North Carolina Coastal Habitat Protection Plan

2016

NC Department of Environmental Quality

Enhancing coastal fisheries through habitat protection and restoration

NC Environmental Quality

North Carolina Marine Fisheries

Albemarle - Pamlico National Estuary Partnership

NC Division of Coastal Management

DWR Division of Water Resources

EXECUTIVE SUMMARY

This document is intended as a resource and guide compiled by Department of Environmental Quality staff to assist the Marine Fisheries, Environmental Management, and Coastal Resources commissions in the development of goals and recommendations for the continued protection and enhancement of fishery habitats of North Carolina. Implementation of any of the recommendations through specific rules or policies will involve further discussion with stakeholders as well as the balancing of competing ecological and economic values. By adopting this update, the commissions agree to cooperatively manage aquatic habitats towards the goal of coastal fishery resources long-term viability. The "Source Document" continues to be a work-in-progress as more scientific data, inventories, and indicators become available. G.S. 143B-279.8 requires that a Coastal Habitat Protection Plan (CHPP) be drafted by the Department of Environmental Quality, (renamed from Department of Environment and Natural Resources, effective July 1,2015), and reviewed every five years. The purpose of the plan is to recommend actions to protect and restore habitats critical to enhancement of North Carolina's coastal fisheries. This is the third iteration of the plan. The Marine Fisheries, Coastal Resources, and Environmental Management commissions are required to approve the plan recommendations.

The updated Coastal Habitat Protection Plan summarizes the economic and ecological value of coastal fish habitats to North Carolina, their status, and the potential threats to their sustainability. Goals and recommendations to protect and restore fish habitat, including water quality, are included. The appended Source Document, compiled by staff of the Department of Environmental Quality, provides the science to support the need for such recommendations. Throughout the plan, there are references to the chapter of the Source Document where more details and references can be found.

This Plan and Source Document describe many of the accomplishments that have occurred since the first iteration of the plan in 2005. Most have been non-regulatory, collaborative efforts across divisions. Continued progress will require cooperation across additional agencies.

Goals and Recommendations

Goal 1. Improve effectiveness of existing rules and programs protecting coastal fish habitats.

Includes 5 recommendations regarding enhancement of compliance, monitoring, outreach, coordination across commissions, and management of invasive species.

Goal 2. Identify and delineate strategic coastal habitats.

Includes 2 recommendations regarding mapping and monitoring fish habitat, assessing their condition, and identifying priority areas for fish species.

Goal 3. Enhance and protect habitats from adverse physical impacts.

Includes 8 recommendations on expanding habitat restoration, managing ocean and estuarine shorelines, protecting habitat from destructive fishing gear, and dredging and filling impacts.

Goal 4. Enhance and protect water quality.

Includes 8 recommendations to reduce point and non-point sources of pollution in surface waters through encouragement of Best Management Practices, incentives, assistance, outreach, and coordination. This applies not only to activities under the authority of the Department of Environmental Quality, such as development and fishing, but to all land use activities, including forestry, agriculture, and road construction.

The Coastal Habitat Protection Plan and Source Document can be viewed and downloaded from:

http://portal.ncdenr.org/web/mf/habitat/chpp/downloads

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The North Carolina Coastal Habitat Protection Plan

North Carolina's approximately 2.3 million acres of estuarine waters comprise the largest estuarine system of any state along the Atlantic seaboard. Located at the confluence of warm southern and cool northern currents, North Carolina's waters support a high diversity of aquatic species and six distinct, but interdependent, marine habitats. These waters are vital not only for the state's important fish species, but also for fish that migrate along the east coast.

North Carolina, with its billion dollar commercial and recreational fishing industries, ranks among the nation's highest seafood producing states. Aquatic species important to these industries depend on sufficient quality and quantity of habitats in our rivers, sounds, and ocean waters. From shellfish beds in the lower estuaries, to swamps in the upper estuaries, fish habitats are at risk. Activities causing habitat loss and degradation threaten more than the fishing industry vital to North Carolina's economy. They also threaten coastal tourism, outdoor recreation, and residential development.

Recognizing the critical importance of healthy fish habitat, the NC General Assembly passed the Fisheries Reform Act (GS.143B-279.8), requiring three of the state's regulatory commissions - the Marine Fisheries, Environmental Management, and Coastal Resources commissions - to adopt a plan to protect and restore resources critical to North Carolina's fisheries. The Department of Environmental Quality (DEQ) developed a Coastal Habitat Protection Plan (CHPP) through a cooperative, multiagency effort. The CHPP was written by DEQ staff, adopted by the three commissions in 2004, and updated in 2010.

The CHPP is a guidance document providing the latest science on North Carolina's coastal fish habitats, their ecological functions, values, and threats, as well as goals and recommendations to protect, enhance, and restore fish habitat. By adopting the revised plan, the commissions are committing to implement these goals and recommendations. To this end, each DEQ division develops a biennial implementation plan that includes tangible and achievable actions to progress forward.

In this plan, there is information on past implementation progress, updated recommendations, and priority issues to focus actions. Background on the six fish habitats, their status, and pertinent threats are included. Full details are in the 2015 CHPP Source Document (**http://portal.ncdenr.org/web/mf/habitat/chpp/downloads**). A key to acronyms is provided at the end of this document.

Value of NC's coastal fish habitats: *

- 2013 Economic impact of NC fisheries: commercial - $305 million; recreational - $1.7 billion.
- Submerged aquatic vegetation produces food, improves water quality. In Bogue Sound, NC, pollution removal services value - $3,000/ac/yr. Ecosystem services of seagrass and algae - $7,700/ac/yr.
- Oyster reefs remove pollutants, increase fish production, stabilize shorelines – ecosystem services estimated $2,200 - $40,200/ac/yr, without value of fishery. Recreational fishing from reef restoration value estimated - $640,000/yr.
- Coastal wetlands provide storm protection valued at $25.6 billion/yr.
- Property values adjacent to open shellfish harvest waters are higher than next to closed waters.
- NC hard bottom fishery generated more than $4.2 million average annually for each of three years between 2011-2013.
- For every $1 invested in land conservation in NC, ~$4 return from natural resource goods and services.
- Beach property 80' wide ~35% more valuable than same property 79' wide.

* Refer to the Source Document for details and literature references.

Water Column | Submerged Aquatic Vegetation | Shell Bottom | Wetlands | Hard Bottom | Soft Bottom

CHPP Implementation

The overarching goal of the CHPP is to enhance fisheries by protecting and restoring important coastal habitats. The plan includes *recommendations* that fall under four broad goals and address issues such as minimizing habitat impacts from fishing gear and channel dredging, as well as reducing water quality impacts from point and nonpoint sources.

To fulfill these recommendations, each DEQ division and department develops biennial *implementation plans* that include tangible achievable actions. Implementation actions have varied over time based on needs and changing priorities. Implementation actions are carried out by DEQ, the Marine Fisheries Commission (MFC) and Division of Marine Fisheries (DMF), the Coastal Resources Commission (CRC) and Division of Coastal Management (DCM), the Environmental Management Commission (EMC) and Division of Water Resources (DWR), the Sedimentation Control Commission (SCC) and Division of Energy, Mineral, and Land Resources (DEMLR), and other partnering agencies. Implementation progress is tracked on a regular basis (Ch. 1).

In the 2015 CHPP, four *priority habitat issues* were selected for the focus of implementation plans. Suggested implementation actions for these issues were developed and are included in the plan. The four issues are oyster restoration, living shorelines, sedimentation, and developing metrics to assess habitat trends and management effectiveness (Ch. 12).

Department of Environmental Quality

DEQ is the lead stewardship agency for the preservation and protection of North Carolina's outstanding natural resources. The organization, which has offices from the mountains to the coast, administers programs designed to protect and enhance water quality, aquatic resources, public health, fish, wildlife, and wilderness areas.

The department is responsible for drafting the habitat plan. The CHPP Team, consisting of staff from DEQ divisions, draft the plan with guidance from the department.

DEQ implementation actions include those of the Albemarle-Pamlico National Estuary Partnership, Office of Land and Water Stewardship, and Division of Mitigation Services. Other participating state agencies include the Division of Soil and Water Conservation, NC Forest Service, Wildlife Resources Commission, and the Department of Agriculture and Consumer Services.

CHPP Steering Committee

The CHPP Steering Committee consists of two commissioners from each of the three commissions specified in the Fisheries Reform Act - MFC, CRC, and EMC. Their role is to review and approve of the draft plan, be an advocate for the plan to their full commission, meet regularly as a committee to discuss solutions for difficult and cross-cutting habitat and water quality issues, and review implementation progress to ensure that the plan is implemented.

CHPP Implementation

The primary divisions responsible for implementing CHPP recommendations are the Division of Marine Fisheries, Division of Coastal Management, Division of Water Resources, and Division of Energy, Minerals, and Land Resources (Ch. 1).

Division of Marine Fisheries

The division, under the rulemaking authority of the MFC, manages the commercial and recreational fisheries in North Carolina's estuarine and ocean waters. The division protects habitats through fishing gear rules, planning, research, and enhancement activities. The division's mission is to ensure sustainable marine and estuarine fisheries for the benefit of the people of North Carolina.

Division of Coastal Management

Under the rulemaking authority of the CRC, this division manages coastal development in accordance with the NC Coastal Area Management Act and the NC Dredge and Fill Law. The DCM works to protect, conserve, and manage North Carolina's coastal resources through an integrated program of planning, permitting, education, and research.

Division of Water Resources

The DWR's mission is to protect, preserve, enhance, and manage North Carolina's surface water and groundwater resources for the health and welfare of the citizens of North Carolina and the economic well-being of the state. This division functions under the rulemaking authority of the EMC.

Division of Energy, Mineral, and Land Resources

The division, under the rulemaking authority of the EMC, manages and provides technical assistance related to sediment and erosion control, stormwater management, mining, and dams. The mission of DEMLR is to promote the wise use and protection of North Carolina's land and geologic resources.

Implementation Progress

Substantial implementation progress has been made over the past ten years, with some positive habitat signs evident. In addition, some fishery species' populations have rebounded or are showing strong signs of recovery. Examples include spotted seatrout, red drum, gag grouper, black sea bass, oysters, and bay scallops. While this advancement cannot be directly or solely related to habitat improvement, it is a positive indication for management overall. Some examples of implementation success are below (Ch. 1).

Oyster restoration

- Since 2005, oyster sanctuary development has greatly expanded. DMF has constructed 13 oyster sanctuaries in the Pamlico Sound system, each ranging from 5 - 60 acres of permitted area, and totaling 159 acres of developed reef (Ch. 3 & 12).
- Creation of an oyster shell recycling program provided additional shell material to supplement the division's shell planting activities. Recycled and purchased shell and rock material is used to create additional oyster reef habitat that supports the oyster fishery and provides fish habitat. The area of oyster reef created annually through shell planting varies based on funding and availability of material. Despite budget cuts, efforts continue through partnerships, grant funding, and mitigation contract work (Ch. 3 & 12).

Improving strategies to reduce nonpoint runoff

- EMC adopted coastal stormwater rules to reduce further degradation of receiving waters (Ch. 14).
- DWR and DEMLR incorporated low impact development techniques as acceptable Best Management Practice options for controlling runoff from development (Ch. 14).

Mapping and assessing habitat condition

- Since 2005, much progress has been made in submerged aquatic vegetation (SAV) mapping. Through a coordinated partnership of APNEP, DMF, DCM, DWR, and others, the entire coast was mapped in 2007-2008, with portions repeated in 2013 and 2015. A monitoring plan was developed to improve mapping methods in low salinity waters and to allow repeat mapping to evaluate change over time (Ch. 4).
- DMF accelerated estuarine shellfish bottom mapping (to a maximum water depth of 15 ft). Mapping is now over 95% complete (Ch. 3).
- DCM mapped the coastal estuarine shoreline and shoreline structures such as bulkheads and piers (Ch.8).
- DMF has developed and begun a process to identify a subset of strategic habitats, based on their condition and location. This will allow conservation measures to focus on priority areas (Ch. 13).

Implementation Progress

Managing shorelines

- DCM developed sediment criteria for beach nourishment and a Beach and Inlet Management Plan that provides guidelines for ocean beach nourishment to minimize ecological impacts and address socioeconomic concerns (Ch. 8).
- DCM has taken several actions to encourage greater use of living shorelines for estuarine shoreline stabilization. Working with DMF, DWR, and other agencies, DCM surveyed living shorelines for success, and agencies worked to simplify the permitting process. Outreach to multiple audiences through workshops, written material, and websites continues (Ch. 8).

Coordination and compliance

Regular CHPP Steering Committee meetings and CHPP quarterly permit reviewer meetings have greatly improved collaboration among divisions and problem solving on cross-cutting issues. New compliance positions were established in several divisions through appropriated funds, allowing greater assessment of compliance. However, due to budget shortfalls and resulting staff reductions over the past few years, divisions have maintained compliance monitoring through reorganization, reprioritization, and placing additional responsibilities on staff. (Ch. 1).

Research and outreach

- The Coastal Recreational Fishing License grant program funded multiple research projects that were identified as priorities in CHPP Implementation Plans or that will expand our understanding of the link between habitat condition and fish use (Ch. 1).
- The National Estuarine Research Reserve has produced educational materials on the value of different fish habitats and environmentally friendly shoreline stabilization techniques. The NERR also held workshops to promote living shorelines (Ch. 14).
- Several educational kiosks and displays on the value of fish habitat were constructed at a variety of museums and public access locations using Coastal Recreational Fishing License funds (Ch. 14).

Restoring fish passage

- In 2012, a rock ramp fish passage was constructed around Lock and Dam #1 on the Cape Fear River by the US Army Corps of Engineers to allow anadromous fish to migrate farther upstream to spawn. The work was done collaboratively with DMF, WRC, USFWS, and other partners (Ch. 9).

Goals and Recommendations

GOAL 1:

IMPROVE EFFECTIVENESS OF EXISTING RULES AND PROGRAMS PROTECTING COASTAL FISH HABITATS

North Carolina has a number of programs in place to protect coastal fisheries and the natural resources that support them. The Marine Fisheries Commission has adopted rules addressing the impacts of certain types of fishing gear and fishing practices that may damage fish habitats. The Coastal Resources Commission regulates development impacts on certain types of critical habitat, such as saltwater marshes and Primary Nursery Areas. The Environmental Management Commission has water quality standards that address pollution of all waters, from direct discharges to dredge and fill impacts. The Division of Energy, Mineral, and Land Resources addresses erosion and sediment control from land development or mining. The Coastal Habitat Protection Plan identifies strategies that could continue to improve rule compliance, coordination of environmental monitoring, and outreach, which in turn will result in greater success in protecting critical fish habitats (Ch. 15).

RECOMMENDATIONS:

1. Continue to ensure compliance with Coastal Resources Commission (CRC), Environmental Management Commission (EMC), and Marine Fisheries Commission (MFC) rules and permits.
2. Coordinate and enhance:
    a. monitoring of water quality, habitat, and fisheries resources (including data management) from headwaters to the near-shore ocean.
    b. assessment and monitoring of effectiveness of rules established to protect coastal habitats.
3. Enhance and expand educational outreach on the value of fish habitat, threats from land use and other activities, and explanations of management measures and challenges.

4. Continue to coordinate among commissions and agencies on coastal habitat management issues.
5. Enhance management of invasive species with existing programs. Monitor and track status in affected waterbodies.

Goals and Recommendations

GOAL 3:

ENHANCE AND PROTECT HABITATS FROM ADVERSE PHYSICAL IMPACTS

The CHPP identifies a number of ways in which fish habitats can be damaged by direct physical impacts. Some examples include filling of wetlands, navigational dredging of soft bottom habitat, destruction of shell bottom and hard bottom areas, damage to submerged aquatic vegetation by use of certain types of fishing gear, and physical obstructions that block fish movement to and from spawning areas. While large impacts can directly contribute to the loss of habitat functions, the accumulation of many small impacts can make a habitat more vulnerable to injuries from which it might otherwise recover quickly. In some cases, historic damage to a habitat can be mitigated through the creation of sanctuaries where the resource can recover. One such program involves creation of protected oyster reefs. In other cases, the cumulative impacts of multiple projects can be more effectively managed through comprehensive planning (Ch. 15).

RECOMMENDATIONS:

1. Expand habitat restoration in accordance with restoration plan goals, including:
    a. increasing subtidal and intertidal oyster habitat through restoration.
    b. re-establishing riparian wetlands and stream hydrology.
    c. restoring SAV habitat and shallow soft bottom nurseries.
2. Sustain healthy barrier island systems by maintaining and enhancing ecologically sound policies for ocean and inlet shorelines, and implement a comprehensive beach and inlet management plan that provides ecologically based guidelines to protect fish habitat and address socioeconomic concerns.
3. Protect habitat from adverse fishing gear effects through improved compliance.

GOAL 2:

IDENTIFY AND DELINEATE STRATEGIC COASTAL HABITATS

Maintaining healthy coastal fisheries requires consideration of the entire ecosystem and the way different types of fish habitats work together. For example, coastal marshes help prevent erosion of shallow soft bottom habitat, which provides a food source and corridor for juvenile finfish. Shell bottom reduces sediment and nutrients in the water column, which enhances conditions for submerged aquatic vegetation. Together these habitats provide different functions for fish and protective stepping stones for their migration through coastal waters. Fragmenting these habitats, or damaging one of a series of interrelated habitats, makes it more difficult for aquatic systems to support strong and healthy coastal fisheries. The Marine Fisheries Commission identified a need to locate strategic habitats. These areas are a subset of all coastal habitats and consist of strategically located complexes of fish habitat that provide exceptional ecological functions ("best of the best"), or are particularly at risk due to vulnerability or rarity. These areas merit special attention and should be given high priority for research, monitoring, and possibly conservation (Ch. 15).

RECOMMENDATIONS:

1. Support assessments to classify habitat value and condition by:
    a. coordinating, completing, and maintaining baseline habitat mapping (including seagrass, shell bottom, shoreline, and other bottom types) using the most appropriate technology.
    b. selectively monitoring the condition and status of those habitats.
    c. assessing fish-habitat linkages and effects of land use and other activities on those habitats.
2. Continue to identify and field groundtruth strategic coastal habitats.

Goals and Recommendations

GOAL 3:

ENHANCE AND PROTECT HABITATS FROM ADVERSE PHYSICAL IMPACTS

RECOMMENDATIONS:

4. Improve management of estuarine and public trust shorelines and shallow water habitats by revising shoreline stabilization rules to include consideration of site specific conditions, and advocate for alternatives to vertical shoreline stabilization structures.
5. Protect and restore habitat for migratory fishes by:
    a. incorporating the water quality and quantity needs of fish in water use planning and management.
    b. restoring fish passage through elimination or modification of stream obstructions, such as dams and culverts.
6. Ensure that energy development and infrastructure is designed and sited to minimize negative impacts to fish habitat, avoid new obstructions to fish passage, and, where possible, provide positive impacts.
7. Protect and restore important fish habitat functions from damage associated with activities such as dredging and filling.
8. Develop coordinated policies including management adaptations and guidelines to increase resiliency of fish habitat to ecosystem changes.

Seasonal restrictions on navigational dredging are an effective means of protecting fish during critical times of their lives, such as during spawning periods or when early juvenile fish are growing in nursery areas.

GOAL 4:

ENHANCE AND PROTECT WATER QUALITY

Clean water is essential to coastal fisheries. Water conditions necessary to support coastal fish include the right combination of temperature, salinity, and oxygen, as well as the absence of harmful pollutants. Achieving and maintaining good water quality for purposes of fish productivity requires management of both direct discharges to surface waters and nonpoint runoff from land activities. While there have been great improvements to water quality management, support through funding and technological advances is needed to sustain water quality as coastal uses increase. The CHPP recommends strategies to address water quality impacts by maintaining rule compliance through inspections, local government incentives, and developing new technology to reduce point and nonpoint pollution through voluntary actions. Maintaining the water quality necessary to support vital coastal fisheries will benefit not only the fishing industry, but also a large sector of the entire coastal economy built around travel, tourism, recreational fishing, and other outdoor activities (Ch. 15).

RECOMMENDATIONS:

1. Reduce point source pollution discharges by:
    a. increasing inspections of wastewater discharges, treatment facilities, collection infrastructure, and disposal sites.
    b. providing incentives and increased funding for upgrading all types of discharge treatment systems and infrastructure.
    c. developing standards and treatment methods that minimize the threat of endocrine disrupting chemicals on aquatic life.
2. Address proper reuse of treated wastewater effluent and promote the use of best available technology in wastewater treatment plants (including reverse osmosis and nanofiltration effluent), to reduce wastewater pollutant loads to rivers, estuaries, and the ocean.

3. Prevent additional shellfish closures and swimming advisories by:
    a. conducting targeted water quality restoration activities.
    b. prohibiting new or expanded stormwater outfalls to coastal beaches and to coastal shellfishing waters (EMC surface water classifications SA and SB) except during times of emergency (as defined by the DWR's Stormwater Flooding Relief Discharge Policy) when public safety and health are threatened.
    c. continuing to phase out existing outfalls by implementing alternative stormwater management strategies.
4. Enhance coordination with, and provide financial/technical support for, local government/private actions to effectively manage stormwater and wastewater.

Goals and Recommendations

GOAL 4:

ENHANCE AND PROTECT WATER QUALITY

RECOMMENDATIONS:

5. Continue to improve strategies throughout the river basins to reduce nonpoint pollution and minimize cumulative losses of fish habitat through voluntary actions, assistance, and incentives, including:
    a. improving methods to reduce pollution from construction sites, agriculture, and forestry.
    b. increasing on-site infiltration of stormwater.
    c. encouraging and providing incentives for implementation of Low Impact Development practices.
    d. increased inspections of onsite wastewater treatment facilities.
    e. increasing use of reclaimed water and recycling.
    f. Increasing voluntary use of riparian vegetated buffers for forestry, agriculture, and development.
    g. increasing funding for strategic land acquisition and conservation.
6. Maintain effective regulatory strategies throughout the river basins to reduce nonpoint pollution and minimize cumulative losses of fish habitat, including use of vegetated buffers and established stormwater controls.
7. Maintain adequate water quality conducive to the support of present and future mariculture in public trust waters.
6. Reduce nonpoint source pollution from large-scale animal operations by:
    a. Ensuring proper oversight and management of animal waste management systems.
    b. Ensuring certified operator compliance with permit and operator requirements and management plan for animal waste management systems.

For every $1 invested in land conservation in NC, there is estimated to be a $4 return in economic value from natural resource goods and services alone, without considering other economic benefits.

Priority Habitat Issue - *Oyster Restoration*

Oyster populations in North Carolina have declined by as much as 90% from historic levels. Overfishing, habitat destruction, disease, and pollution have contributed to the significant decline and slow recovery rates of oyster reefs. Recognized as an ecosystem engineer, oyster reefs are critical economically for the seafood industry, and ecologically for improving water quality and providing fish habitat. For 100 years, DMF has been "planting" oyster shell in open harvest areas to provide additional hard substrate for oyster recruitment. The planted shell soon becomes a living oyster reef, enhancing the oyster fishery and providing fish habitat. Since 1998, DMF has constructed 13 subtidal oyster sanctuaries where shellfish harvest is not allowed. Oysters growing in the protected sanctuaries serve as broodstock, providing larvae that recruit onto hard substrate in surrounding waters. Despite these efforts, oyster populations remain well below historic levels, fishing pressure increases, and water quality declines. Lack of additional funding to purchase and deploy hard material and conduct research limits the ability to expand oyster restoration activities. The CHPP Steering Committee considers this one of the most important activities that could be done to improve habitat and water quality in North Carolina's coastal waters (Ch. 12).

Proposed Implementation Actions

Cultch Planting

- ◊ Increase spending limit per bushel of shell to compete with other states.
- ◊ Develop a cooperative public/private, self-sustaining shell recycling program by providing financial incentives in exchange for recycled shell.
- ◊ Work with the shellfish industry to institute an "oyster use fee" to help support the cultch planting program.
- ◊ Identify alternative substrates for larval settlement in intertidal and subtidal reefs, including a cost-benefit analysis.
- ◊ Establish long term monitoring program to support future decision making.
- ◊ Utilize new siting tools and monitoring protocols to maximize reef success.

Hatchery Oyster Seed Production

- ◊ Explore options for increasing funds to support UNCW oyster hatchery.
- ◊ Identify regional genetic variability within NC.
- ◊ Improve availability of seed oysters genetically suited to respective regions.

Oyster Sanctuaries

- ◊ Identify alternative substrates for larval settlement in intertidal/subtidal reefs, including cost-benefit analysis.
- ◊ Identify the size and number of sanctuaries needed.
- ◊ Develop reefs that deter poaching by mechanical means.
- ◊ Utilize new siting tools to maximize reef success.
- ◊ Explore options for in situ sampling protocol to incorporate alternative construction materials.

Priority Habitat Issues - *Living Shorelines*

Living shorelines is the term used for a type of designed shoreline stabilization technique that incorporates live components such as marsh plants, frequently in combination with rock or oyster sill structures. Wetland and shell bottom habitat along the shoreline have declined in many areas due to natural erosion and vertical shoreline hardening with bulkheads. Living shorelines offer an effective alternative for protecting waterfront property, while restoring fish habitat and ecosystem services. Since 2005, progress has been made in documenting, through scientific studies, the benefits and limitations of living shorelines. Research in North Carolina has shown that living shorelines support a higher diversity and abundance of fish and shellfish than bulkheaded shorelines, effectively deter erosion, and survive storm events well. Outreach efforts have been done to increase awareness of this technique to the public and contractors. Nonprofit organizations and DCM have constructed several demonstration projects. Despite these efforts, approximately 60 living shorelines have been permitted coastwide, in contrast to 93 miles of bulkheads (based on 2012 DCM mapping). The CHPP Steering Committee requested that efforts continue to focus on encouraging living shorelines to protect property, restore shoreline habitat, and improve water quality (Ch. 12).

Proposed Implementation Actions

Outreach

- ◊ Seek funding and partnerships to increase the number of highly visible demonstration projects.
- ◊ Develop case studies that property owners can relate to that discuss site conditions, initial and ongoing costs, and performance of the structure.
- ◊ Actively engage with contractors, realtors, and homeowners associations in the design and benefits of living shorelines.
- ◊ Enhance communications, marketing, and education initiatives to increase awareness of, and build demand for, living shorelines among property owners.

Research

- ◊ Examine the effectiveness of natural and other structural materials for erosion control and ecosystem enhancement.
- ◊ Examine the long-term efficacy of living shorelines and vertical structures, particularly after storm events.
- ◊ Map areas where living shorelines would be suitable for erosion control.
- ◊ Investigate use of living shorelines as BMP or mitigation options.

Permitting

- ◊ Continue to simplify the federal and state permitting process for living shorelines.

Priority Habitat Issue - *Sedimentation*

Sedimentation in creeks, particularly in nursery areas, is a continuing concern. While a moderate amount of sediment input is necessary to maintain shallow soft bottom habitat that supports wetlands, excessive amounts can silt over existing oyster beds and submerged aquatic vegetation, smother invertebrates, clog fish gills, reduce survival of fish eggs and larvae, reduce recruitment of new oysters onto shell, and lower overall diversity and abundance of marine life. Pollutants such as toxins, bacteria, and nutrients bind to sediment particles and are transported into estuarine waters, where they can accumulate in the sediment and impact aquatic organisms. Sediment enters the upper estuary via runoff and ditching due to land clearing activities associated with agriculture, forestry, and development. Shoreline erosion, tidal inflow, and dredging also contribute sediment in the lower estuary. Studies in North Carolina indicate that relatively high sedimentation has occurred in the past. The effect on estuarine productivity is uncertain. More assessment on the extent and effect of sedimentation in coastal creeks and rivers is needed, along with current rates of sediment inputs, to determine the best way to address the issue (Ch. 12).


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Proposed Implementation Actions

- ◊ Determine magnitude and change in sedimentation rates and sources over time at sufficiently representative waterbodies and regions.
- ◊ Determine the effect of sedimentation in the upper estuaries on primary and secondary productivity and juvenile nursery function.
- ◊ Encourage research for innovative and effective sediment control methods in coastal river basins.
- ◊ Encourage expanded use of stormwater BMPs and low impact development (LID) to reduce sediment loading into estuarine creeks.
- ◊ Partner with NC Department of Transportation to retrofit road ditches that drain to estuarine waters.
- ◊ Improve effectiveness of sediment and erosion control programs by:
  - ♦ Encouraging development of effective local erosion control programs to maintain compliance and reduce sediment from reaching surface waters.
  - ♦ Enhancing monitoring capabilities for local and state water quality and sediment control programs (e.g., purchase turbidity meters and train staff in their use).
  - ♦ Continuing to educate the public, developers, contractors, and farmers on the need for sediment and erosion control measures and techniques for effective sediment control.
  - ♦ Provide education and financial/technical support for local and state programs to better manage sediment control measures from all land disturbing activities.

In 2014, 6,290 acres were impaired by turbidity for the aquatic life use support classification in coastal subbasins (DWR 2014 Integrated Report).

Priority Habitat Issue - *Developing Metrics*

Developing metrics to assess habitat trends and management effectiveness is the cornerstone of habitat protection and restoration. Without them, needed habitat conservation initiatives are unknown. Ecosystem-based management is the process where monitoring of ecosystem indicators is done to assess the condition of the resource and the effectiveness of management strategies; management actions are modified based on monitoring results. This process requires mapping all habitat to assess trends in distribution, developing and monitoring representative indicators to assess habitat condition, monitoring fish use of habitats in priority areas, and developing management performance criteria for measuring success of management actions. The DEQ has already initiated mapping and monitoring of some habitats, but has not established continual monitoring to evaluate management effectiveness. The Albemarle-Pamlico National Estuary Partnership established ecosystem indicators in 2012 to help determine the status of that system. The DMF has identified strategic coastal habitats in most of the coastal waters that are high priority for protection so that fish populations are sustained. More work is needed to establish a cyclic process to monitor, assess, and successfully and efficiently manage North Carolina's coastal resources.

The lack of quantified trends in habitat condition and success of management actions was identified as a priority concern of the CHPP Steering Committee (Ch. 12).

Proposed Implementation Actions

- ◊ Develop indicator metrics for monitoring the status and trends of each of the six habitat types within North Carolina's coastal ecosystem (water column, shell bottom, SAV, wetlands, soft bottom, hard bottom).
- ◊ Establish thresholds of habitat quality, quantity, or extent similar to limit reference points - or traffic lights - which would initiate pre-determined management actions.
- ◊ Develop indicators for assessing fish utilization of strategic coastal habitats.
- ◊ Develop performance criteria for measuring success of management decisions.
- ◊ Include specific performance criteria in CHPP management actions where possible.

The Fishery Reform Act requires the CHPP to describe, classify, and evaluate biological habitat systems, including wetlands, spawning grounds, nursery areas, shellfish beds, and submerged aquatic vegetation, and outstanding resource waters.

NC Coastal Habitats

North Carolina's coastal fish habitats provide crucial functions for the plants and animals living in them. This diversity of interconnected habitats provides food and shelter in which to reproduce and grow for a tremendous variety of fish, shellfish, and crustaceans. Protecting and restoring these habitats is essential to the survival of North Carolina's fisheries.

While poor water quality puts the habitats' ability to function and support fish populations at risk, physical damage caused by humans is also a serious threat. Conversion of wetlands by draining, filling, and water control projects are the major sources of wetland loss in eastern North Carolina. Shell bottom habitat along our coast has been decimated by a century of excessive mechanical harvests and diseases. More recently, dredging for navigation channels and marinas, as well as damage from bottom-disturbing fishing gear, threatens remaining shell bottom and submerged aquatic vegetation habitat and impedes establishment of those habitats. Submerged aquatic vegetation is also vulnerable to uprooting by boat propellers and to shading by docks and piers. These and other types of physical impacts affect the ability of fish habitats to sustain fisheries and increase their vulnerability to water quality problems (Ch. 2-7).

The CHPP identifies six fish habitats that need protection or enhancement:

- Water Column
- Shell Bottom
- Submerged Aquatic Vegetation (SAV)
- Wetlands
- Soft Bottom
- Hard Bottom

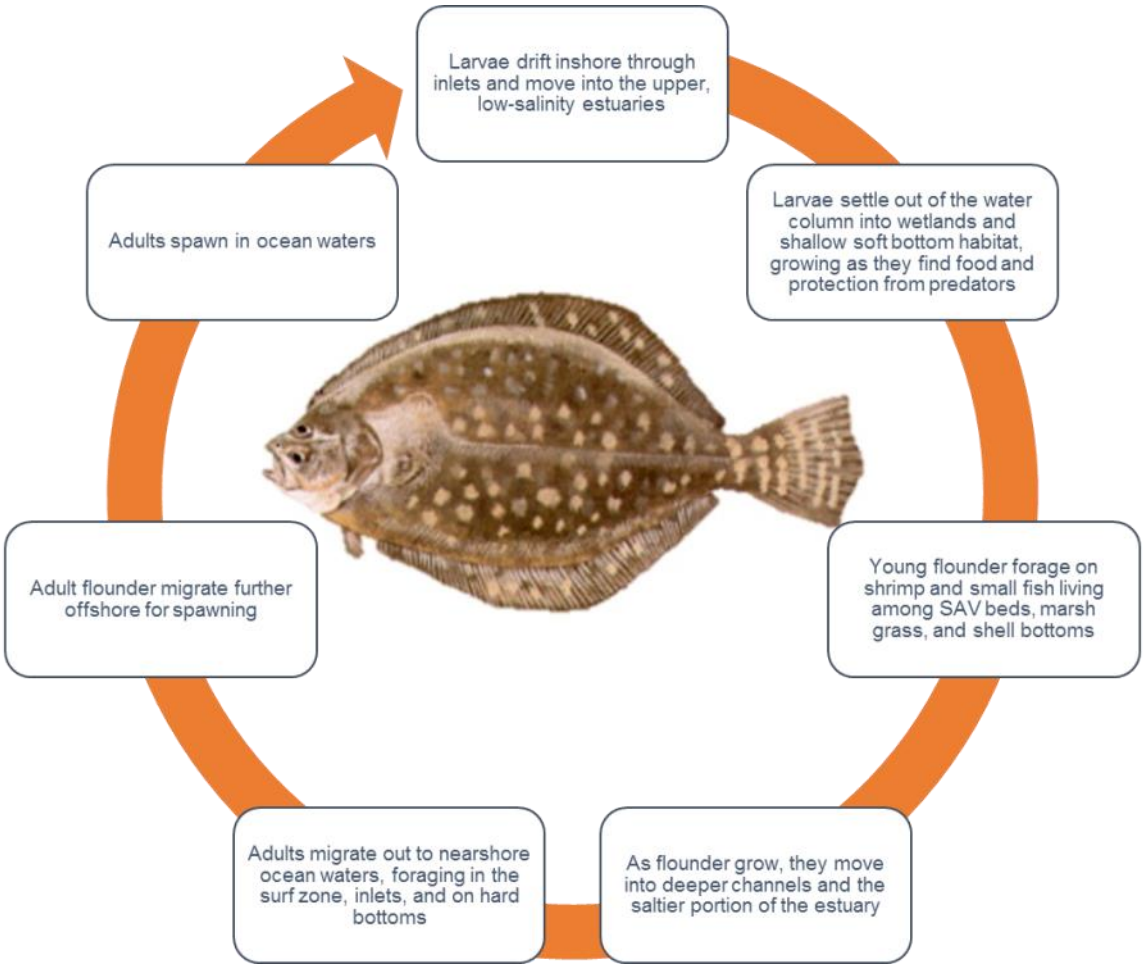
Habitats provide important functions for fish species.

Refuge:	shelter for fish at various life stages and a place for plants and animals to attach
Nursery:	refuge and foraging habitat suitable for development of juvenile life stages of fish, shellfish, and crabs
Spawning:	conditions that allow adults to reproduce
Foraging:	presence and accessibility of food sources
Corridor:	connectivity for safe passage among foraging, spawning, and refuge areas

Habitat: "a place, or set of places, in which a fish or fish population finds the physical, chemical, and biological features needed for life."

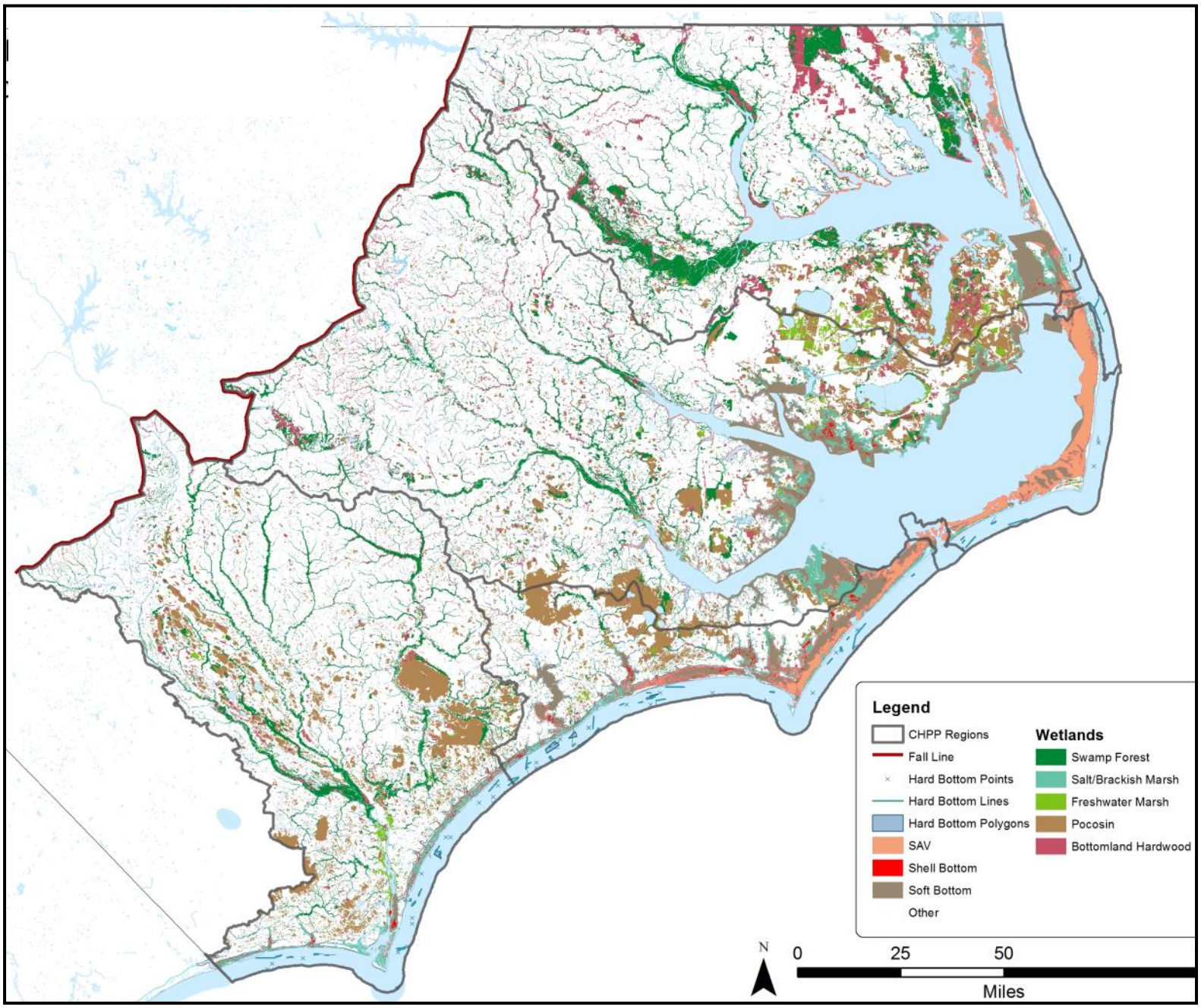
NC Coastal Habitats

All fish habitats are integral components of the entire aquatic ecosystem because species require use of multiple habitats throughout their life history; the water column connects them all. Organisms occupy specific areas or habitats that meet their needs for each particular life stage. Certain areas, such as nursery areas, are especially important to fish production, and some, such as shallow grass beds, are particularly vulnerable to human impacts. To maintain a healthy coastal ecosystem that provides all the ecological functions necessary for North Carolina's coastal fish populations, it is more effective to address the entire system of interdependent habitats, rather than a single habitat type (Ch. 2-7).



The relationship between habitat conditions and populations of fishery species is complex. In the past, the decline of a particular fish stock was often attributed to overfishing. We know now that the quality and quantity of fish habitats is important to healthy fish populations. Habitat loss and degradation make fish populations more susceptible to overfishing and can cause a delay in recovery, even after management actions have successfully reduced fishing pressures. River herring and shortnose sturgeon are examples of species that have not recovered despite lengthy fishing moratoriums. Thus, the status of fisheries can be an indicator of impacts to fish habitats. Successful implementation of the CHPP recommendations is a necessary component for sustaining productive fisheries for future generations.

MAPPED FISH HABITATS OF COASTAL NORTH CAROLINA



Water Column - *The Most Essential Habitat*

Water column is the medium through which all aquatic habitats are connected, affecting all other habitats and the distribution and survival of fish. The water column includes riverine, estuarine, lacustrine, palustrine, and marine systems. Properties affecting fisheries resources and distribution include: temperature, salinity, dissolved oxygen (DO), total suspended solids (TSS), nutrients (nitrogen, phosphorus), chlorophyll a, pollutants, pH, velocity, depth, movement, and clarity. Within a river basin, these properties change as you move from the headwaters to the ocean (Ch. 2).

Fish distribution in the water column is often determined by salinity and proximity to inlets. The potential productivity of fish and invertebrates begins with energy and nutrient production at the base of the food chain. Productivity in the water column comes from phytoplankton, floating plants, macroalgae, benthic microalgae, and detritus.

Economic Benefits

U.S. commercial and recreational saltwater fishing generated more than $199 billion in sales in 2012, according to the Fisheries Economics of the United States. In North Carolina, the recreational and commercial fishery generated $1.87 billion in 2011.

Habitat Functions and Fish Use

The corridor between freshwater creeks or rivers and estuarine/marine systems is important to all fish, particularly species whose life spans more than one system, such as species that must migrate upstream to spawn (anadromous) or marine-spawning estuarine-dependent species.

Water column provides nursery habitat for juvenile pelagic species, such as bluefish and pompano, in the surf zone. Optimum physical and chemical properties, such as currents, temperature, and salinity determine survival and settlement of larvae. The water column is a food source for all size organisms, supporting microscopic plants and animals (phytoplankton and zooplankton), and prey species of all sizes.

The ability of the water column to provide predatory refuge varies relative to area, depth, water quality, and vegetation. Juvenile fishes are protected in shallow areas inaccessible to larger fish. Turbidity and DO can provide refuge for pelagic species by excluding predators that feed visually or are not tolerant of low DO.

FACT: 76,927 acres of coastal water column is designated as Primary Nursery Area. 82,000 acres is designated as Secondary or Special Secondary Nursery Area.

Habitat Profile

Water Column Functions

- Connects all habitat types
- Allows fish to move among habitats
- Surrounds and supports aquatic animals and habitats

How Fish Use the Water Column

- Transports eggs, larvae, and oxygen
- Nursery area for all fish species
- Foraging area for all fish species
- Spawning area for all fish species

Water Column - *The Most Essential Habitat*

Status and Trends

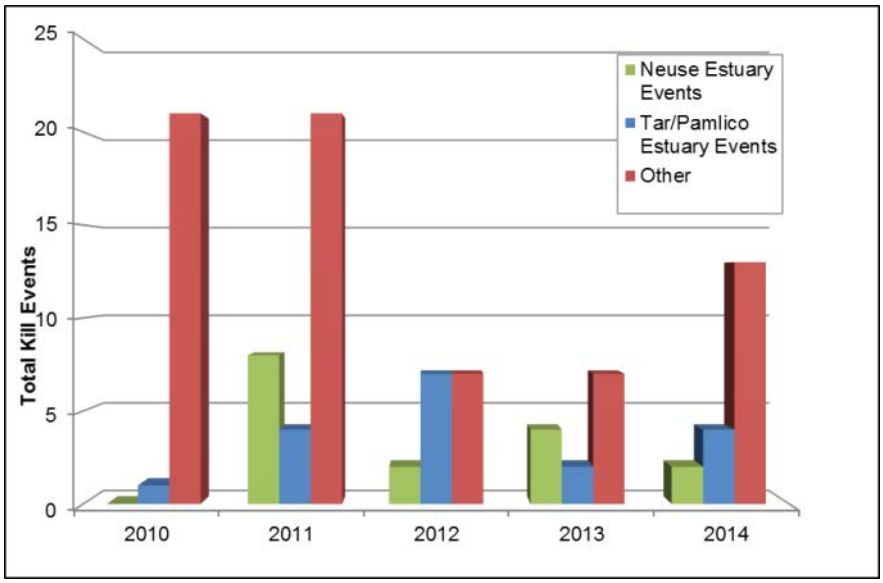
The condition of the water column is described by physical and chemical properties, pollution indicators, and the status of the fishery resources. However, evaluating the status and trends of water column characteristics is difficult. The number of monitoring agents, monitoring site distribution, frequency of data collection, and parameters measured are not conducive to comprehensive water quality assessments. Monitoring for microbial contamination of shellfish harvesting waters remains the most abundant measurement of estuarine water quality. Data collected from monitoring stations within the CHPP area include those from ±1,020 shellfish growing area stations, 240 recreational water quality stations, and ±256 DWR ambient stations. Water quality data from selected stations are shown in the CHPP Source Document.

The health of pelagic fishery species can be an indicator of water quality. Spanish mackerel, bluefish, and Atlantic menhaden are positive examples of species with improving or stable populations.

FACT: As of March 2014, over 442,106 acres of shellfish harvesting waters, or 20% of classified shellfish waters, were closed in North Carolina due to high levels of fecal coliform or the potential risk of bacterial contamination. As an adaptive measure to reduce permanent closures, 55,628 acres are conditionally opened and closed based on rainfall and sampling.

Threats to Water Column

Whether certain species will thrive and reproduce is strongly affected by conditions such as water clarity, DO, and nutrient levels. Fish kills and harmful algal blooms during the 1980s and 1990s were visible signs of coastal water quality problems. Most frequently reported species in fish kills are Atlantic menhaden, spot, flounder, and croaker. Large fish kills have diminished somewhat in recent years, but many coastal waters remain impaired. Excess sediment loading is the most common cause of impairment.



Human activities often change the chemistry of the water, reducing water quality. These changes can originate from point sources, such as industrial or wastewater discharges, or from non-point runoff from construction or industrial sites, development, roads, agriculture, or forestry. Any number of sources can result in pollutants and sediment entering surface waters. It is apparent when excess sediment clouds the water and fills a waterway, but beneath the water's surface, these particles clog fish gills and bury plants, shellfish, and other aquatic species.

All coastal habitats are connected by water. Clean water is essential to aquatic life.

Shell Bottom - *Building Reefs & Cleaning Water*

Shell bottom is unique because it is the only coastal fish habitat that is also a fishery species (oysters). Shell bottom is estuarine intertidal or subtidal bottom composed of surface shell concentrations of living or dead oysters, hard clams, and other shellfish. Oysters, the primary shell-building organism in North Carolina estuaries, are found throughout the coast, from southeast Albemarle Sound to the South Carolina border. The protection and restoration of living oyster beds is critical to the restoration of numerous fishery species, as well as to the proper functioning and protection of surrounding coastal fish habitats. Historically, restoration was managed for oyster fishery enhancement. Current efforts mix fishery and ecosystem enhancement with sanctuary development (Ch. 3).

Habitat Profile

Shell Bottom Functions

- Provides structure, shelter, and food source
- Filters pollutants and other particles from water
- Protects shoreline by slowing wave energy

How Fish Use Shell Bottom

- Place for oysters and other shellfish to attach
- Nursery area for blue crab, sheepshead, and stone crab
- Foraging area for drum, black sea bass, and southern flounder
- Spawning area for hard clams, toadfish, and goby
- Refuge for goby, grass shrimp, and anchovy

Economic Benefits

Conservatively, restored and protected oyster reefs provide up to $40,200 per acre per year (2012 dollars) in ecosystem benefits, including water filtration and sediment stabilization. The dollar benefit of the nitrogen removal service provided by oyster reefs was estimated to be $3,167 per acre per year (2014 dollars).

Habitat Functions and Fish Use

Shell bottom is widely recognized as essential fish habitat (EFH) for oysters and other reef-forming mollusks and provides critical fish habitat for ecologically and economically important finfish, mollusks, and crustaceans. In North Carolina, over 40 species of fish and crustaceans have been documented to use natural and restored oyster reefs, including American eel, Atlantic croaker, Atlantic menhaden, black sea bass, sheepshead, spotted seatrout, red drum, and southern flounder. Oysters are ecosystem engineers that alter current and flows, protect shorelines, and trap and stabilize large quantities of suspended solids, reducing turbidity by building high relief structures. The interstitial spaces between and within the shell matrix of oyster reefs are critical refuges for the survival of recruiting oysters and other small, slow-moving macrofauna, such as worms, crabs, and clams. Shell bottom is also valuable nursery habitat for juveniles of commercially and recreationally important finfish, such as black sea bass, sheepshead, gag grouper, and snappers. Additionally, shell bottom is important foraging ground for many economically and ecologically important species. The proximity and connectivity of oyster beds enhances the fish utilization of nearby habitats, especially SAV. Shell bottom contributes primary production indirectly from plants on and around it, but it is more important for its high secondary productivity contribution from the biomass of oysters and other macroinvertebrates living among the shell structure. This in turn supports a high density of mobile finfish and invertebrates, which was found to be more than two times greater than in marshes, soft bottom, and SAV.

Shell bottom areas include reefs made of living oysters or shells, located in the subtidal or intertidal zone of estuaries.

Shell Bottom - Building Reefs & Cleaning Water

Status and Trends

North Carolina oyster stocks declined for most of the twentieth century. Poor harvesting practices led to initial degradation and loss of shell bottom habitat in the Pamlico Sound area. After 1991, oyster stocks and harvests began to collapse from disease mortalities and low spawning stock biomass. Harvests began to rise again around 2002, and the trend has continued. Between 2000 and 2013, oyster dredging trips and hand harvest trips have risen substantially, with increasing harvest. A trend of stable or increasing spatfall coastwide is indicative of increasing larval availability, connectivity, and recruitment potential for restored and existing reefs. As of January 2015, there were 13 established oyster sanctuaries, with an additional two proposed.

Fact: Oyster beds were once so abundant that they were considered a navigation hazard.

Threats to Shell Bottom

Shell bottom habitat can be damaged by overharvesting, mechanical harvest fishing gear, navigational dredging, marinas and boating activity. Water quality degradation, especially toxin contamination, sedimentation, and hypoxia, can cause lethal or sublethal impacts. Shell bottom is occasionally susceptible to diseases and microbial stressors. The protozoan pathogen *Perkinsus marinus*, also called "dermo" has been responsible for major oyster mortalities in North Carolina. Monitoring of dermo disease by DMF shows a declining trend in prevalence, with an increasing trend in overall infection.

Boring sponge, sponges belonging to the genus *Cliona*, are found in North Carolina shell bottom habitats. Boring sponges compromise the integrity of shells and are linked to reduced reproductive viability and possibly increased oyster mortality rates. Two North Carolina oyster sanctuaries experienced dramatic population declines since 2012, coinciding with increasing percent cover of marine boring sponge. *Cliona* is endemic to North Carolina but has recently become more pervasive, especially on limestone marl rocks. To improve reef design in high salinity waters, DMF is conducting research on alternative substrates to identify materials that maximize oyster recruitment, growth, and survival, while offering high resistance to environmental stressors, such as *Cliona* boring sponge.

Shell bottom is considered to be one of the most threatened habitats because of its greatly reduced extent.

SAV - Underwater Gardens

Submerged aquatic vegetation (SAV) is a fish habitat dominated by one or more species of underwater vascular plants that occur in patches or extensive beds in shallow estuarine waters. The presence and density of SAV varies seasonally and inter-annually. A key factor affecting distribution is adequate light penetration; therefore, SAV occurs in shallow clear water. Sediment composition, wave energy, and salinity are also determining factors (Ch. 4).

Habitat Profile

SAV Functions

- Provides refuge for fish and other aquatic animals
- Serves as food for fish and waterfowl
- Produces dissolved oxygen
- Reduces wave energy and limits erosion
- Uses nutrients and traps sediments

How Fish Use SAV

- Nursery area for blue crab, pink shrimp, and red drum
- Foraging area for spotted sea trout, gag, and flounder
- Spawning area for spotted sea trout, grass shrimp, and bay scallop
- Refuge for bay scallop and hard clam

Economic Benefits

SAV habitat has a very high economic value due to the ecosystem services it provides. The estimated value of SAV and algal beds combined is $7,700/acre/year. This estimate takes into account services such as seafood production, wastewater treatment, climate regulation, erosion control, recreation, and others. The value of SAV for denitrification services (wastewater treatment) is estimated at $3,000/acre/year compared to approximately $400/acre/year for subtidal soft bottom. With North Carolina having the second largest expanse of SAV on the east coast, protection and enhancement of this valuable resource should be a high priority for the state.

Habitat Functions and Fish Use

Submerged aquatic vegetation is recognized as essential fish habitat because of five interrelated features – primary production, structural complexity, modification of energy regimes, sediment and shoreline stabilization, and nutrient cycling. Water quality enhancement and fish utilization are especially important ecosystem functions of SAV relevant to the enhancement of coastal fisheries. Seagrasses produce large quantities of organic matter. Many fish species occupy SAV at some point in their life for refuge, spawning, nursery, foraging, and corridors. SAV is considered essential fish habitat for red drum, shrimp, and species in the snapper-grouper complex. Spotted seatrout are also highly dependent on SAV, and bay scallops occur almost exclusively in SAV beds.

Due to its stringent water quality requirements, SAV presence is considered a barometer of water quality.

SAV - Underwater Gardens

Status and Trends

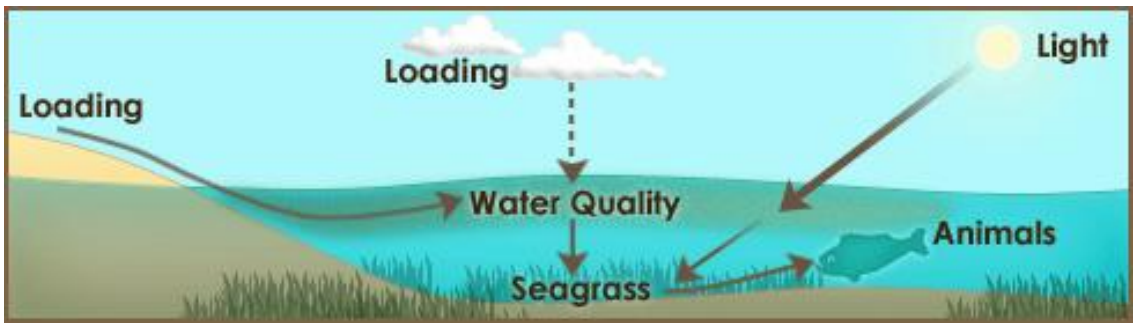
There has been a global and national trend of declining SAV habitat, with seagrasses disappearing at rates similar to coral reefs and tropical rainforests. In North Carolina, SAV loss has not been quantified, but anecdotal reports indicate that the extent of SAV may have been reduced by as much as 50%, primarily on the mainland side of coastal sounds. Mapping of SAV has been done by several entities since the 1980s, but often with different methods, and not coastwide. Comprehensive mapping of SAV habitat in coastal North Carolina was initiated in 2007 by a joint effort of federal and state agency and academic institutions. In 2013, mapping protocols for high and low salinity areas was developed so that mapping can be repeated approximately every five years on a rotational basis among five coastal areas. This mapping, in combination with sentinel sampling, will allow trends to be assessed. In 2013 high salinity SAV from Currituck Sound to Bogue Sound were mapped using aerial photography and field groundtruthing. In Albemarle Sound and Tar-Pamlico River SAV was mapped in 2014-15 using a newly developed method for low salinity turbid waters with side scan data and low light underwater photography for groundtruthing. In 2015, SAV south of Bogue Sound was mapped.

Fact: Over 150,000 acres of SAV were mapped in coastal North Carolina since 2000.

While a quantified change analysis is not yet available, preliminary review of core areas of SAV, such as behind the Outer Banks in Pamlico Sound and Core Sound, did not detect large changes since previous imagery for those areas in 2004. Expansion of SAV has been observed in Albemarle Sound and south of Bogue Inlet. Bay scallop abundance in the southern area is increasing in areas of expanding SAV.

Threats to SAV

Major threats to SAV habitat are channel dredging and water quality degradation from excessive nutrient and sediment loading. Natural events, human activities, and an ever-changing climate influence the distribution and quality of SAV habitat. Natural events include shifts in salinity due to drought and excessive rainfall, animal foraging, storm events, temperature, and disease. Submerged vegetation is vulnerable to water quality degradation, in particular, suspended sediment and pollutant runoff. Large amounts of algae and sediment make the water cloudy such that sufficient light cannot reach the plants, reducing their growth, survival, and productivity. Dredges and boat propellers can also have a direct effect on SAV habitat by uprooting and destroying the plants.



Wetlands - *Nature's Nurseries*

Wetlands are essential breeding, rearing, and feeding grounds for many species of fish and wildlife. They provide critical ecosystem services that contribute to healthy ecosystems and fisheries habitat. Coastal wetlands cover 40 million acres in the continental United States, with 81% in the southeast. Wetlands require the presence of water at or near the surface and vegetation adapted to wet soils. Wetlands occupy low areas, often marking the transition between uplands and submerged bottom, in areas subject to regular or occasional flooding by lunar or wind tides. Wetlands are vegetated with marsh plants such as cordgrass and black needle rush, or forested wetland species like sweet gum, cypress, and willows (Ch. 5).

Habitat Functions and Fish Use

Services provided by wetlands include improving the quality of habitats through water control and filtration; protecting upland habitats from erosion; providing abundant food and cover for finfish, shellfish, and other wildlife; and contributing to the economy. By storing, spreading, and slowly releasing waters, wetlands are linked to reduced risk of flooding; wetland loss has been linked to increased hurricane flood damage. Wetland communities are among the most productive ecosystems in the world. The plant matter decays into detritus, where it is exported to other waters and provides food for numerous organisms. Additionally, wetlands provide food, ideal growing conditions, and predator refuge for larval, juvenile and small organisms.

Economic Benefits

It is estimated that over 95% of the finfish and shellfish species commercially harvested in the United States, and over 90% in North Carolina, are wetland-dependent. Consequently, wetlands significantly contribute to the productivity of North Carolina's seafood and fishing industries.

Habitat Profile

Wetland Functions

- Provide refuge and food for fish and other animals
- Filter pollutants
- Trap sediments
- Shoreline erosion control
- Hold and slowly release flood waters

How Fish Use Wetlands

- Nursery area for blue crab, shrimp, and southern flounder, spot, and croaker
- Foraging area for spotted sea trout, red drum, and flounder
- Spawning area for river herring, killifish, and grass shrimp
- Refuge for blue crab and grass shrimp

The economic benefit of wetlands in providing flood control, stabilizing shorelines, and trapping and filtering pollutants has been extensively studied. By providing flood control and reducing shoreline erosion, wetlands protect coastal property. Wetlands also protect property by deterring shoreline erosion. Studies have shown that even narrow (7-25m) marsh borders reduce wave energy by 60-95%. These services explain why wetland habitat has been linked to reducing hurricane damage. One study estimated that the loss of 1 acre of coastal wetlands could result in a $13,360 loss in gross domestic product ($14,759 in 2014 dollars), and that U.S. coastal wetlands could provide as much as $23.2 billion/year (25.63 billion/year in 2014 dollars) in storm protection services.

Wetlands - *Nature's Nurseries*

Status and Trends

The 2015 CHPP Source Document summarizes wetlands within the CHPP region based on two data sources: the National Land Cover Dataset (NLCD) and the National Wetlands Inventory (NWI). According to the 2011 NLCD, there were ±3,759,729 acres of woody and emergent herbaceous wetlands within the CHPP regions. This represents a 2.7% decrease in woody wetlands and an 18.9% increase in emergent herbaceous wetlands since 2001. During the same time and area, developed land increased approximately 30%. The US Fish and Wildlife Service (FWS) has produced a NWI since the mid 1970s. The distribution of these wetlands is presented in Table 5.1 of the 2015 CHPP Source Document. Populations of spotted seatrout and red drum, two wetland-dependent species, have shown great improvements in the past few years.

Fact: Over 95 percent of the United States' commercially harvested finfish and shellfish are wetland dependent.

Threats to Wetlands

In the late 1800s and early 1900s, large amounts of wetland loss resulted from ditching and draining for agriculture and forestry. Over the years, wetland loss has occurred from dredging conversion to deep-water habitat for boat basins and navigation channels, followed by upland development, erosion, and shoreline hardening.

Statewide wetlands losses/gains and compensatory mitigation during FY 2012/13, 2013/14, and 2014/15. Data reflect permitting by DEQ and compensatory mitigation by DMS.

	Permitted gains and losses		
Linear feet of streams	**2012-13**	**2013-14**	**2014-15**
Losses	81,473.0	117,694.0	59,498.9
Gains	48,712.0	78,024.0	22,620.0
Net change	-32,761.0	-39,670.0	-36,878.9
Acres of wetlands			
Losses	203.6	98.9	102.1
Gains	197.8	59.9	104.5
Net change	-5.8	-39.0	2.4
Acres of riparian buffers			
Losses	75.6	48.0	56.1
Gains	37.9	21.2	18.2
Net change	-37.8	-26.9	-37.9

*Data provided by DWR and DMS

Wetland impacts are now regulated by numerous federal and state laws including the US River and Harbors Act, the US Clean Water Act, the NC Coastal Area Management Act (CAMA), and the NC Dredge and Fill Law, among others. Wetland filling for development and wetland loss due to erosion and rising water levels are currently the primary threats. Reduction of vegetated buffers can result in wetland loss and increased stormwater runoff. Legislative changes increasing thresholds for permitted impacts could contribute to additional freshwater wetland loss. Mitigation is required for larger wetland impacts. Offsetting historic wetland loss may now be possible through opportunities such as wetland restoration on conservation lands, creating marsh habitat on unused dredge disposal sites, and constructing living shorelines.

Coastal wetlands are critical nursery areas and serve as the primary buffer between land and water-based impacts.

Soft Bottom - *The Dynamic Habitat*

Soft bottom is unconsolidated, unvegetated sediment that occurs in freshwater, estuarine, and marine systems. Mud flats, sand bars, inlet shoals, and intertidal beaches are specific types of soft bottom. Grain size distribution, salinity, DO, and flow characteristics affect the condition of soft bottom habitat and the type of organisms that use it. Soft bottom covers approximately 1.9 million acres. North Carolina's coast can be divided into geologically distinct northern and southern provinces. In the northern province (north of Cape Lookout), the seafloor consists of a thick layer of unconsolidated mud, muddy sand, and peat sediments. The low slopes of the bottom result in an extensive system of drowned river estuaries, long barrier islands, and few inlets. The southern province has a thin and variable layer of surficial sands and mud, with underlying rock platforms, a steeper sloping shoreline with narrow estuaries, short barrier islands, and numerous inlets (Ch. 6).

Habitat Functions and Fish Use

Soft bottom is important as a storage reservoir of nutrients, chemicals, and microbes in coastal ecosystems, allowing for both deposition and resuspension of nutrients and toxic substances. The surface supports benthic microalgae, contributing substantial primary production to the coastal system. Estuarine soft bottom supports over 400 species of benthic invertebrates in North Carolina. Juvenile stages of species such as summer and southern flounder, spot, Atlantic croaker, and penaeid shrimp use the shallow unvegetated flats, which larger predators cannot access, as important nursery habitat. As fish get larger, they will venture out of protective cover to forage in soft bottom. Fishery independent data from shallow creeks and bays in Pamlico Sound documented 78 fish and invertebrate species. Eight of those — spot, bay anchovy, Atlantic croaker, Atlantic menhaden, silver perch, blue crab, brown shrimp, and southern flounder — comprised > 97% of the total nekton abundance. Soft bottom between structured habitat (SAV, wetlands, shell bottom) acts as a barrier to connectivity, which can be beneficial to small invertebrates by reducing predation risk. Fish and invertebrates that commonly occur in this habitat, including hard clams, flatfish, skates, rays, and other small cryptic fish such as gobies, avoid predation by burrowing into the sediment, thus camouflaging themselves from predators. Ocean soft bottom, particularly in the surf zone and along shoals and inlets, serves as an important feeding ground for fish that forage on benthic invertebrates. These predators generally have high economic value as recreational and commercial species, and include Florida pompano, red drum, kingfish, spot, Atlantic croaker, weakfish, Spanish mackerel, and striped bass. Many demersal and estuary-dependent fish spawn over soft bottom habitat in North Carolina's coastal waters.

Habitat Profile

Soft Bottom Functions

- Stores and recycles nutrients, chemicals
- Is a source of sand for other habitats
- Provides an area for marine animals to burrow

How Fish Use Soft Bottom

- Nursery area for blue crab, flounder, and croaker
- Foraging area for seatrout, red drum, and flounder
- Spawning area for shrimp, sturgeon, and kingfish
- Refuge area for hard clam, shrimp, and flounder

Soft bottom includes features such as mud flats, inlets, shoals, channel bottoms, and ocean beaches.

Economic Benefits

Soft bottom benefits the economy by providing habitat for critical food sources, by cycling nutrients, burying pollutants, and dampening wave energy. Beaches are extremely valuable for tourism and recreation, including surf fishing, surfing, and beach going. One study, averaging data from seven North Carolina beaches, found the net economic benefits of a day at a beach ranged from $14—$104 for single day trips and $14 to $53 overnight stays. For example, the total average annual benefits of long-term beach nourishment was estimated to be $14,836,688 (2014 dollars) due to recreational and storm damage reduction benefits.

Status and Trends

Comprehensive mapping of soft bottom habitat has not been completed. The loss of more structured habitat, such as SAV, wetlands, and shell bottom, has undoubtedly led to gains in soft bottom habitat. The quality of soft bottom habitat is a better indicator of soft bottom status than quantity. The best available information on sediment quality comes from EPA's latest National Coastal Condition Report (NCCR IV). The report rated the coast from North Carolina to Florida at 3.6 (fair) overall, while sediment quality was rated 2 (fair to poor), which was lower than in previous reports. Sediment quality is based on toxicity, contaminants, and total organic carbon (TOC). The percentage of area determined to be in poor condition was 13%. The primary reason for the low rating was sediment toxicity. The quality of soft bottom habitat can affect species abundance and diversity. Sediments in soft bottom habitat can accumulate both chemical and microbial contaminants, potentially affecting benthic organisms and community structure. Tidal creeks are sensitive to various aspects of human development, but sensitivity depends on the size and location of the creeks. Because tidal creeks are the nexus between estuaries and land-based activities, potential for contamination is high. Intertidal creeks close to headwaters demonstrate greater concentrations of nonpoint source contamination than larger systems near the mouth. The degree of contamination also depends on the impervious cover surrounding the land.

Fact: Soft bottom covers about 2.1 million acres of estuarine and ocean bottom within state waters.

Threats to Soft Bottom

Soft bottom strongly influences the water column by the constant cycling of nutrients and sediments.

Inadequate information is available to determine the current condition of soft bottom. Many human activities aimed at enhancing the "coastal experience" can inadvertently degrade this habitat. The ecological functions provided by soft bottom can be altered by activities such as dredging for channels or marinas, shoreline stabilization, water churning in marinas, and use of certain types of fishing gear. Along the oceanfront, jetties form barriers to the movement of sand, altering the natural sediment cycle. Excess nutrient concentrations in coastal rivers, in combination with certain environmental conditions, can lead to no or low oxygen levels near the bottom, killing the benthic organisms in the sediment, which reduces food availability for larger invertebrates and fish. Sediment contaminated with toxins can affect reproduction and growth of shellfish and other aquatic animals. Soft bottom habitat is relatively resistant to a changing environment.

Hard Bottom - *Rocks, Reefs, and Wrecks*

Hard bottom habitat, also referred to as live bottom or reef, consists of exposed areas of rock or consolidated sediments that may or may not be characterized by a thin veneer of live or dead biota and is generally located in the ocean rather than in the estuarine system. Natural hard bottom is colonized to a varying extent by algae, sponges, soft coral, hard coral, and other sessile invertebrates. In South Atlantic waters, hard bottom can consist of exposed rock ledges or outcrops with vertical relief or can be relatively flat and covered by a thin veneer of sand.

Artificial reefs are structures constructed or placed in waters for the purpose of enhancing fishery resources. Because artificial reefs become colonized by algae, invertebrates, and other marine life, they provide additional hard bottom habitat and serve similar ecological functions for fish. Some of the materials used in artificial reef construction are vessels, concrete pipe, or prefabricated structures such as reef balls. The DMF Artificial Reef Program is responsible for deployment and maintenance of artificial reef sites in state and federal waters. There are 50 DMF-managed artificial reefs of varying construction in North Carolina, of which 29 are located in federal ocean waters, 13 in state ocean waters, and eight in estuarine waters (Ch. 7).

Habitat Functions and Fish Use

Exposed hard substrate provides stable attachment surfaces for colonization by numerous marine invertebrates and algae. This productive three-dimensional habitat is often the only source of structural refuges in open shelf waters and a source of concentrated food. Most reef fish spend almost their entire life cycle on hard bottom, which serves as nursery, spawning, and foraging grounds. The presence of ocean hard bottom off North Carolina, along with appropriate water temperatures, allows for the existence of a temperate-to-subtropical reef fish community and a snapper-grouper fishery. Because of their importance for spawning, nursery, and foraging, all of the nearshore hard bottoms off North Carolina have been federally designated as Habitat Areas of Particular Concern for the snapper-grouper complex.

Habitat Profile

Hard Bottom Functions

- Provides a place for sponges, algae, and coral to attach
- Offers refuge for reef fish
- Supplies new sand through erosion

How Fish Use Wetlands

- Nursery area for groupers, snapper, and black sea bass
- Foraging area for king mackerel, gag, and snapper
- Spawning area for black sea bass, grouper, and tropicals
- Refuge area for gag and black sea bass

Economic Benefits

Between 2011 and 2013, the North Carolina commercial snapper-grouper fishery harvested an annual average of 1,638,434 lbs of fish (total of 5,015,570 lbs) with an annual market value of over $4.2 million (total for 3 years - $12,567,964). During that same time period, recreational fisherman (private boats, charter boats, and head boats) harvested an average of 568,146 lbs of fish in the snapper-grouper complex/year, for a total of 1,204,439 lbs. Economic benefits also include revenue from the dive industry, since hard bottom reefs are popular dive sites.

Hard Bottom - Rocks, Reefs, and Wrecks

Status and Trends

The condition of shallow hard bottom in North Carolina state territorial waters is of particular importance to the health and stability of estuary-dependent snapper-grouper species that utilize this habitat as “way stations” or protective stopping points as they emigrate offshore. Because of market value, high recreational participation, and the associated fishing tackle industry, the offshore snapper-grouper complex supports productive commercial and recreational fisheries. The South Atlantic Fishery Management Council reported that nearshore hard bottoms in the South Atlantic were considered to be in “good general” condition overall in 2002. Although adequate information exists on the distribution of hard bottom off the North Carolina coast, little information is available to evaluate the status and trends of hard bottom habitat in state territorial waters. The black sea bass populations north and south of Cape Hatteras and gag grouper have improved in the past few years.

Fact: 50 artificial reefs are located in ocean waters along North Carolina’s coast and 8 are located in estuarine waters. In addition, there are numerous shipwrecks along the coast

Threats to Hard Bottom

Threats to nearshore hard bottom habitat in North Carolina include beach nourishment, certain fishing gear, and water quality degradation. Sand from nourished beaches can also cover hard bottom structures. Studies have found that some hard bottom areas adjacent to nourished beaches were buried by sand washed off of nourished beaches. These once productive reef fishing grounds are no longer fished due to poor yield. Boat anchors and bottom trawls can uproot coral and tear loose chunks of rock. Poor water quality can affect growth or survival of the invertebrates living on hard bottom structure. A growing threat to hard bottom is the impact of the highly invasive Pacific lionfish on the reef community. This species has rapidly expanded in range from more southerly waters to North Carolina, and has exhibited extremely high predation rates on snapper and grouper species. Ocean acidification is another concern. More acidic ocean water over time is expected with increasing carbon dioxide levels which can cause calcium based organisms like corals and sponges to disintegrate.

The hard bottom habitat of the North Carolina coast is considered crucial spawning and foraging habitat for many commercially important species of grouper and snapper.

ACRONYM LIST

APNEP:	**Albemarle-Pamlico National Estuary Partnership**
BMPs:	**Best Management Practices**
CAMA:	**NC Coastal Area Management Act**
CHPP:	**Coastal Habitat Protection Plan**
CRC:	**Coastal Resources Commission**
CRFL:	**Coastal Recreational Fishing License**
DACS:	**Department of Agriculture and Consumer Services**
DCM:	**Division of Coastal Management**
DEMLR:	**Division of Energy, Mineral, and Land Resources**
DENR:	**Department of Environment and Natural Resources**
DEQ:	**Department of Environmental Quality (formerly DENR)**
DMF:	**Division of Marine Fisheries**
DMS:	**Division of Mitigation Services**
DO:	**Dissolved Oxygen**
DOT:	**Department of Transportation**
DSWC:	**Division of Soil and Water Conservation**
DWR:	**Division of Water Resources**
EBM:	**Ecosystem-Based Management**
EFH:	**Essential Fish Habitat**
EMC:	**Environmental Management Commission**
EPA:	**US Environmental Protection Agency**
FWS:	**US Fish and Wildlife Service**
LID:	**Low Impact Development**
MFC:	**Marine Fisheries Commission**
NCCR:	**National Coastal Condition Report**
NCFS:	**NC Forest Service**
NLCD:	**National Land Cover Database**
NWI:	**National Wetlands Inventory**
SAFMC:	**South Atlantic Fishery Management Council**
SAV:	**Submerged Aquatic Vegetation**
SCC:	**Sedimentation Control Commission**
SCH:	**Strategic Coastal Habitats**
SWCC:	**Soil and Water Conservation Commission**
TOC:	**Total Organic Carbon**
TSS:	**Total Suspended Solids**
USACE:	**US Army Corps of Engineers**
WRC:	**Wildlife Resources Commission**

For more information or to download the CHPP and Source Document, go to http://portal.ncdenr.org/web/mf/habitat/chpp/downloads

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