge (26-50%, >50%) when compared to SHA sites (Figure 18, $\chi^2(1) = 66.908$, $p < 0.001$). In Region 4, the there was a marginal significance ($\chi^2(1) = 7.751$, $p = 0.051$), with significant pairwise comparisons only occurring at the 26-50% eroded category, with non-SHAs being overrepresented.

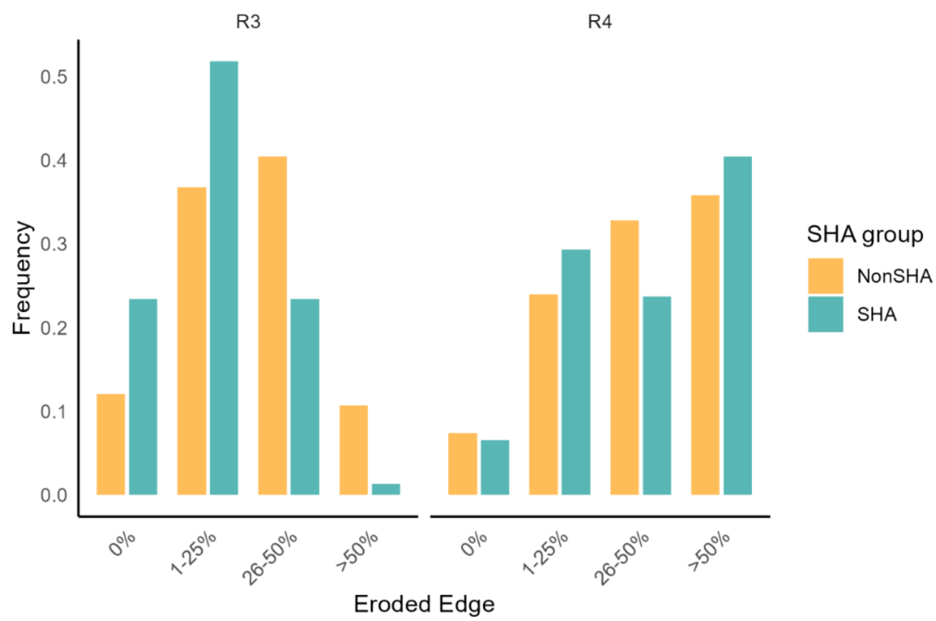

Figure 18. The frequency of SHA and non-SHA sites having 0%, 1-25%, 26-50%, and >50% eroded marsh edge.

SHAs had lower hardened shoreline scores than reference areas, but patterns depended on the region (Figure 19; Region 3, ($\chi^2(1) = 30.088$, $p < 0.001$; Region 4, ($\chi^2(1) = 75.477$, $p < 0.001$)). In Region 3, non-SHAs were overrepresented in sites that were over 50% hardened, while SHAs were overrepresented, but not significantly, in all categories 0-50%. In Region 4, pairwise comparisons were significant in the 10-25% hardened category with SHAs being overrepresented and in the >50% category with non-SHAs being overrepresented.

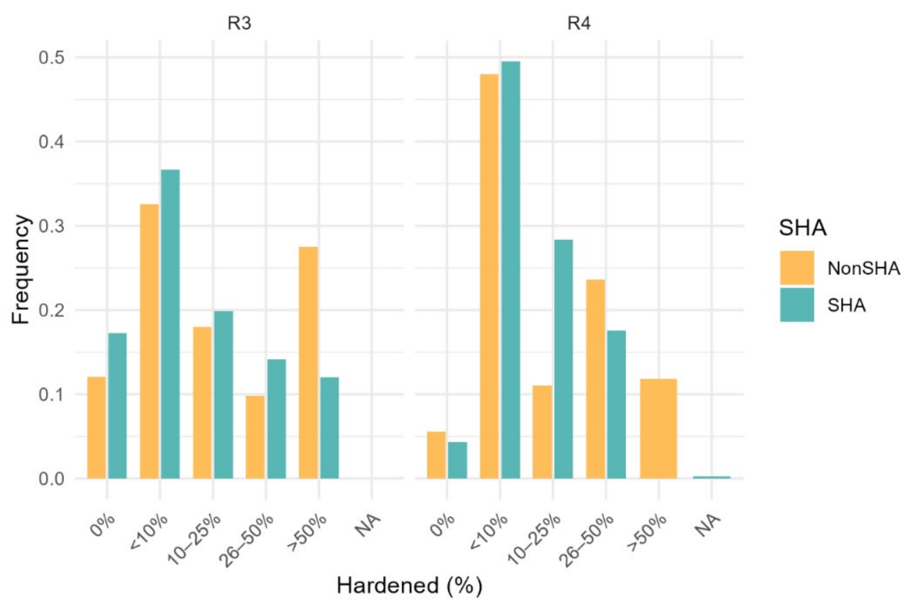

Figure 19. The frequency of SHA and non-SHA sites having 0%, 1-25%, 26-50%, and >50% hardened shorelines.

Conclusions

These results verify that the SHA designation process accurately selected areas with a greater extent of relatively unaltered, diverse habitats, with high ecological function. SHAs had a larger area of structured habitats than the reference sites as well as more habitats present in the landscape. SAV meadows were only present in SHA sites in Region 4. Habitat conditions within SHAs were also higher- salt marshes had higher *Spartina alterniflora* stem density and live oyster cover than the reference sites.

Strategic Habitat Areas were also less altered than reference sites. Reference areas outside of SHAs were more likely to have high levels of eroded marsh shoreline and more hardened shoreline present at sampling locations. Observations of manmade culverts and bridges were also lower in Strategic Habitat Areas, adding to the validation that areas nominated for SHAs were relatively unaltered.

The lack of difference between the total fish abundance in and outside of SHAs in Region 3 may be due to a combination of lower alteration level, smaller differences in habitat presence, and basin geography. Additionally, large catches of schooling species (e.g., spot, menhaden) may have limited differences in total catch. However, Strategic Habitat Areas in Region 3 did show evidence of higher biodiversity indices and different community composition in the trawl data.

Finally, Strategic Habitat Areas had higher nekton abundance and biodiversity in Region 4. This validates the initial goals of identifying areas that provide exceptional habitat function by supporting a higher abundance of diverse fish populations. In combination with findings that Strategic Habitat Areas have a more diverse estuarine landscape, a higher area of structured habitats, and less alteration than areas outside of SHAs, the results of this validation study lend further support to the designation of the nominated Strategic Habitat Areas.

Due to the high time and cost of this sampling program, DMF will explore using current independent sampling for validation of the remaining two regions. In Region 1, data from DMF Programs 100, 135, and 150 can be used, and for region 2, data can be pulled from DMF Programs 120, 915, 610, 611, and 195. Given the differences between the regions, additional factors or habitat characteristics may need to be measured. The complete analysis of validation for all regions will be presented in a future issue paper to the Marine Fisheries Commission that includes options for the designation of Strategic Habitat Areas.

Strategic Habitat Area Management

Following validation of all regions, DMF will reconvene the internal SHA workgroup to develop management strategies. A workshop with state, federal, NGO, and academic partners will be held to prioritize and further develop ideas to protect strategic habitat areas. The leading management options from these discussions will be presented to the MFC and any other appropriate commissions in an issue paper(s). Since each SHA unit has different threats and alterations, a site-specific approach may be needed based on the area function and the severity of threats.

Strategic Habitat Areas can be used in conservation planning by federal, state, and local agencies. They could be added to the NC Conservation Planning Tool which identifies and prioritizes essential high quality natural resources required to maintain healthy and sustainable ecosystem (NC NHP 2025). When planning for sea level rise, marsh migration corridors upland or adjacent to SHAs should be prioritized in land acquisition (see 2021 CHPP Amendment, Chapter 5: *Wetland shoreline protection and enhancement with a focus on nature-based solutions*). SHAs could also be a ranking criterion for the Coastal and Estuarine Land Conservation Program (NC CELCP) plan.

Areas that remain relatively unaltered may need additional protection. SHA locations overlap with Deep Water Oyster Recovery Areas (DORAs: Oyster FMP, NCDMF 2025). DORAs prioritize the ecological value of oyster habitat and protect oyster habitat by prohibiting mechanical harvest. Reducing disturbance from harvest will allow oyster communities to have a higher relief and lower risk of total loss of live oysters during hypoxia events. Additionally, DORA closures have the benefit of providing a refuge for fish during these events. DORA closures in region 2 protecting 81% of identified deep water oyster habitat includes three nominated SHA areas (SHA 52, 86, 137 which are Swanquarter Bays, Neuse Mouse 1, Neuse Mouth 2, respectively).

Strategic Habitat Areas can be prioritized for restoration and enhancement. DMF should consider SHA units when selecting sites for restoration or enhancement when appropriate and prioritize projects that increase connectivity of habitats and SHA units. Funding programs that support enhancement and restoration of fish passage, hydrology, and habitats could also use Strategic Habitat Areas to as a ranking criterion for proposals.

SHA designation could be added to local land use plans, permitting guidance, and watershed planning to bridge marine conservation priorities and land-use decision making. Management actions may also include pursuing funding for agriculture cost-share programs to implement best management practices in watersheds draining to SHAs.

General outreach to the public should include encouraging best management practices adjacent to SHAs.

Recommended Actions

1. Explore feasibility of using DMF independent sampling data to validate SHAs for Albemarle Sound and Pamlico Sound regions.
2. Develop an issue paper that presents validation of Strategic Habitat Areas statewide and propose designation options to the Marine Fisheries Commission.
3. Establish an internal working group to develop management options for Strategic Habitat Areas.
4. Conduct a workshop with federal, state, and private partners to further develop potential management strategies.
5. Complete a SHA management issue paper and present management options to the appropriate commissions and external partners.

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