

## CHAPTER 8. ECOSYSTEM MANAGEMENT AND STRATEGIC HABITAT AREAS

Ecosystem management is defined as an approach to maintaining or restoring the composition, structure, function, and delivery of services of natural and modified ecosystems that integrates ecological and socioeconomic perspectives within a geographic framework, for the goal of achieving sustainability. Ecosystem management, as a concept, is a broadening of the narrow focus of single species, single habitat, or single threat management to consider multiple species and habitats that are interdependent. An ecosystem approach is necessary given the interrelationships among species, habitats, and threats. Thus, any management activity that considers multiple species, habitats, and/or threats could be considered ecosystem management. North Carolina's coastal fishery resources (the "fish") exist within a system of interdependent habitats that provide the basis for long-term fish production available for use by people (the "fisheries"). Most fish rely on different habitats throughout their life cycle (Figure 8.1); therefore, maintaining the health of an entire aquatic system is essential. The integrity of the entire system depends upon the health of areas and individual habitat types within the system.

In recent years, there has been increasing awareness of the need to manage aquatic resources on an ecosystem scale (Beck et al. 2000; NRC 2001; SAFMC 2009). To address habitat biodiversity within the South Atlantic, the SAFMC is adopting an ecosystem approach to fisheries management with the development of a Fishery Ecosystem Plan (FEP) and Comprehensive Ecosystem-Based Amendment (CE-BA) that will amend all the Council's Fishery Management Plans. Other regional initiatives, such as the Southeast Aquatic Resource Partnership (SARP) developed a habitat plan (SARP 2008) that provides regional watershed conservation and restoration targets. Ecoregional assessments have been conducted in over half of the ecoregions of the United States to develop conservation priorities (Beck et al. 2000) for regional funding sources. The North Carolina Department of Environment and Natural Resources has developed a conservation planning tool (CPT) to provide guidance for both aquatic and terrestrial conservation efforts in the state (see "Designations" section of Water Column chapter for more information on the CPT).

One of the most challenging aspects of ecosystem management is the setting of management priorities, objectives, and measures of success. Success criteria could take the form of indicator metrics and threshold values. The APNEP is currently developing indicator metrics for the Albemarle-Pamlico region (D. Carpenter/APNEP, pers. com., 2009). However, there is also a need to set threshold values that reflect a fundamental, destabilizing shift in ecosystem function. The finding of fundamental indicators with threshold values is an essential goal of ecosystem management research (Grossman et al. 2006). Without indicator metrics and threshold values, the management of ecosystems has relied upon maintenance of ecosystem characteristics (i.e., no net loss of wetlands). Because climate change may alter ecosystem characteristics, a shift in maintenance goals based on predicted changes may need to be considered (see "Sea level rise and climate change" sections of habitat chapters). Research suggests that even minute changes in temperature, salinity, and other basic parameters can have major impacts on biological community structure (Apple et al. 2008; Baird 2009).

One fundamental metric of ecosystem assessment is biodiversity and the richness of genetic information it represents (literature review in Airoidi et al. 2008). By fostering enhanced species diversity, structurally complex habitats add resilience and efficiency to ecosystems in the face of changing conditions. Less complex habitats favor generalist, colonizing species forming relatively disorganized systems with more biomass in microbial pathways (Baird 2009). Hypoxia in the Neuse River, for example, can shift biomass away from the benthic invertebrates (fish food) and more into the phytoplankton and microbial decomposers. Increasing abundances of toxic algae and pathogenic microbes have also been associated with nutrient enrichment and hypoxia (Jackson et al. 2001). Carbon-building, structurally complex habitats in shallow water (i.e., SAV, shell bottom, marsh) also provide greater denitrification services compared to deeper, less structured habitats (Piehler and Smyth in press), suggesting their importance as

waste treatment facilities. The value of services, in terms of nutrient trading rates, ranged from \$1000-2000/acre/year over subtidal bottom.

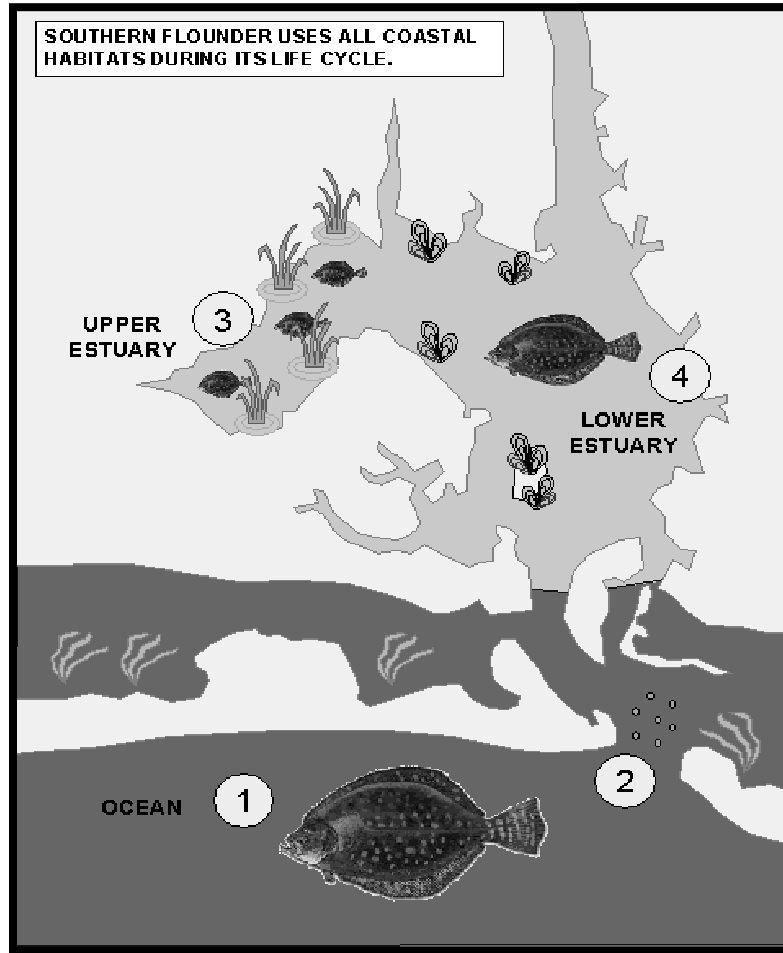


Figure 8.1. Life cycle of the southern flounder.

- 1 - Adults spawn in nearshore ocean waters during late winter months.
- 2 - Larvae drift inshore on currents, eventually passing through inlets and to the estuary beyond.
- 3 - Small juveniles settle out of the water column in upper, low-salinity estuaries containing marsh wetlands and shallow soft bottom habitat.
- 4 - As flounder grow, they begin to occupy deeper channels and the lower portion of the estuary. Juvenile flounder also move throughout the estuary, foraging on crabs and small fish living in oyster reefs and along the marsh edge. Once the juvenile flounder recruit to the adult population, the cycle is continued.

There is abundant evidence that structurally complex habitats (i.e., SAV, shell bottom, hard bottom, wetlands) are becoming more rare across the globe, with a corresponding increase in less structured habitats (i.e., soft bottom) (Airoldi et al. 2008). The changes have been linked to coastal development, overfishing, and eutrophication described in the CHPP habitat chapters. With persistent overfishing and loss of structural habitats, an ecosystem can change its stabilizing processes to reach an alternative stable state (Beisner et al. 2003; Briske et al. 2008). Once an Alternative Stable State (AltSS) is reached, restoration to a former state can be more difficult. However, an AltSS is only one of many possible behaviors based on a review of AltSS literature (Schroder et al. 2005). Whereas vulnerability or

proximity to AltSS is lacking in evidence, maintaining bio-diversity and structurally complex habitat is undoubtedly a stabilizing influence. Human activities that degrade biodiversity and structurally complex habitats are therefore destabilizing ecosystems.

### **Threats and cumulative impacts**

The previous habitat chapters cover the effects of individual human activities as threats to a single habitat. However, threats often affect multiple habitats, with a corresponding impact on bio-diversity and ecosystem function. Threats affecting a single habitat have indirect impacts on other habitats depending on their proximity and ecosystem enhancement services (see “Ecosystem enhancement” sections of habitat chapters). For example, reductions in wetland area and filter-feeding shellfish could degrade water quality conditions needed for SAV growth. There are also multiple threats affecting habitat areas that are not necessarily confined to individual property boundaries. A good example is the indirect relationship between degraded water quality along an individual shorefront property and the cumulative contribution of pollution sources upstream of the property (see “Water quality degradation - sources” section of the Water Column chapter for more information). The management of cumulative impacts is an area lacking in state regulatory authority and practices due to the lack of an effective assessment methodology and management tools. The state’s best attempts at managing cumulative impacts have been the coastal impervious surface limits, development of Local Watershed Plans (EEP) and Total Maximum Daily Loads (DWQ), and acquisition of lands managed for conservation. Though required in the permit process, assessment of cumulative impacts as the basis for determining significant adverse impacts is rarely put forward due to the limitations of existing data, lack of threshold values, and anticipated legal challenges. However, a precedent has been set with the application of impervious surface limits to individual lots, though no limits have been placed on a hydrologic unit basis.

A review of top threats to coastal marine ecosystems across the globe listed habitat loss, overexploitation, eutrophication and hypoxia, pollution, invasive species, altered salinities, altered sedimentation, climate change, ocean acidification, and disease (Crain et al. 2009). The threats were not habitat-specific, unlike the CHPP, which discusses threats in each habitat chapter (for continuity). In the 2005 CHPP, a threats table was produced to evaluate the relative threat of various anthropogenic activities to fish habitats in North Carolina. From that table, it was evident that most threats affected more than one habitat and all habitats were affected by multiple threats. The original table has been modified to provide a cross-reference for locating all the information on each threat discussed among the habitat chapters (Table 8.1). The primary discussion of individual threats can be found in the habitat chapter they most affect. The table also includes the relative severity of a threat to each habitat. Some alteration sources and/or impacts clearly threaten the entire ecosystem. The most “cross-cutting” threats include climate change/sea level rise, water quality degradation from nutrients and toxins, dredging for navigation, water-dependent development, and non-native/invasive/introduced species. The synergy of these threats may also exacerbate or mitigate the individual impacts discussed in the habitat chapters. This is particularly true for sea-level rise and climate change.

The impacts of sea level rise are most apparent along the estuarine and ocean shoreline, where management decisions regarding water-dependent development can profoundly impact nearshore habitats (both landward and waterward of shoreline). For this and other reasons, climate change and associated sea level rise are now recognized as a priority issue for DENR strategic planning. The DENR climate change initiative includes comprehensive strategies across programs that effectively identify and address potential impacts to the environment and natural resources that DENR is charged with protecting (J. Nicholson/DENR, pers. com., February 2010). In the effort to proactively prepare for sea level rise, DENR has established a working group with representatives from OCCA, DCM, APNEP, DWQ, DMF, and Natural Heritage Trust Fund. This group will work with external agencies such as NOAA and Sea Grant, to develop coordinated policies, land use planning guidelines and other recommendations that will increase the resiliency of estuarine and coastal lands to changing climate and associated impacts.

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Table 8.1. Threat sources, impact severities (both measured and potential), and documentation in the habitat chapters. The primary discussion of a threat is indicated by which chapter(s) it receives the most attention. Note: X = discussed as a section heading, XX = primary discussion of threat affecting multiple habitats. Shading = relative severity of impact; 0% = no impact/unknown, 25% = minor, 50% = moderate, 75% = major.

Threat category	Source and/or impact	Water column	Shell bottom	SAV	Wetlands	Soft bottom	Hard bottom
Physical threats/ hydrologic modifications	Boating activity	-	X	X	X	-	X
	Channelization	X	-	-	X	-	-
	Dredging (navigation channels, boat basins)	X	X	X	X	X	X
	Fishing gear impacts	X	X	X	-	X	X
	Infrastructure (i.e., pipelines)	-	-	X	X	X	X
	Jetties and groins	X	-	-	-	XX	-
	Mining	X	-	-	X	X	-
	Obstructions (dams, culverts, locks)	XX	-	-	X	-	-
	Estuarine shoreline stabilization	X	X	X	XX	X	-
	Ocean shoreline stabilization	-	-	-	-	XX	X
	Upland development	-	-	-	X	-	-
Water withdrawals	XX	-	-	X	-	-	
Water quality degradation-sources	Land use and non-point sources	X	-	-	-	-	-
	Water-dependent development (marinas and docks)	XX	X	X	X	X	-
	Point sources	X	-	-	-	X	-
Water quality degradation-causes	Marine debris	X	-	-	-	-	-
	Microbial contamination	XX	X	-	-	-	-
	Nutrients and eutrophication	XX	X	X	X	X	X
	Saline discharge	X	-	-	-	-	-
	Suspended sediment and turbidity	XX	X	X	-	X	-
Toxic chemicals	X	X	X	X	X	X	
Disease and microbial stressors	-	X	X	-	-	-	
Non-native, invasive or nuisance species	X	X	X	X	X	X	
Sea-level rise/climate change	X	X	X	XX	X	X	

### Strategic Habitat Areas

An important step toward developing ecological thresholds in hydrologic units is the selection of exceptional areas to protect, enhance, or restore. The areas that contribute most to the integrity of the system are the category of habitat termed Strategic Habitat Area (SHAs). Strategic Habitat Areas are defined as specific locations of individual fish habitat or systems of habitat that have been identified to provide critical habitat functions or that are particularly at risk due to imminent threats, vulnerability, or rarity. Location and designation of SHAs is an attempt to identify such exceptional areas within the coastal fisheries ecosystem. Exceptional habitat areas are relatively unaltered and represent a proportion

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of habitat types to maintain.<sup>58</sup> The amount to maintain is adjusted up or down from 30%, based on relative ecological importance, rarity, vulnerability, sensitivity to alteration, and/or historic losses.

The process for locating and designating SHAs can be downloaded from the DMF website ([http://www.ncdmf.net/habitat/miscdownloads/FINAL\\_MFC\\_SHAreport12-6-06.pdf](http://www.ncdmf.net/habitat/miscdownloads/FINAL_MFC_SHAreport12-6-06.pdf)). Using this process and several refinements, the first of four regional assessments was completed and presented to the Marine Fisheries Commission in January 2009. Through the analysis, maps of habitats and relative alteration levels are produced, and a network of exceptional areas are selected as SHAs (Maps 8.1 and 8.2). The designation of SHAs was postponed until field verification could be conducted. In the meantime, Region 1 SHAs (Albemarle Sound and tributaries) and supporting data are used in conservation planning (at the DENR level) and as information for the CHPP update. There are also Sea Grant research fellowships supporting SHA assessments. The first project was conducted for Region 1 comparing DMF sampling data and proximity to altered habitats. The results indicated some correlations between juvenile fish data and cumulative alteration within a 0.5 kilometer radius, with low fish abundance where alteration levels were greater (DMF 2009b). Current research and assessment work is focused on SHA region 2 (Tar-Pamlico, Neuse, and Pamlico Sound subregions). *The SHA assessment for Region 2 should be complete by late 2010; Regions 3 and 4 should be completed by late 2011 (Map 1.2 of the Introduction chapter). Additional research is needed to verify the relative impact and distribution of cumulative alterations affecting the selection of areas.*

The input data and results of SHA assessment should help permit reviewers in assessing cumulative impacts and deciding habitat trade-offs acceptable for development projects. One could estimate how much more altered an area would get with the addition of proposed structures. The habitat trade-off issue is exemplified by the criteria required for constructing marsh-sills instead of vertical bulkheads. In this case, the exchange of soft bottom with shell bottom and wetlands could be justified by comparing representation levels in the region. The question to ask is whether the loss of soft bottom habitats would result in those habitats not meeting their representation levels in the SHA network. The addition of habitats with higher representation levels (i.e., shell bottom and wetlands) and less over-representation could be applied to restoration goals for those habitats in the area. *A basic need of SHA assessment continues to be the development of accurate and contemporary distribution maps for habitats (see "Distribution" sections of habitat chapters for specific recommendations) and threats (see "Threats and management needs" sections of habitat chapters for specific recommendations).*

The EEP, along with permitting agency input, is currently developing criteria for out-of-kind restoration credits based on projected improvements in downstream water quality.<sup>59</sup> This is fundamentally an ecosystem approach to maintaining water quality and associated bottom habitats with permitted impacts. The SHA approach could provide some input regarding the maintenance of habitat diversity in a restoration crediting system (see "Wetland enhancement and restoration" section of Wetlands chapter for more information).

### Other habitat designations and protection programs

While Region 1 SHAs have been identified and approved under the CHPP, they have not been placed in agency rule due to the need to develop site specific management plans for each SHA that will determine if regulatory actions or restrictions are needed. There are however, several different existing designations used in North Carolina that identify, delineate, and designate functionally important habitat areas. At the federal level, the Magnuson-Stevens Fishery Conservation and Management Act Reauthorization of 1996 [the Sustainable Fisheries Act (SFA)] requires the National Marine Fisheries Service (NMFS) to amend

<sup>58</sup> In the SHA region 1 (Albemarle Sound and tributaries), there were 42 habitat types and 18 alteration factors.

<sup>59</sup> The EEP contracted with East Carolina University to develop a rapid assessment process for coastal watersheds and compensatory mitigation that is consistent with the goals of the Coastal Habitat Protection Plan. The 2007-09 CHPP implementation plan called for developing an innovative system for out-of-kind mitigation credit that includes aquatic habitat restoration. [http://www.nceep.net/services/lwps/pull\\_down/by\\_basin/WhiteOak\\_RB.html](http://www.nceep.net/services/lwps/pull_down/by_basin/WhiteOak_RB.html)

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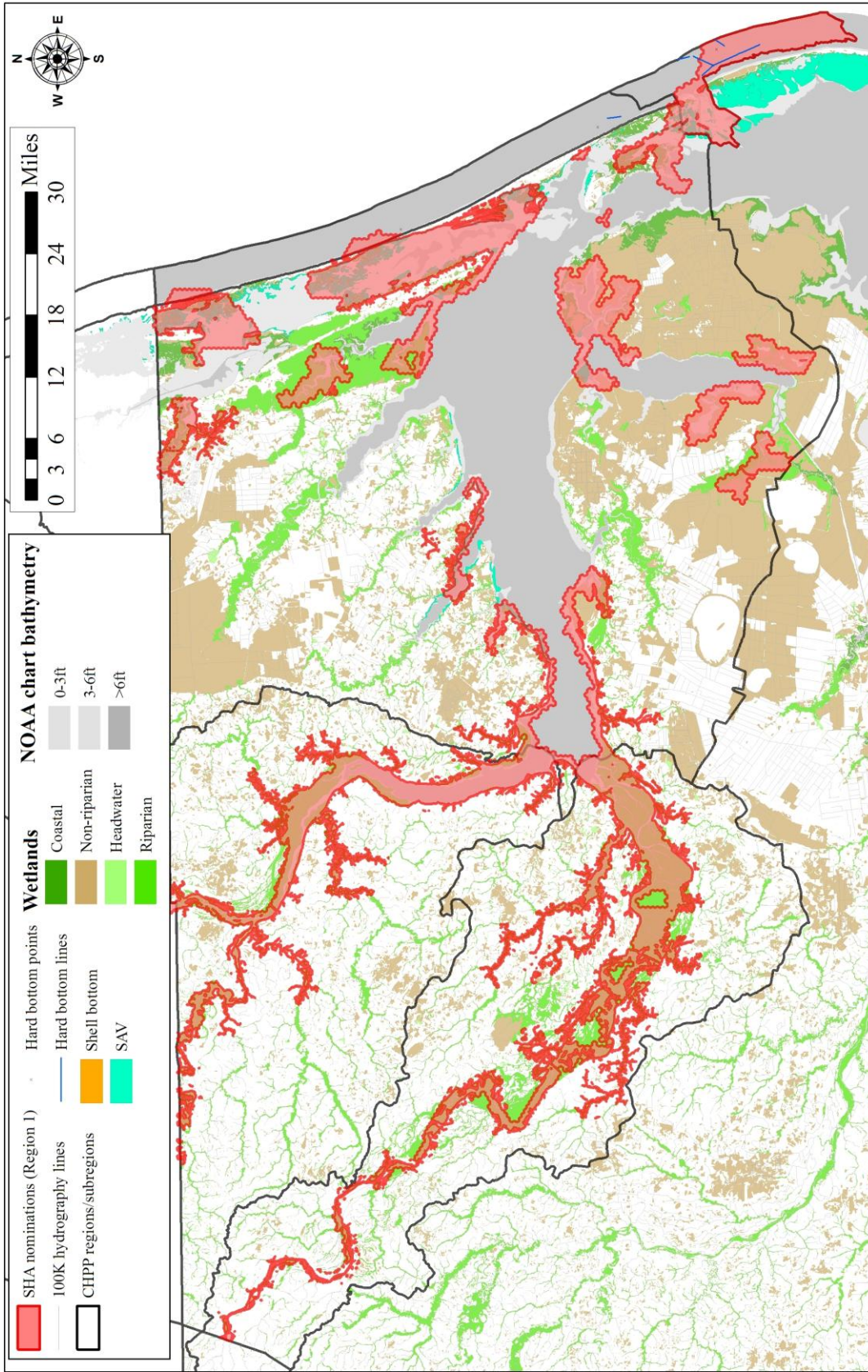
federal Fishery Management Plans (FMPs) to include provisions for protection of “Essential Fish Habitat” (EFH), defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” In North Carolina, salt marshes, oyster reefs, and seagrass beds are designated EFH for red drum and penaeid shrimp, species managed cooperatively by state and federal authorities. Similar to CHPP Strategic Habitat Areas, federal “Habitat Areas of Particular Concern” (HAPCs) are designated for areas of EFH that are particularly important for managed species or species complexes (SAFMC 1998a). North Carolina Primary Nursery Areas, first designated by the MFC in 1977, are similar in concept to HAPCs. However, the NMFS has designated very few HAPCs (none in North Carolina), while the MFC/DMF and WRC have designated tens of thousands of acres as nursery areas in North Carolina (see below). The state designations are well accepted by the various state and federal regulatory and permitting agencies, as well as by the public.

The MFC and WRC have designated nursery areas since 1977 and 1990, respectively, based on field sampling. Approximately 162,000 acres of Coastal Fishing Waters are currently designated by the MFC as Primary, Secondary, and Special Secondary Nursery Areas. About 10,000 acres of Inland Fishing Waters in the coastal area are designated as Inland Primary Nursery Areas, as well as the following areas of the four main rivers draining to North Carolina’s coast:

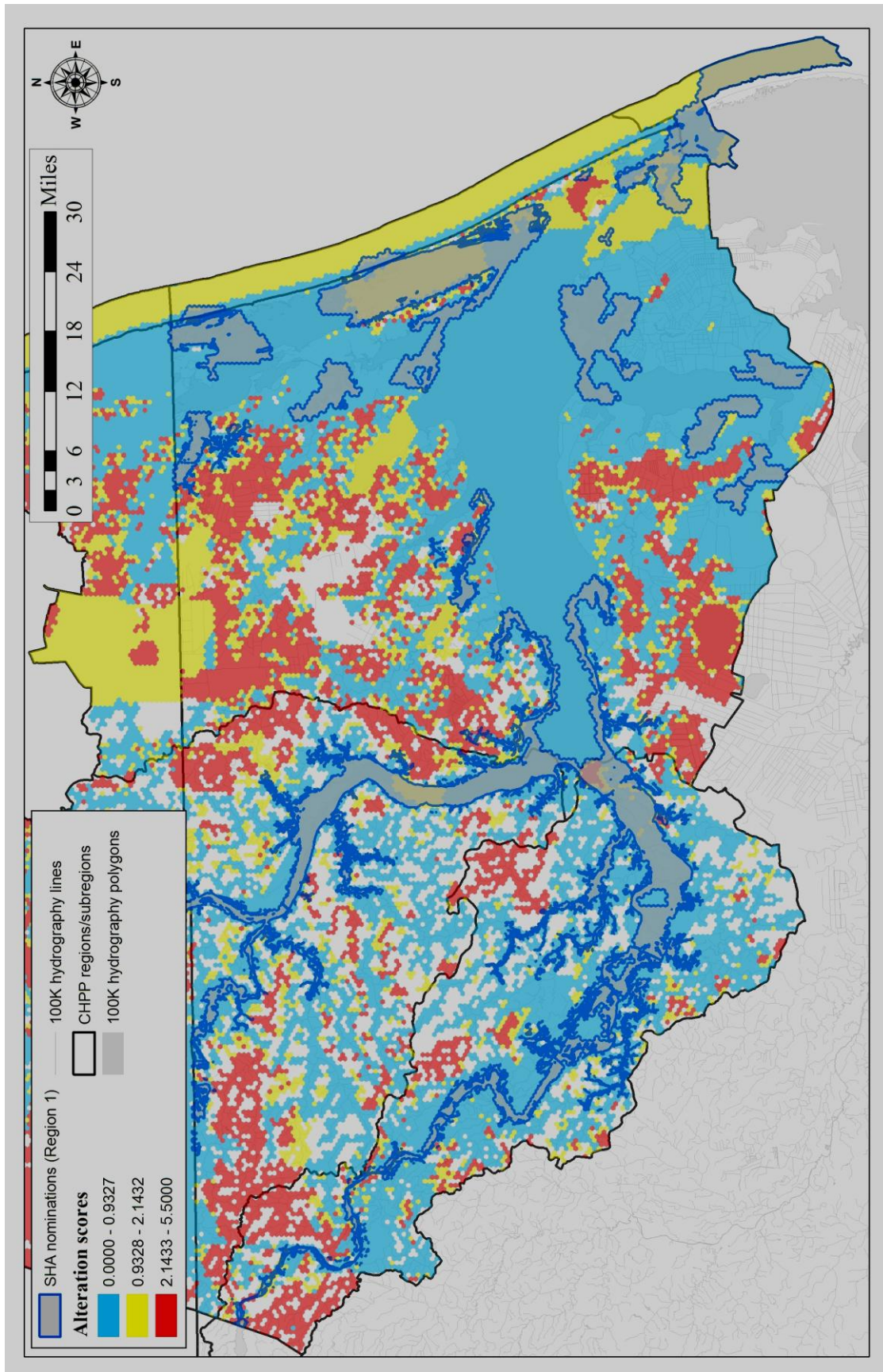
- Roanoke River, U.S. 258 bridge to Roanoke Rapids Dam (35.5 stream miles, 57.1 km)
- Tar-Pamlico River, railroad bridge at Washington to Rocky Mount Mill Dam (90.2 stream miles, 145.2 km)
- Neuse River, Pitchkettle Creek to Milburnie Dam (160.6 stream miles, 258.4 km)
- Cape Fear River, Lock and Dam #1 to Buckhorn Dam (126.7 stream miles, 203.9 km).

There are specific protections for designated nursery areas included in the rules of all three commissions. For example, an MFC rule [15A NCAC 3N .0104] prohibits use of trawls, dredges, long haul and swipe seines, and mechanical shellfishing gears in Primary Nursery Areas (PNAs). Once an area has been designated as a PNA by the MFC, the area also comes under protection of existing CRC rules [15A NCAC 07H .0208] and EMC rules [EMC rule 15A NCAC 02B .0301(c)] that protect physical and water quality parameters of PNAs as a class.

The existing rule definitions for various fish habitats were revised by the Marine Fisheries Commission in April 2009 [MFC Rule 15A NCAC 03I .0101(4)]. The word “critical” was omitted since all fish habitats, under the ecosystem concept, are critical to a properly functioning system as a whole. The DMF also delineated in rule anadromous fish spawning areas based on sampling conducted from the early 1970s to the present. Although neither CRC nor EMC rules offer any specific protection for anadromous fish spawning areas, regulatory protections exist for other fish habitats, such as submerged aquatic vegetation and shellfish producing areas. Beds of submerged aquatic vegetation are protected from the direct impacts of dredging and trawling (in some locations [MFC rule 15A NCAC 3J .0104]), and open shellfish harvesting areas are protected from new marina pollution and wastewater discharges [CRC rule 15A NCAC 07H. 0208(5) (E)]. (More information regarding protection of fish habitat types is provided in Chapters 2 – 7). Designation and protection of Strategic Habitat Areas was meant to improve on the piecemeal protection of individual habitats and functional areas.



Map 8.1.1. Strategic Habitat Area nominations presented and approved by the Marine Fisheries Commission in January 2009.



Map 8.2. Total alteration scores calculated from 18 individual alteration factors coinciding with habitat targets in the Albemarle Sound region.