



# COASTAL HABITAT PROTECTION PLAN

## **Coastal Habitat Protection Plan Update**

### **CHPP Steering Committee October Meeting Minutes**

#### **Public Comment Summary**

#### **North Carolina Coastal Habitat Protection Plan Amendment**



ROY COOPER

*Governor*

ELIZABETH S. BISER

*Secretary*

KATHY B. RAWLS

*Director*

October 26, 2021

## MEMORANDUM

TO: Marine Fisheries Commission  
Environmental Management Commission  
Coastal Resources Commission

FROM: Jimmy Johnson, APNEP  
Anne Deaton, DMF

SUBJECT: Coastal Habitat Protection Plan 2021 Amendment

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### Issue

Present to the Marine Fisheries Commission (MFC), Coastal Resources Commission (CRC), and Environmental Management Commission (EMC) comments received from the standing and regional MFC Advisory Committees and public on the draft North Carolina Coastal Habitat Protection Plan (CHPP) 2021 amendment.

### Action Needed

Staff is requesting approval from the commissions on the final CHPP 2021 Amendment.

### Overview

At the previous MFC, CRC, and EMC business meetings, CHPP staff presented the draft recommended actions (RAs) in the CHPP 2021 Amendment and asked for approval to take the plan out for public comment. The public comment period was open from September 21, 2021 to October 21, 2021. Comments were received from an online survey, written and emailed comments, and at five MFC Advisory Committee meetings held virtually in October.

All five advisory committees voiced support for the CHPP document verbally and in motions that passed unanimously (Table 1). Refer to the MFC AC meeting memos for more details of each meeting. The Southern, Finfish, Shellfish/Crustacean, and Habitat and Water Quality ACs passed identical motions. The Northern AC was similar, but requested additions in the “Wastewater Infrastructure Solutions for Water Quality Improvement” issue paper to address concerns regarding septic tank systems. The Northern and Finfish ACs each made an additional motion.

The identical motion made at the four committees states that they support the draft CHPP, along with the inclusion to explore the formation of a public/private partnership.

There was strong support for a public/private partnership at all of the meetings from the AC and the public. It was noted that adding a public/private partnership would be beneficial due to increased collaboration and resources to implement CHPP recommendations, and increased public awareness and support. The public and private partners would be able to advocate for action with the General Assembly and others and broaden funding opportunities for implementation.

Table 1. Motions from the October 2021 MFC standing and regional advisory committee meetings.

Advisory Committee	Motion
<b>Southern, Finfish, Shellfish/ Crustacean, Habitat and Water Quality</b>	The AC supports the intent of the 2021 draft Amendment to the CHPP and the inclusion within the plan of the stakeholder recommendations to explore including the formation of a public/private partnership with stakeholders to seek state, federal and private funding to support the plans recommended actions and stakeholder recommendations.
<b>Northern</b>	The AC accepts the recommendations of the 2021 CHPP with additions to the Wastewater Infrastructure Solutions for Water Quality Improvement Issue Paper relative to concerns about septic systems and infrastructure.
<b>Northern</b>	The AC recommends inclusion of a recommended action in the Protection and Restoration of Submerged Aquatic Vegetation (SAV) through Water Quality Improvements Issue Paper to address and reduce nitrogen loading to the atmosphere from livestock waste lagoons, which is a significant source of nitrogen input to our coastal waters.
<b>Finfish</b>	The document should include that they work with Division of Soil and Water Conservation to introduce vegetative buffer zones on farmland and livestock operations in the coastal region and near river water ways.

All the advisory committees voiced concern over water quality, frustration that more has not been done regarding degrading water quality and expressed a sense of urgency to take action.

The Southern AC discussed the impact that intense development is having on runoff, flooding, and water quality. They discussed that development is continuing even where existing stormwater measures were not being enforced to prevent problems. There was support for establishing nutrient criteria to protect and restore SAV, and to conduct habitat monitoring to quantify the link between land use and water quality. Two members of the public commented, mentioning concern with wastewater entering coastal waters, runoff, and that climate change would exasperate those issues. They said there was a need for more low impact development, using wetlands in nature based solutions, and establishing a public-private partnership.

The Northern and Finfish ACs agreed with the emphasis on SAV and wetlands protection and restoration. There was discussion about creating areas to retain runoff and allow nutrients to settle. Landowners could possibly be paid an incentive to set land aside for this, or farmers could be given carbon credits for letting land convert back to wetlands. Both committees mentioned that lack of vegetated buffers around farms and animal operations, and large-scale clearing of wetlands for forestry were major contributors to water quality degradation that need to be addressed. The Northern AC also noted concern that air deposition of nutrients from animal operations was contributing to nutrient increases and should be addressed. Both committees agreed that failing wastewater infrastructure, as well as septic tank systems, contribute to eutrophication and that more information be added into the CHPP to address septic tanks. Septic tank concerns were especially concerning due to rising sea level and low coastal elevations.

The Habitat and Water Quality AC also brought up concerns over agriculture and wanted more done through the CHPP addressing agriculture impacts. They said it was important to get the Department of Agriculture brought into the process at a high level. Several members provided additional information regarding trends of high salinity SAV becoming patchier, and the connection of flow conditions to water quality that they suggested be added to the plan. Another member suggested the benefit of changing the permit process so

that when a waterfront property owner wants a dock or other water-dependent permit, they should be responsible for offsetting the impact by also doing a positive environmental project, such as a living shoreline.

A total of 12 people spoke at the five AC meetings. There were many concerns and suggestions related to water quality, including support for addressing wastewater infrastructure; addressing runoff and flooding through low impact development (LID) and nature-based solutions; and the need for clean water and therefore support for developing water quality standards to sustain SAV. It was also pointed out that clean water is essential for the coastal economy, particularly for shellfish mariculture. Other concerns included emerging contaminants and plastic in wastewater effluent, impacts to wetlands from debris, bulkheads, logging for the wood pellet industry, and the need for additional outreach to the public. Several mentioned support for formation of a public/private partnership and a member of the NC Oyster Steering Committee said the group is willing to collaborate on the CHPP initiative. One person spoke on behalf of the NC Water Quality Association about the SAV Issue Paper. While supportive of protecting SAV and developing water clarity criteria, he provided several specific comments on the approach and to not establish other nutrient criteria.

In addition to the AC meetings, an online survey was available and had 93 respondents. On a scale of 1 to 5, with 5 being very concerned, and 1 not concerned, the average level of concern among respondents over habitat and water quality was 4.87 (Figure 1).

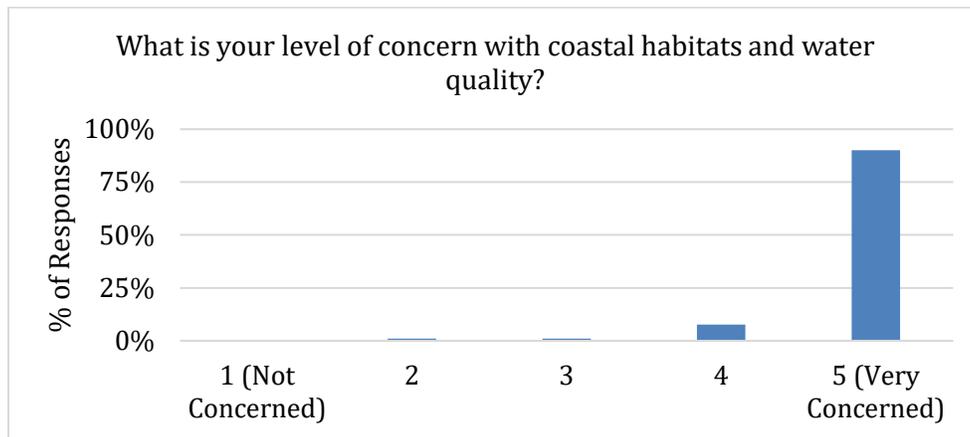


Figure 1. Level of concern with coastal habitats and water quality of the participants of the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment public comment survey.

Regarding the “Protection and Restoration of Submerged Aquatic Vegetation (SAV) through Water Quality Improvements” issue paper, over 80% of survey participants strongly agreed with the implementation of nutrient targets/standards (i.e. rules) to improve water quality for SAV, and that state funding should be provided to implement the recommended actions to protect and restore SAV to its documented former extent in acreage. Over 75% of survey participants strongly agreed with implementing a coastwide SAV mapping and monitoring program to determine if management changes are effective. Additionally, over 90% of survey participants strongly agreed that nature-based best management practices and low impact development should be used to a greater extent to reduce runoff associated with development and agriculture (Figure 2).

When asked about the “Protection and Restoration of Wetlands through Nature-based Solutions” issue paper, over 75% of survey participants strongly agreed that obtaining accurate maps of wetland habitat are needed to evaluate status and determine if and where restoration and protection efforts are needed, and would be willing to voluntarily use nature-based solutions on owned property to reduce stormwater runoff. Over 90% of the survey participants strongly agreed restoring wetland hydrology and conserving land for marsh migration should be done to increase coastal community resilience (e.g. reduced flooding, improved water quality, improved fisheries), while only about 70% strongly agreed that oyster harvest should be prevented from living shorelines that rely on oysters to maintain the integrity of the shoreline stabilization structure (Figure 3).

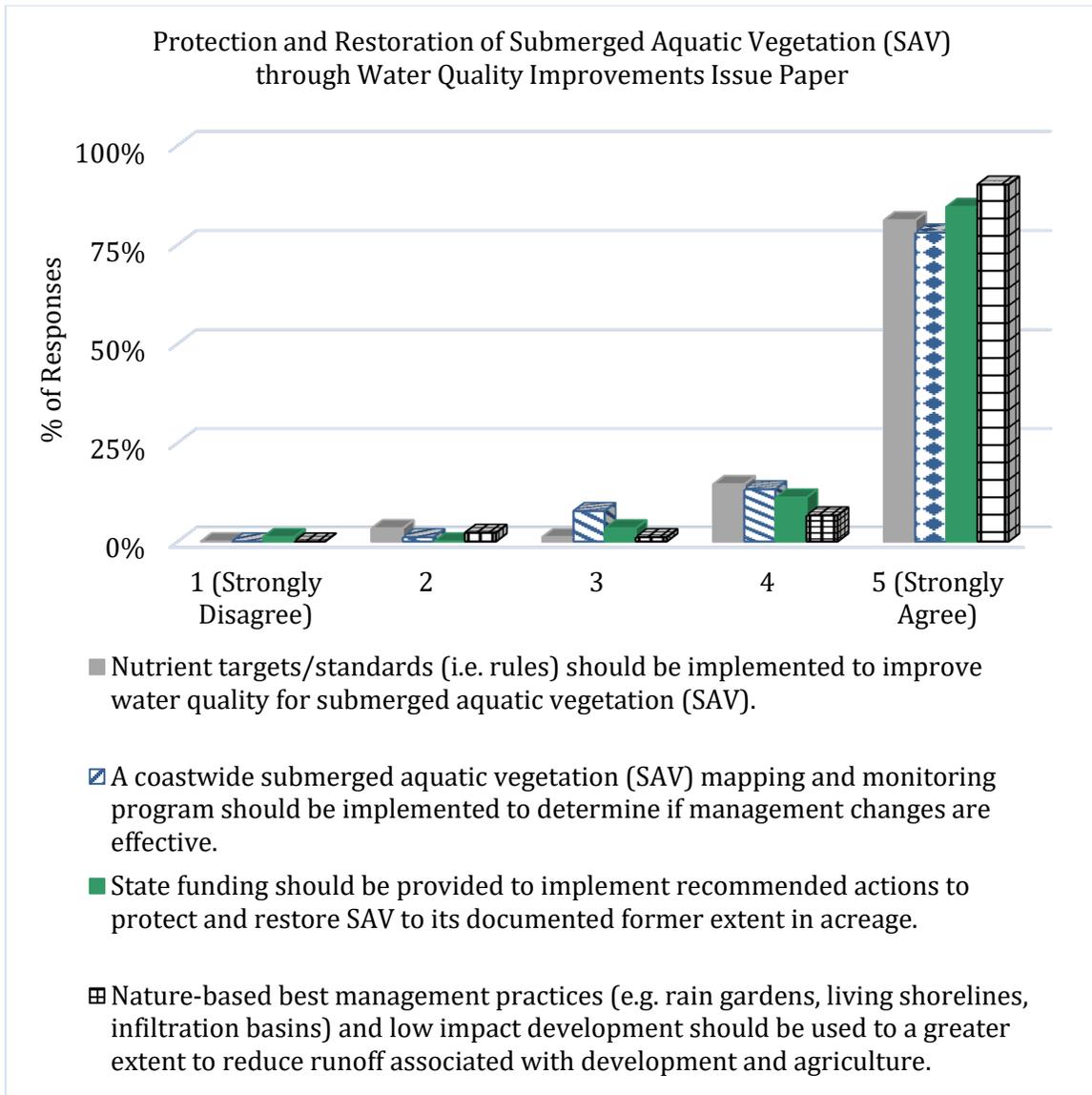


Figure 2. Responses about “Protection and Restoration of Submerged Aquatic Vegetation (SAV) through Water Quality Improvements” issue paper by survey participants.

For the “Environmental Rule Compliance and Enforcement to Protect Coastal Habitats” issue paper, almost 90% of survey participants strongly agreed that adhering to environmental rules can prevent habitat and water quality degradation (e.g. following rules on wetland clearing limits, maintaining required sediment and erosion control measures, properly constructing and maintaining stormwater management measures), and increasing staffing and funding to better enforce existing environmental rules would improve compliance.

Regarding the “Wastewater Infrastructure Solutions for Water Quality Improvement” issue paper, about 56% of survey participants said they have seen or been affected by a sanitary sewer spill caused by failing wastewater infrastructure (i.e. swimming closures, shellfish closure, unpleasant sights and smells).

Almost 90% of survey participants strongly agreed that additional priority to maintain and repair wastewater infrastructure projects should be given to projects that would protect sensitive estuarine waters, such as nursery areas and open shellfish harvest waters.

When asked about the “Coastal Habitat Mapping and Monitoring to Assess Status and Trends” issue paper, almost 85% of survey participants strongly agreed that assessing the status and trends of our coastal habitats is important for informing habitat protection, restoration, and management decisions. Wetlands were ranked as the highest priority to map and monitor, followed by water quality, and then SAV.

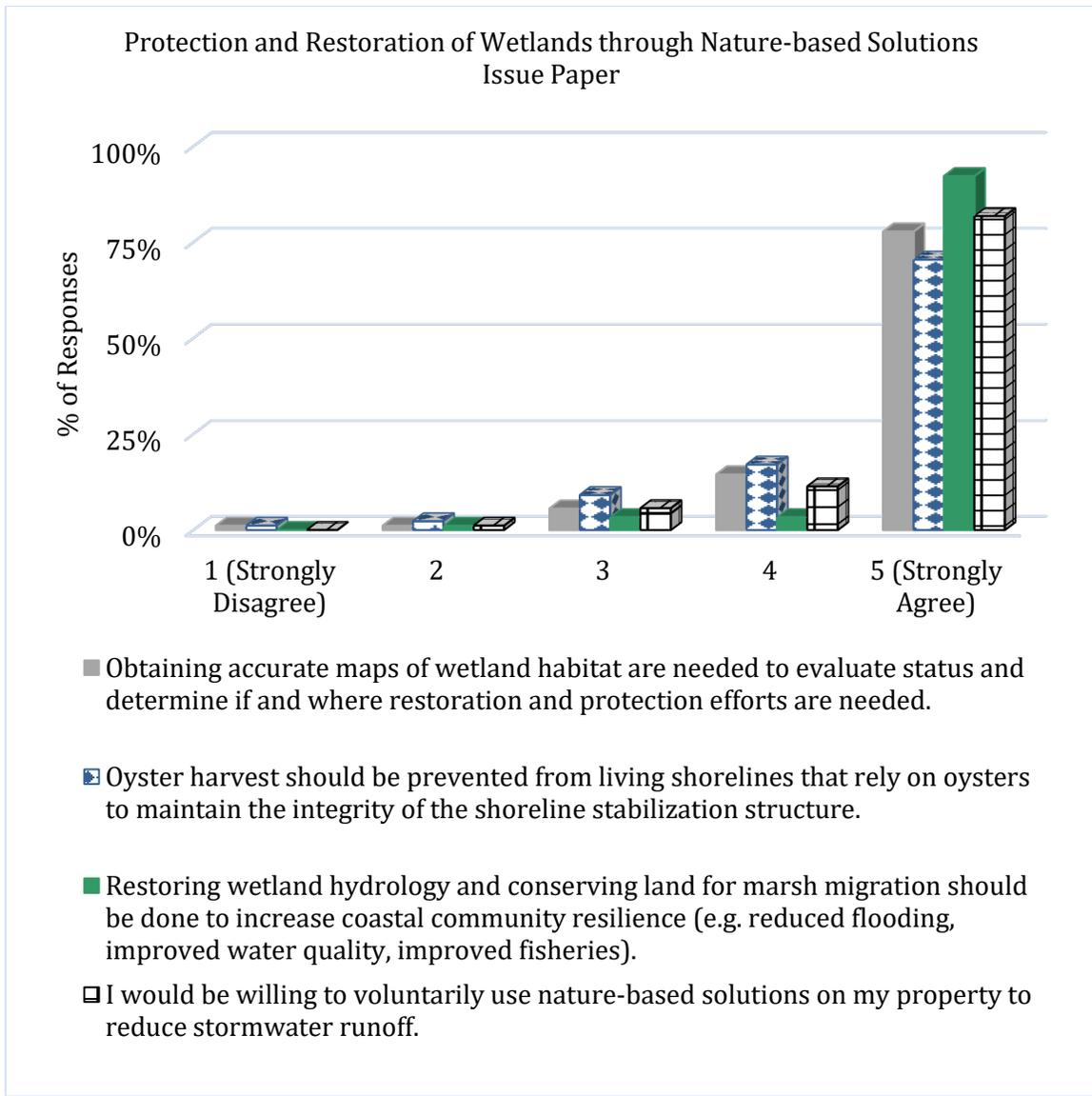


Figure 3. Responses about “Protection and Restoration of Wetlands through Nature-based Solutions” issue paper by survey participants.

The DEQ received two petitions in strong support of the CHPP amendment and implementation of the recommended actions. NC Audubon submitted 461 signatures, and NC Conservation Network had 796 signatures, from NC residents.

The Department also received 40 letters through email on the CHPP. The majority of the comments (33) were highly supportive of the recommended actions in the plan. Seventeen letters specifically mentioned supporting a public-private partnership and inclusion of the other recommendations in the Water Quality Stakeholder Report in the CHPP. Eight expressed wanting bottom disturbing gear addressed in the CHPP. Three letters were opposed to regulatory measures to reduce nutrient loading, but supported voluntary approaches. Several other letters supported the plan but suggested new or revised recommended actions.

The CHPP Steering Committee met on October 25, 2021. They reviewed a summary of the comments received from the advisory committee meetings, online survey, and emailed letters. They discussed what changes to the recommended actions or text were warranted.

## **The CSC approved the following changes through motions:**

Regarding public/private partnership, the CSC passed a motion for the staff to add a recommendation to “support the formation of a public/private partnership that will engage a diverse group of stakeholders to assist in developing, implementing, and securing decision-maker support and funding for measures in the 2021 CHPP Amendment that protect and restore water quality”. The motion also included that the recommendation be included at the end of Chapter 9 and reference Appendix A. NCCF/Pew Stakeholder Report, with Appendix B becoming Public Comment.

Specific wording changes to existing recommended actions:

RA 4.1 - reword to: “By 2023, the North Carolina Department of Environmental Quality (DEQ) will pursue recurring state funding, as well as from recurring as well as other state, federal, and private sources that includes the adequate amount of staff to successfully evaluate and meet the submerged aquatic vegetation (SAV) acreage goals and implement all of the SAV recommended actions that contribute to meeting the goals”.

RA 4.4 - reword to: “By 2022, DEQ will form a workgroup with the NC Division of Water Resources (DWR), NC Division of Energy, Mineral, and Land Resource (DEMLR), Soil and Water Conservation, local governments, and other partners to increase best management practices (BMPs) to the extent possible related to water quality within the SAV waterbody regions consistent with current funding level and request increased state cost-share funding”.

RA 4.7 - reword to: “By 2022, the Environmental Management Commission (EMC) will receive guidance from the Nutrient Criteria Development Plan (NCDP) Scientific Advisory Council (SAC) on establishing a water quality standard for light penetration, with a target value of 22 percent to the deep edge (1.7 m) of SAV for all high salinity SAV waterbody regions, and a light penetration target of 13 percent to the deep edge (1.5 m) for all low SAV waterbody regions (Table 4.5; Figures 4.1-4.9)”.

RA 4.8 - reword to: “By 2022, at the request of the EMC, the NCDP SAC will evaluate the chlorophyll a water quality standard and as needed, recommend it be revised by the EMC to ensure protection of SAV in high and low salinity waterbody regions, beginning with the Albemarle Sound and Chowan River, and continuing with other waterbodies that support SAV (Table 4.5; Figures 4.1-4.9)”.

The CSC also agreed without a formal motion to a public comment suggestion to modify RA 4.2, to round the SAV acreage goal from 191,155 to 191,000 acres.

There were some other requested additions that were not accepted by the CSC for various reasons, either because they were considered unnecessary, or they disagreed, or they were outside the scope of the five selected priority issue papers. Refer to the CSC meeting memo for more details. No new recommended actions were added. The request to include several recommendations regarding wastewater infrastructure will be included in Chapter 9, as support for recommendations included in the State Water Infrastructure Authority Report.

The CSC passed a motion recommending sending the CHPP, as amended by the steering committee, to the three commissions for final approval. Changes to the text and recommended actions, as well as a summary of the public comments, were incorporated into the draft plan that was included in the commission’s briefing materials. Refer to Chapter 9 or the executive summary for a complete list of final draft recommended actions.



NORTH CAROLINA  
Environmental Quality

ROY COOPER  
Governor

ELIZABETH S. BISER  
Secretary

## MEMORANDUM

TO: Coastal Resources Commission  
Environmental Management Commission  
Marine Fisheries Commission  
Coastal Habitat Protection Plan Steering Committee

FROM: Jimmy Johnson  
Albemarle-Pamlico National Estuary Partnership  
Anne Deaton  
Division of Marine Fisheries

DATE: October 27, 2021

SUBJECT: Coastal Habitat Protection Plan Steering Committee Meeting

The Coastal Habitat Protection Plan Steering Committee met via webinar at 1:00 p.m. Monday, October 25, 2021. The following attended:

Commissioners: Martin Posey, Pete Kornegay, Larry Baldwin, David Anderson, Yvonne Bailey, Bob Emory  
DMF Staff: Anne Deaton, Casey Knight, Trish Murphey, Alan Bianchi, Jacob Boyd, Jimmy Harrison, Kevin Brown, Kim Harding, Anne Markwith, Chris Stewart  
APNEP Staff: Bill Crowell, Jimmy Johnson, Tim Ellis  
DCM Staff: Braxton Davis, Daniel Govoni, Mike Lopazanski  
DWR Staff: Jim Hawhee  
DEMLR Staff: Samir Dumpor  
DWM Staff: James Cook  
NCDA&CS: Tom Gerow (NCFS)  
Public: Paul Cough (APNEP Leadership Council), Kelly Garvy (The Pew Charitable Trust), Anne Coan (NC Farm Bureau Federation), David Sneed (NCCCA), Ross Smith (Terracon Consultants)

## WELCOME AND INTRODUCTIONS

Chairman Martin Posey (MFC) welcomed everyone on the webinar and asked them to sign in through the chat in order to get a list of attendees.



North Carolina Department of Environmental Quality

217 West Jones Street | 1601 Mail Service Center | Raleigh, North Carolina 27699-1601

919.707.8600

## **APPROVE MINUTES FROM AGUST 5, 2021 MEETING**

**Motion by Larry Baldwin to approve the minutes. Seconded by Bob Emory. Motion carries unanimously.**

## **REVIEW TIMELINE**

Jimmy Johnson (APNEP) reviewed the timeline of the 2021 Coastal Habitat Protection Plan (CHPP) amendment. Johnson commented on the effort by DEQ CHPP staff on developing the plan and the unprecedented amount of public participation and comment. If approved today, the plan will be taken to the three commissions for approval next month and then will be sent to the DEQ secretary for a 30-day review. Afterwards, the Joint Legislative Commission of Governmental Operations will receive the CHPP for a 30-day comment period and will be final in early 2022. After final approval, staff will develop a public friendly document similar to the 2016 CHPPlet.

## **PUBLIC COMMENT**

There was no public comment.

## **REVIEW PUBLIC COMMENTS RECEIVED DURING PUBLIC COMMENT PERIOD**

Anne Deaton (DMF) provided a summary of public comment to the steering committee. She explained that there were public meetings through the various MFC Advisory Committees. There was also an online survey and public comment was also provided through email. She reviewed motions from the MFC Advisory Committees, who all supported the CHPP but also provided additional input which she reviewed. She also summarized public comment received during these meetings.

Casey Knight (DMF) reviewed results from the online survey. There were 93 respondents with over 90% having a very high level of concern about coastal habitats. Knight proceeded in summarizing the input from the survey on each issue paper.

Deaton then provided a summary of written comments received through email. There were 42 comments with 33 of these supporting all or most of the recommended actions. There were also two petitions with over 1,000 signatures total that supported the CHPP. Deaton also reviewed with the steering committee, several suggested edits to recommendations from various groups who commented.

Chairman Martin Posey (MFC) began the discussion with a question whether the committee wanted to include the suggestion of a public private partnership in the plan. Pete Kornegay (MFC) stated that he felt it was appropriate to include in the plan. The committee discussed how the proposed committee would be formed and implemented. Posey gave examples of the Oyster Steering Committee which also has state, federal and private stakeholders/industry membership. DEQ would need to determine how best to form the committee. It was suggested that this recommendation be added to Chapter 9 where the stakeholder report is discussed.

**Motion by Yvonne Bailey (EMC) to request staff add the recommendation to support the formation of a public/private partnership that will engage a diverse group of stakeholders to assist in developing, implementing, and securing decision-maker support and funding**



**for measures in the 2021 CHPP Amendment that protect and restore water quality. Seconded by David Anderson (EMC). Motion carries unanimously.**

Johnson added that the DEQ may want to be the lead for the proposed partnership but has not had the opportunity to discuss.

Bob Emory (CRC) asked if DEQ has seen the public input and if their staff had any input. Johnson replied that there has not been any opportunity, but DWR staff are on this meeting and attended some of the public meetings virtually. Emory asked about the recommendations with numeric criteria and how specific it was. Deaton explained that the recommendations provide flexibility by including input from the Nutrient Criteria Development Plan (NCDP) Scientific Advisory Committee and is regional in the approach. NC Farm Bureau Federation and the NC Water Quality Association want the criteria removed, while the Pew Charitable Trust would like it reworded to reflect the need for the EMC to act.

The committee discussed how to incorporate the stakeholder report in Appendix A. It was decided that the report would remain in Appendix A but would be renamed.

Deaton discussed additional comments from the Farm Bureau regarding rounding the SAV acreage and BMPs and cost share programs. Deaton stated that staff can round the acreage to 191,000 in the recommendation. Farm Bureau recommended removing the 50% target in the current recommendation for BMP implementation since it may be too high because there are more applicants for funding than available funding.

**Motion by Bob Emory to change recommendation 4.4 to “By 2022, DEQ will form a workgroup with the NC Division of Water Resources (DWR), NC Division of Energy, Mineral, and Land Resource (DEMLR), Soil and Water Conservation, local governments, and other partners to increase best management practices (BMPs) to the extent possible related to water quality within the SAV waterbody regions consistent with current funding level and request increased state cost-share funding”. Seconded by Pete Kornegay. Motion carries unanimously.**

Another issue brought up by the NC Farm Bureau was agriculture being singled out in recommendation 4.12 concerning requesting the NC Policy Collaboratory to investigate impacts of agricultural practices and land use change on water quality. The committee discussed several ways to reword to address the concern.

**Motion by David Anderson to change recommendation 4.12 to “By 2022, DWR will request the NC Policy Collaboratory to investigate the impacts of land use change and practices on water quality within SAV waterbody regions, to determine types and location of BMPs needed to effectively improve water quality”. Failed due to lack of a second.**

The steering committee discussed the Lower Neuse River Basin comments and decided to make no additional changes.

Deaton began discussion of Pew Charitable Trust comments and proposed changes to recommendations.



**Motion by Bob Emory to change recommendation 4.1 to “By 2023, the North Carolina Department of Environmental Quality (DEQ) will pursue funding from state, federal, and private sources that includes the adequate amount of staff to successfully evaluate and meet the submerged aquatic vegetation (SAV) acreage goals and implement all of the SAV recommended actions that contribute to meeting the goals”. Second by Pete Kornegay. Motion carries unanimously.**

**Motion by Bob Emory to change recommendation 4.7 to “By 2022, the Environmental Management Commission (EMC) will receive guidance from the Nutrient Criteria Development Plan (NCDP) Scientific Advisory Council (SAC) on establishing a water quality standard for light penetration, with a target value of 22 percent to the deep edge (1.7 m) of SAV for all high salinity SAV waterbody regions, and a light penetration target of 13 percent to the deep edge (1.5 m) for all low SAV waterbody regions (Table 4.5; Figures 4.1-4.9).”.** Second by Pete Kornegay. Motion carries unanimously.

**Motion by Pete Kornegay to change recommendation 4.8 to “By 2022, at the request of the EMC, the NCDP SAC will evaluate the chlorophyll a water quality standard and as needed, recommend it be revised by the EMC to ensure protection of SAV in high and low salinity waterbody regions, beginning with the Albemarle Sound and Chowan River, and continuing with other waterbodies that support SAV (Table 4.5; Figures 4.1-4.9).”** Seconded by Yvonne Bailey. Motion carried unanimously.

Deaton reviewed comments from the Southern Environmental Law Center (SELC) submitted on behalf of the NC Wildlife Federation, Sound Rivers, the Pamlico-Tar Riverkeeper, and the Neuse Riverkeeper. They were highly supportive of protecting SAV through water quality standards as well as existing authority. They requested additional recommendations be added to the Wastewater Infrastructure Solutions for Water Quality Improvement Issue Paper. Because those recommendations are discussed in the State Water Infrastructure Master Plan, the committee decided to reference those additions in the Chapter 9 table of the CHPP.

**Motion by David Anderson to add SELC recommendations to Table 9.1 of the CHPP Amendment. Second by Pete Kornegay. Motion carries unanimously**

Deaton then reviewed comments from the NC Coastal Federation who also supported the formation of the public/private partnership.

**Motion by Yvonne Bailey to include the recommendation to support the formation of a public/private partnership that will engage a diverse group of stakeholders to assist in developing, implementing, and securing decision-maker support and funding for measures in the 2021 CHPP Amendment that protect and restore water quality at the end of Chapter 9 and referencing Appendix A. NCCF/Pew Stakeholder Report with Appendix B becoming Public Comment. Seconded by Pete Kornegay. Motion carries unanimously.**

Deaton reviewed comments for NC Coastal Conservation Association. Their comments were about concerns of the incompleteness of the CHPP with regard to bottom fishing gear



disturbance, forage fish and the lack of timeliness in establishing SHAs. Kornegay stated that he agreed that the CHPP was incomplete and will discuss at the MFC meeting in November.

The comments from Coastal Carolina Riverwatch were concerning CAFOs and PFAS. The committee felt that these water quality issues are generally addressed in the CHPP Source Document.

Comments from the NC Coastal Conservation Network suggested that some information regarding environmental justice be included.

**Motion by Bob Emory to include information on environmental justice to the chapter on climate change. Motion fails for lack of a second.**

Johnson asked to revisit the Pew recommendation 4.1. He felt it would be good to add the word “recurring funding” into newly reworded recommendation.

**Motion by Bob Emory to add “recurring as well as.....” to revised recommendation 4.1. Seconded by Pete Kornegay. Motion carries unanimously.**

The steering committee discussed additional comments from the MFC Advisory Committees but decided no additional changes were required. Bailey asked about how the public comment is to be incorporated into the CHPP. Deaton explained that the survey results and summary of the MFC Advisory Committee meetings will be placed in Appendix B Public Comment. There will also be a summary of letters submitted and a summary of changes we made today.

Chairman Posey asked for a motion to take the CHPP amendment to the commissions for final approval.

**Motion by Yvonne Bailey the CHPP Steering Committee recommends sending the 2021 CHPP Amendment as amended by the steering committee to the three commissions for final approval. Seconded by Pete Kornegay. Motion carries unanimously.**

#### **ISSUES FROM COMMISSIONERS**

Chairman Posey brought up discussion of a letter to be sent on behalf of the steering committee as comment to the Division of Water Infrastructure on the draft priority rating system for viable utility reserve wastewater and drinking water construction project funding. It specifically asks that waters such as PNA, ORW, etc. be expanded into the ranking system and overall supports the ranking system.

**Motion by Bob Emory to send the letter to the Division of Wastewater Infrastructure. Seconded by Yvonne Bailey. Motion carries unanimously.**

#### **ADJOURN**

**Motion by Pete Kornegay to adjourn. Seconded by Yvonne Bailey. Motion carries unanimously.**

/plm



**APPENDIX C. PUBLIC COMMENT WRITTEN LETTERS**

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DRAFT

October 21, 2021

Division of Marine Fisheries Offices - NC DEQ  
CHPP 2021 Amendment Comments  
P.O Box 769, Morehead City, N.C. 28557

To whom it may concern,

I am writing to submit public comment on behalf of 461 state residents in support of the updates to the Coastal Habitat Protection Plan (CHPP). The proposed update includes strong commitments to protecting and restoring coastal habitats that birds depend on. Please find the comments and signatures below.

Sincerely,

Cat Bowler  
Coastal Resilience Project Manager  
Audubon North Carolina

October 21, 2021

Division of Marine Fisheries Offices - NC DEQ  
CHPP 2021 Amendment Comments  
P.O Box 769, Morehead City, N.C. 28557

To whom it may concern,

As a North Carolinian who appreciates birds and enjoys spending time at our coast, I support the 2021 Coastal Habitat Protection Plan (CHPP) update and the commitment it represents to protecting and restoring the coastal habitats in North Carolina that birds need.

Wetlands and submerged aquatic vegetation, for example, seagrass beds, are critical components of North Carolina's coastal ecosystem that support robust fisheries and provide habitat and food for birds like waterfowl and colonial nesting waterbirds like Royal Terns and Brown Pelicans.

Among the most effective and cost-effective ways to protect coastal ecosystems is by conserving and restoring nature. I join Audubon North Carolina in supporting CHPP recommendations to strengthen funding for, and increase implementation of, nature-based solutions like living shorelines and oyster reef restoration that serve as critical habitat for birds and fish, mitigate climate change, enhance water quality, reduce flood risk, and provide many other cultural and economic benefits to communities.

Sincerely,

Signatures removed for privacy



**North Carolina  
Conservation  
Network**

234 Fayetteville Street  
5<sup>th</sup> Floor  
Raleigh, NC 27601  
919.857.4699

October 20, 2021

NC Department of Environmental Quality  
CHPP 2021 Amendment Comments  
P.O Box 769  
Morehead City, NC 28557

Re: CHPP Comments

Dear Department of Environmental Quality,

Please see the attached petition signed by 796 North Carolina residents who support the Department of Environmental Quality's (DEQ) Coastal Habitat Protection Plan (CHPP). As written, the plan ensures that meaningful action will be taken to protect our water quality, and it helps make our coast more resilient in the face of climate change. The CHPP plan sets forth a clear directive for all agencies working to protect our coastal habitats and it's critical that the plan is adopted.

Specifically, we are glad that the plan includes recommendations for strong action to improve water quality and make our coast more resilient. Please keep these strong, explicit recommendations in the final plan – and then implement the recommendations in the coming years to restore and protect our coast.

Thank you for your time.

A handwritten signature in black ink that reads "Brittany Iery".

Brittany Iery, Online Organizer  
NC Conservation Network

Dear Department of Environmental Quality,

We the undersigned, support the Department of Environmental Quality's (DEQ) Coastal Habitat Protection Plan (CHPP). As written, the plan ensures that meaningful action will be taken to protect our water quality, and it helps make our coast more resilient in the face of climate change. The CHPP plan sets forth a clear directive for all agencies working to protect our coastal habitats and it's critical that the plan is adopted.

We're particularly excited that the plan includes recommendations for strong action to improve water quality and make our coast more resilient, including:

- Developing and adopting water quality standards – for light penetration and for management of nutrient pollution – that will keep our estuaries healthy and productive (actions 4.7- 4.9).
- Improving investments and oversight of water infrastructure to ensure that wastewater systems are resilient in the face of sea level rise and do not leak pollutants into coastal waters as a result of poor maintenance (actions 7.1 – 7.5).
- Advancing nature-based solutions to help insulate communities from sea level rise and increasingly intense storms (actions in chapter 9).
- Restoring and protecting wetlands, which buffer storm impacts and provide vital nursery habitat for vibrant coastal fisheries (actions 5.1 – 5.17).

Please keep these strong, explicit recommendations in the final plan – and then implement the recommendations in the coming years to restore and protect our coast.

Thank you.

Sincerely,

Signatures removed for privacy



Our mission is to identify, protect, and restore  
the significant resources of the Albemarle-Pamlico estuarine system.

Secretary Elizabeth Biser  
NC Department of Environmental Quality  
217 West Jones Street  
Raleigh, North Carolina 27603  
Via email

October 21, 2021

Dear Secretary Biser,

On behalf of the Albemarle-Pamlico National Estuary Partnership's (APNEP) Leadership Council (LC), I am pleased to write this letter in support of many of the recommended actions contained within the 2021 Amendment to North Carolina's Coastal Habitat Protection Plan (CHPP). The APNEP is part of the National Estuary Program. It is a water quality program funded by the EPA and housed in NC's Department of Environmental Quality (DEQ). To that end, the LC is especially pleased to see that much of the amendment is focused on water quality and water quality improvements. We believe that a number of the recommended actions compliment the objectives of the *2012-2022 Comprehensive Conservation & Management Plan (CCMP)* for the Albemarle-Pamlico estuarine system.

Specifically, the LC in consultation with the APNEP Scientific and Technical Advisory Committee (STAC), views the following recommended CHPP actions synergetic with the CCMP:

- 1) *Submerged Aquatic Vegetation Protection and Restoration through Water Quality Improvements*: Mapping and Monitoring (4.4.3), Research (4.4.5) and Outreach (4.4.6).
- 2) *Wetland Shoreline Protection and Enhancement with Focus on Nature-Based Solutions*: Mapping and Monitoring (5.4.1), Conservation (5.4.2) and Research (5.4.4).
- 3) *Wastewater Infrastructure Solutions for Water Quality Improvement*: Research (7.4.3).
- 4) *Coastal Habitat Mapping and Monitoring to Assess Status and Trends*: All recommended actions.

In addition, *Submerged Aquatic Vegetation Protection and Restoration through Water Quality Improvements*: Planning (4.4.2) and Potential Rulemaking (4.4.4) directly support the CCMP and are strongly endorsed by the LC.

The APNEP Leadership Council supports the cross cutting actions noted in this letter. We look forward to working with the other agencies within DEQ to not only improve the water quality in NC and southeastern VA, but to also improve the quality of life for all of our citizens. Thank you for the opportunity to provide these comments.

Sincerely,

A handwritten signature in black ink, appearing to read "Kirk Havens".

Dr. Kirk Havens  
Chair – APNEP Leadership Council

## CCA NC Comments on Draft Amendment 2 to the Coastal Habitat Protection Plan October 18, 2021

From the Draft Amendment 2 to the Coastal Habitat Protection Plan (CHPP), *The coastal habitats of North Carolina are the foundation for healthy fisheries.* The significance of this statement should not be lost in the 261-page draft, it should be highlighted and restated over and over. **Failure to provide a healthy foundation for our fisheries will result in continued failure in building healthy fisheries.**

The Draft also states that, *although progress has been made to implement CHPP recommendations, water quality has generally shown a declining trend with concerns about degrading submerged aquatic vegetation (SAV), shell bottom, and wetlands.* To address these concerns, and *Similar to previous years, the CHPP includes four overarching goals for the protection of coastal habitats in NC (recommendations under these goals were reviewed and modified by the CSC): 1. Improve effectiveness of existing rules and programs protecting coastal habitats. 2. Identify and delineate strategic coastal habitats. 3. Enhance coastal habitat and protect it from physical impacts. 4. Enhance and protect water quality.*

### 1) No Discussion in the Draft Amendment Re: Bottom-Disturbing Gear

Several areas of specific concern are highlighted yet there is no discussion within the Draft, nor has there been any discussion by the CHPP Steering Committee on the effects of bottom disturbing gear on these areas of concern:

#### Shell Bottom

*Due to the combined effects of habitat destruction, overfishing, disease, and deteriorated water quality, oyster populations have experienced tremendous declines world-wide, particularly within subtidal oyster reefs that occur along the Mid-Atlantic coastline of the United States. It has been estimated that 85 percent of oysters have been lost globally.*

#### Submerged Aquatic Vegetation

*Currently, NC is steward to one of the most productive and biodiverse SAV resources on the Atlantic seaboard. Anecdotal reports indicate SAV beds may be reduced by as much as 50 percent, especially on the mainland side of the coastal sounds.*

#### Wetlands

*Wetland resources in the United States have declined considerably (>50 percent) since the colonial period. It is estimated nearly half of NC's 11 million historical acres of wetlands were lost (physically or functional) between pre-colonial times and the 1980s. The loss of NC's wetlands continues into the 21st century. Approximately 40 percent of total documented coastal wetland losses occurred between 1950 and 2000 with approximately 95 percent of NC's wetland resources in the state's Coastal Plain.*

**No discussion has taken place during CHPP Amendment 2 workshops concerning the cumulative effects over time on native oyster reefs, SAV and wetlands from the continued use of destructive commercial bottom-disturbing gear, including, mechanical shellfish harvest (oyster dredges and clam kicking) and shrimp trawlers.**

The CHPP has recognized and directed significant interest toward stormwater runoff, *managing stormwater will not only reduce sediment loading as discussed earlier in the chapter, but also nutrient and bacteria loading*, so we no longer ignore the problems we are having with more frequent excessive freshwater flushes and what they bring with them from nutrient overload to heavy metal contamination. **However, Amendment 2 should also recognize and direct interest to the fact that bottom disturbing gear re-suspends much of that sediment, especially the heavy metals that oysters and clams secure in soft bottom.**

There is also emerging evidence that estuarine soft bottom has its own “microhabitat” that serves an important, yet not fully understood, function in improving water quality by removing pollutants in a similar manner to oysters and clams. The food of many juvenile fish is also found in that zone and tickler chains and doors used with trawls disturb and/or destroy that layer on every pass.

In addition, a recent study written by 26 marine biologists, climate experts and economists and published in Nature in March 2021 found that **fishing boats that trawl the ocean floor release as much carbon dioxide as the entire aviation industry**. Bottom trawling pumps out 1 gigaton of carbon every year, according to [a groundbreaking study](#). The carbon is released from the seabed sediment into the water, and can increase ocean acidification, as well as adversely affecting productivity and biodiversity, the study said. **Marine sediments are the largest pool of carbon storage in the world.**

*The legislative goal of the CHPP is “...the long-term enhancement of coastal fisheries associated with coastal habitats.” The law specifies that the CHPP identify threats and recommend management actions to protect and restore coastal habitats critical to NC’s coastal fishery resources.*

**Has the threat of bottom disturbing gear to our coastal habitat not been identified?** The CHPP should not go forward without serious consideration and discussion of this threat to the development of healthy fisheries.

## **2) No Discussion in the Draft Amendment Re: Forage Fish as Habitat**

The second glaring omission from discussion has been the absence of any recognition of forage fish as habitat. Forage species are critical species in ecosystems and need protection.

Forage fish are small fish or crustaceans that often that eat phytoplankton and zooplankton (microscopic plants and animals). Phytoplankton captures the suns energy initially and that energy moves up the food chain; thus, forage fish are an indispensable link in that chain because they serve as prey for larger predator fish. Often forage species move in large schools which makes them susceptible to capture by fishing gear, most often trawls.

Forage fish in federal waters have rightly received some attention at the Council level, but other than menhaden, they have been essentially ignored by State regulatory bodies. States such as NC, contain several other species of forage species present in their state waters that remain unprotected and that are overfished. Species such as menhaden, grass shrimp, penaeid shrimp, blue crab, spot, croaker, mullets, pinfish and others lack significant protection.

For example, in NC the most common stomach content of red drum was blue crab, but also included squid and Atlantic Croaker. As for spotted sea trout, the most common prey species were shrimp, threadfin shad and Atlantic croaker. The importance of forage species is no better exemplified than in flounder where they consume 4-8% of their body weight daily. Stomach content analysis of Southern and Gulf flounder yielded multiple species of small forage fish and shrimp.

The current Draft Coastal Habitat Protection Plan (CHPP), as well as many other documents, conclude that habitat includes food. **However, there is no mention of protecting these critical ecosystem components.**

The CHPP should not go forward without a discussion on the role of forage species as critical habitat components and the importance of protecting them. It is the role of the CHPP Steering Committee to inform the Marine Fisheries Commission and to recommend protection for the various habitat components.

### **3) No Sense of Urgency in Identifying and Establishing Strategic Habitat Areas**

*Since the 2016 CHPP, the nomination of Strategic Habitats Areas (SHAs) was completed for all four CHPP regions. The progress made towards establishing baseline habitat conditions through sentinel sites and long-term monitoring of coastal habitats, and **the validation and verification of SHAs in all CHPP regions is the foundation for establishing management thresholds for coastal habitats.** The quality, quantity, and extent of the coastal habitats in North Carolina must be identified before management thresholds can be applied.*

**Shrimp trawling by large, industrial, ocean-going vessels capable of pulling 220-feet of headrope, four-barrel rigs, pulling large, heavy otter doors continues in many of these nominated SHAs.** This effort is unsustainable from both habitat and bycatch perspectives. Previous CHPPs have failed to identify and delineate SHAs in the Pamlico Sound, and adjacent rivers and creeks, that serve as secondary nursery areas for many economically important finfish and forage species under 15A NCAC 03N.0101. **It is well past time for the CHPP process to actively engage and address bottom disturbing gears and nursery area protection versus giving it lip-service in the plan.**

Until these issues are addressed, the CHPP will remain incomplete. Moreover, coastal ecosystems, and importantly, marine fisheries, will continue to decline until we truly recognize that *the coastal habitats of North Carolina are the foundation for healthy fisheries.*

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**Coastal Carolina Riverwatch**  
700 Arendell Street, Suite 2  
Morehead City, North Carolina 28557



October 21, 2021

North Carolina Department of Environmental Quality  
217 West Jones Street  
Raleigh, NC 27603

Dear Review Team,

Thank you for the opportunity to submit comments regarding the proposed *Coastal Habitat Protection Plan*.

We submit these comments on behalf of **Coastal Carolina Riverwatch**. We represent a coalition of hundreds of eastern North Carolina citizens, committed to protecting our local waterways.

#### SUMMARY OF COMMENTS AND RECOMMENDED ACTIONS

1. The development of performance criteria for measuring success of management is very important.
  - We recommend that a performance review team be assigned to monitor progress and report out to the community at least once a year.
  - We recommend that annual reports be made available online and that specific measurable goals show performance records in the annual report.
  - Currently, the last available CHPP report (online) is 2015-16.
2. Coastal Carolina Riverwatch's ***Water Quality for Fisheries Program***<sup>1</sup> (WQ4F) works with NC coastal fishing communities to identify top water quality concerns. We recommend that these concerns be included in the CHPP and Industry Working Group recommendations be included as an addendum to/resource for the CHPP.
  - In partnership with ECU's Center for Survey Research, these priority concerns were determined to be **agricultural pollution, stormwater runoff, industrial pollution, plastics, and municipal wastewater and septic system pollution**.
  - Through the WQ4F program an **Industry Working Group**, made up of coastal commercial and recreational fishers, was established to participate in facilitated meetings addressing each of the water quality concerns.

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<sup>1</sup> Coastal Carolina Riverwatch. "Water Quality for Fisheries." *Water Quality for Fisheries*, 2021, <https://coastalcarolinariverwatch.org/water-quality-for-fisheries/>. Accessed 21 10 2021.

- The following are the WQ4F Program **Industry Working Group's** prioritized actions. These actions come directly from the coastal fishing community (made up of both commercial and recreational fishers). We request that these action items be considered when finalizing the update to the Coastal Habitat Protection Plan:

#### **I. Industrial Agriculture and Factory Farm Pollution**

- Update waste management systems.
- Requirement for pre-storm preparation.
- Evaluation of best management practices.
- Evaluation of hormonal, pharmaceutical, and microbiological contaminants.
- Enhancement of water quality monitoring technologies.
- Conservation practices for coastal, flat topography.
- Bridge gaps between scientists and policymakers for advocacy purposes.

#### **II. Stormwater Pollution**

- Green infrastructure policy development through standardizing the use of permeable pavement, green streets, filtration systems, and nature-based infrastructure.
- Reclaiming or enhancing areas with poor stormwater controls.
- Enhance monitoring of stormwater runoff.
- Publicize successful stormwater control efforts.

#### **III. Industrial Pollution**

- Reducing industrial activities that utilize industrial chemicals in their processes (ex. PFAS).
- Development of new filtration technologies.
- Enforceable maximum contaminant levels for wastewater treatment facilities.
- Analysis of the effects of all heavy metals on aquatic ecosystems.
- Researching safe alternatives to industrial pollutants.
- Educating consumers on PFAS-containing products.

#### **IV. Plastic Pollution**

- Restructuring the manufacturing process of plastics by changing chemical composition and product design.
- Plastic bag, styrofoam, single-use plastic, and straw bans.
- Extended Producer Responsibility policies.
- Studies focused on the interactions of molecules in the environment and the physiological effects on fish.
- Public outreach regarding human contribution to aquatic plastic pollution from land sources.

## V. Municipal Wastewater and Septic System Pollution

\*we note that this is the primary topic of *CHPP Chapter 7*

- Preventative repairs and updates on current infrastructure.
  - Increase use of ecologically engineered wastewater treatment technologies.
  - Legislation increasing federal funding for updating infrastructure.
  - Establish water quality standards for additional pollutants found in wastewater such as plastics and industrial pollutants.
  - Research effective wastewater treatment infrastructure for coastal regions with high water tables and flooding.
  - Increase community outreach and support for improving wastewater treatment infrastructure.
3. While agriculture is mentioned in the amendment it could be expanded. We request to specifically indicate Concentrated Animal Feeding Operations (CAFOs) as a source of agricultural nutrient pollution.
- Studies in Coastal NC suggest that CAFOs can be a more significant source of nitrogen than fertilizers from row crop agriculture. Under certain hydrological conditions, this nitrogen can be detected in estuaries many miles downstream.<sup>2</sup>
  - Recommend more comprehensive water quality monitoring related to CAFOs, assessments of cumulative impacts of CAFOs including nutrients and other pollution from both swine operations and the rapidly growing poultry industry, more enforcement following waste management violations, improved transparency in public records and information requests, and assistance for buyout programs.
4. Emerging contaminants are absent from CHPP. These are a threat to coastal habitats because they persist in the environment for undeterminable periods of time resulting in bioaccumulation, endocrine disruption, and reproductive and development issues in fish and aquatic species.<sup>3</sup> PFAS and other emerging contaminants are subject to little regulation and monitoring. Research is ongoing and long term data is still developing. Despite proven and suspected impacts on the environment, these contaminants are entering our waters.
- We recommend that PFAS be included in the future of CHPP. Potential actions may include increasing research, imposing restrictions on the release of PFAS and other chemicals, and prioritizing cleanups and mitigation of existing chemical contaminants in our waterways.

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<sup>2</sup> Brown, Colleen & Mallin, Michael & Loh, Ai Ning. (2020). Tracing nutrient pollution from industrialized animal production in a large coastal watershed. *Environmental Monitoring and Assessment*. 192. 10.1007/s10661-020-08433-9.

<sup>3</sup>Gonsioroski A, Mourikes VE, Flaws JA. Endocrine Disruptors in Water and Their Effects on the Reproductive System. *International Journal of Molecular Sciences*. 2020; 21(6):1929. <https://doi.org/10.3390/ijms21061929>

5. While funding, technical assistance, and incentives for voluntary actions should all be expanded, the need for accountability and enforcement through regulation should be assessed.
  - More regulatory measures should be implemented by the agencies listed in CHPP who are responsible for water quality protection.
  - Voluntary compliance to CHPP and completion of recommended actions may not be met with the same urgency or result in adequate reduction of nutrients, sediments, pathogens, and other forms of coastal pollution.
  - There is a need to address staffing and funding issues resulting in underregulation.
  - Additionally, research must be utilized to identify indicators and thresholds for policy development and enforcement moving forward.
  
6. As NC moves towards a more sustainable future for our coastal habitats, we emphasize the importance of a just transition.
  - DEQ should reference Environmental Justice tools and consult with communities, experts, and advisors in the event that implantation and actions associated with CHPP are proposed in environmental justice communities.
  
7. Coastal Carolina Riverwatch requests to be a partner on the following workgroups:
  - **4.4** *By 2022, DEQ will form a workgroup with DWR, Soil and Water Conservation, local governments, and other partners to develop a plan to increase the use of BMPs related to water quality within the SAV waterbody regions by 50 percent (Table 4.5; Figures 4.1-4.9).*
  - **8.1** *By 2022, convene interagency workgroups of DEQ agency staff, academics, and subject matter experts by coastal habitat type (i.e., water column, shell bottom, SAV, wetlands, hard bottom, and soft bottom) to define indicator metrics and identify data gaps and monitoring needs for the ability to determine long-term status and trends of coastal habitats and the estuarine ecosystem.*
  
8. Coastal Carolina Riverwatch requests to be a partner in the effort to develop, partner-on, and review public education and stewardship programs.
  - **4.13** *By 2022, DEQ Office of Education and Public Affairs will work with local governments and NGOs to start the development of public education and stewardship programs with social media campaigns and citizen science monitoring to increase public awareness of SAV's importance for fish habitat and other co-benefits, as well as instill public commitment to SAV conservation.*

9. We believe the following actions (below with questions) are very important:
- **4.9** *By 2024, EMC will adopt scientifically defensible nitrogen and/or phosphorus criteria if recommended through the NCDP process, to help protect and restore ~12,900 acres of low salinity SAV habitat in the Albemarle Sound SAV waterbody region and continuing with other water bodies that support SAV.*
  - **4.14** *By 2022, DEQ through funding of NCSU by APNEP will provide an economic evaluation of the co benefits SAV provides to the coastal economy in terms of habitat for fish, waterfowl, wildlife, recreation, shoreline stabilization, water purification, and carbon sequestration.*
  - **5.5** *By 2022, DEQ will provide information to NC legislators regarding the need for increased appropriated funds for the three state conservation trust funds to increase conservation of critical wetland properties and critical corridors that will allow for future marsh migration.*
  - **5.9** *By 2025, DEQ will determine if living shoreline projects can be built in a manner that qualifies for salt marsh or nutrient mitigation credits.*
  - **7.1** *By 2024, DEQ will request that funding programs under the purview of the SWIA give additional priority for projects with a direct benefit to sensitive estuarine waters, including SA waters, fish nursery areas, and impaired waters, particularly those adversely impacting estuarine fish and their habitat.*
  - **7.3** *By 2025, DCM and DWR will work with NC Office of Recovery and Resiliency (NCORR) and local governments in the coastal counties to develop strategies regarding flood-proofing wastewater infrastructure; siting new and relocating existing infrastructure away from sensitive estuarine waters and floodplains; upgrading sewer infrastructure; and develop strategic priorities for public and natural infrastructure improvements.*

## QUESTIONS

1. How will this be measured? Can this be included in the plan?
  - **5.10** *By 2025, DEMLR and other divisions should increase education, outreach, and training to consultants, local government, and landowners for nature-based stormwater and watershed management strategies.*
  - **7.6** *Prioritize research on alternative wastewater collection system designs that may be better suited for coastal conditions (i.e., alternative sewer systems, composting toilets).*
2. Who is responsible for this?
  - **7.7** *Evaluate the feasibility of re-designing and re-engineering existing systems that are inadequately protecting ground and surface water quality.*

On behalf of the Coastal Carolina Riverwatch team, we thank you for the opportunity to comment on the 2021 amendment to CHPP. As water quality impairment becomes more prevalent across North Carolina, we commend this dedication to improving coastal habitats. We encourage partnership and accountability in the progress of CHPP and respectfully request review of the above comments.

Respectfully,



Lisa Rider, Executive Director  
Coastal Carolina Riverwatch



Rebecca Drohan, White Oak Waterkeeper  
Coastal Carolina Riverwatch



# CREATION JUSTICE MINISTRIES

*Justice for God's planet and God's people.*

Mr. Jimmy Johnson  
North Carolina Department of Environmental Quality  
217 W Jones St  
Raleigh, NC 27603

Dear Jimmy Johnson,

Creation Justice Ministries (CJM) is a faith-based organization that educates, equips and mobilizes Christian communions/denominations, congregations and individuals to protect, restore, and rightly share God's creation. Based on the priorities of its members, with a particular concern for the vulnerable and marginalized, CJM provides collaborative opportunities to build ecumenical community, guides people of faith and faith communities towards eco-justice transformations, and raises a collective witness in the public arena echoing Christ's call for just relationships among all of creation.

North Carolina is already experiencing more intense hurricanes, more rainfall, and more flooding as a result of climate change. These changes are happening rapidly, and having devastating consequences on vulnerable communities, who are unprepared through no fault of their own. This is an unjust reality and fighting this injustice is at the heart of CJM's mission. As such, CJM is committed to climate action and building climate resilience for all of God's creation, with an awareness that the most vulnerable are also at the most risk for pain and suffering through climate disaster.

Many people need physical and emotional support after a disaster, especially the vulnerable, and our churches naturally provide this support as they are often the center of communities and hubs for social capital. With a changing climate, the need for physical and emotional support will only grow. In order to reduce human suffering and care for all of creation, our faith communities must be prepared today for what will come tomorrow.

As such, CJM supports a public/private partnership that will engage stakeholders in watershed planning and resiliency. CJM believes that our faith communities must be at the table for resilience and watershed-level planning conversations. A stakeholder-driven public/private partnership is the best mechanism for engaging all residents in understanding and planning for the challenges that lie ahead.

Furthermore, CJM supports the Coastal Habitat Protection Plan's recommended actions that protect and restore natural habitats, and increases climate resilience through the restoration and protection of wetlands and living shorelines. These resources are a critical factor for protecting our natural habitats while also providing important benefits including flood mitigation, wave reduction, carbon sequestration and water filtration.

In Faith,

A handwritten signature in black ink, appearing to read 'Avery Davis Lamb'.

Avery Davis Lamb  
Co-Executive Director,  
Creation Justice Ministries



October 21, 2021

NC Division of Marine Fisheries

P.O. Box 769

Morehead City, NC 28557

RE: Comments on the North Carolina Coastal Habitat Protection plan 2021 Amendment

Dear NCCHPP Steering Committee members,

The Environmental Defense Fund submits the following comments on the North Carolina Coastal Habitat Protection Program (NCCHPP) 2021 Amendment. EDF appreciates the hard work of NCDEQ and the Steering Committee to develop the comprehensive 2021 Amendments to the NCCHPP. We strongly support the climate change and resilience discussion in Chapter 3 and encourage all future decisions to be based on the latest climate science. The following three comments focus on opportunities to increase coastal habitats in the face of climate change.

**To advance protection of submerged aquatic vegetation, support funding for a wide array natural infrastructure practices across various state and federal programs.** Table 4.9 notes the need to lessen sediment and nutrient loading to coastal waters that support SAV, a wide array of natural infrastructure practices' function is to reduce sediment and nutrient loading. The NCCHPP should include a Proposed Strategy under section 4.2 calling on state and federal agencies to support natural infrastructure through landowners and local government education, technical assistance, and direct funding to implement practices and projects. With a clear acreage goal for SAV as called for in the NCCHPP (pg 73), the NCCHPP Steering Committee and other agencies and stakeholders can connect SAV goals to support for natural infrastructure investments.

**Facilitate implementation of multiple natural infrastructure practices through a regional general permit or other streamlined regulatory approaches.** The NCCHPP recognizes the important role of regional general permits for marsh silt to enhance marsh restoration efforts along the coast (pg 31) and for living shorelines (pg 111). As new wetland practices such as flood control wetlands and other natural infrastructure practices are identified for flood mitigation and water quality improvements, an interagency process should evaluate when permits or other approvals are likely to be required. Where appropriate, natural infrastructure practices requiring permits should be considered for inclusion in a regional general permit to facilitate adoption across the coast and coastal plain.

**Compound flooding, a growing threat to coastal habitats and communities, should be evaluated through a NCCHPP-organized committee.** The growing threat and impacts of compound flooding are increasingly recognized by local residents, coastal communities and state leaders. By increased flooding of wastewater infrastructure, agricultural fields and coastal cities, compound flooding is contributing to coastal habitat degradation through increased nutrient pollution, changing salinity levels and increased sedimentation. As a cross-cutting issue, compound flooding does not fit neatly into any one of the five priority issue papers provided in the 2021 NCCHPP. Compound flooding deserves a committee comprised of agency staff, academic researchers, and other experts to develop an interim report by 2023 and to inform recommendations leading up to the next NCCHPP plan amendment.

North Carolina has world class coastal habitat. The NCCHPP underscores the resources in the state and the need for proactive strategies. EDF is proud to have contributed to earlier versions of the Coastal Habitat Protection Plan and appreciates the opportunity to provide these brief comments on the 2021 Amendment. We look forward to working with NCDEQ and other steering committee members to build resilience for North Carolina's coasts and coastal plain.

Sincerely,

Michelle Lovejoy

Landscapes Resilience Manager



**NORTH CAROLINA  
FARM BUREAU FEDERATION, INC.**

PO Box 27766, Raleigh, NC 27611 Phone: 919-782-1705 Fax: 919-783-3593 www.ncfb.org

October 21, 2021

CHPP Comments

Submitted via email to: [publiccomments@ncdenr.gov](mailto:publiccomments@ncdenr.gov)

P.O Box 769

Morehead City, N.C. 28557

**Re: Draft Coastal Habitat Protection Plan 2021 Amendment - CHPP Comments**

Dear Sir or Madam:

The North Carolina Farm Bureau Federation (NCFB, Farm Bureau) is this State's largest general farm organization, representing the interests of farm and rural people in North Carolina. This letter is to comment on the Draft Coastal Habitat Protection Plan (CHPP) 2021 Amendment accessed at:

<https://files.nc.gov/ncdeq/Marine-Fisheries/coastal-habitat-protection-plan/CHPP-2021-Amendment-Draft-20210806-Commissions.pdf> and the Appendix A – Public comment from The Pew Charitable Trust and NC

Coastal Federation accessed at:

<https://files.nc.gov/ncdeq/Marine-Fisheries/coastal-habitat-protection-plan/CHPP-2021-Amendment-Appendix-A.-Public-Comment-Pew-and-Coastal-Fed.pdf>

Both documents were accessed on October 20, 2021.

North Carolina farmers are stewards of the land. NCFB and our State's farmers recognize the importance of good stewardship of our land, riverine and coastal resources. Farmers in North Carolina have worked hard to reduce the nutrient, sediment and chemical impacts from their farms over the past several decades. Scientists recognize that inputs such as nitrate to our waterways from agricultural sources have decreased. This is due to the efforts of farmers to reduce their footprint on the land and our waterways.

However, our farmers are facing unprecedented challenges due to changing weather patterns. North Carolina is experiencing more intense droughts, storms, and more flooding. These are increasing and unprecedented challenges for farmers affecting their crops, land and livelihoods. Simultaneously the intense storms and flooding bring more pollutants and sediments into our waterways from **all** of the various land uses across the landscape. Increased drought can cause crop failures, but can also adversely impact water quality through low flows that increase salt water intrusion, cause stagnant water, and concentrate pollutants in NC waterways from point sources such as wastewater treatment plants.

**The CHPP should support voluntary, incentive-based approaches to assist farmers in their efforts to improve water quality and enhance coastal habitats. There are several programs described in the CHPP and in these comments that provide such assistance, but they are woefully underfunded. The CHPP should support increasing funding for these programs, even those that are in agencies outside of NC DEQ, such as those in NCDA&CS and USDA.**

**Also, the CHPP should seek ways to bring various stakeholders together for the purpose of coordination and cooperation to improve and enhance the coastal resources of our State.**

NCFB appreciates the amount of effort over the last two years by the CHPP Steering Committee to develop the draft Plan Amendment. The Committee put a great deal of work into the drafting of the White Papers and the draft recommendations. NCFB staff attended (virtually) at least three of the Steering Committee meetings.

While NCFB is generally supportive of the draft Amendment, we offer the following specific comments and concerns about the draft Amendment, the Pew/Coastal Federation document in Appendix A, and two of the

*Farm Bureau and Agriculture...  
We keep North Carolina growing!*

additional recommendations proposed to be added to the draft Amendment by the Marine Fisheries Commission (MFC) Advisory Committees.

Our comments will focus primarily on the SAV and Wetlands portions of the document. Where possible we will reference section numbers and/or page numbers.

## **Chapter 4. Submerged Aquatic Vegetation Protection and Restoration through Water Quality Improvement**

**First, NCFB strongly supports the comments on the draft Amendment submitted by the North Carolina Water Quality Association (NCWQA) regarding the SAV and hereby incorporates those comments as part of our comments.** These are included in the email with our comments and should be considered a part of NCFB's comments. The comments include the following six recommendations along with justifications for the recommendations:

1. Support of the CHPP's intent to protect and restore SAV.
2. SAV acreage goals should be non-regulatory.
3. Water clarity should be the primary parameter for SAV-related water quality targets, with application depths tailored based on local environment, and natural "no grow" zones recognized.
4. North Carolina's SAV protection strategy should not focus only on nutrients nor underemphasize the importance of other stressors including inorganic turbidity.
5. The individual components of light attenuation should be used for region-specific diagnostic purposes rather than water quality criteria.
6. Nutrient concentration criteria should not be adopted.

### **4.2.3 Impacts of Water Quality Impairment to Submerged Aquatic Vegetation**

#### **Page 61**

We note the following from the document as support for not just focusing on nutrients when addressing SAV declines, "In the Neuse River estuary, CDOM is increasing and may be linked to the salinity regime. As such, declines in water quality for this region could be harder to manage because they are not just directly related to nutrient enrichment." CDOM is also similarly discussed on page 71 stating that, "CDOM is linked to river discharge and salinity, but is not nutrient related and may make areas such as the Neuse and other coastal rivers more difficult to address in terms of nutrient management." Again, this supports not just focusing on nutrients when addressing SAV declines.

### **4.2.4 Case Studies of Water Quality Improvements that Benefit Submerged Aquatic Vegetation**

#### **Page 63**

The draft Amendment states that. "Based on research, literature review and modeling, the minimal amount of light necessary for SAV is  $\geq 22$  percent light availability through the water column (PLW) for polyhaline and mesohaline species. For tidal fresh and oligohaline species,  $>13$  percent light availability is necessary." Each of the references cited are from the Chesapeake Bay. NCFB recommends that before these light values are used in North Carolina that they adequately studied to determine if these numbers are correct for NC. If North Carolina research indicating that these numbers are correct for SAV in NC exists, then that literature should be cited.

### **4.2.5 Nutrient Control in the Albemarle Sound/Chowan River**

#### **Page 64**

The draft Amendment states that, "Based on sampling in Chowan River, a tributary of the Sound, organic nitrogen has increased over time. In Potecasi Creek, a tributary of the Chowan River, nutrient patterns shifted around 2002, with nitrate concentrations declining and total nitrogen increasing. The cause for this is unknown." We do know that, in general, nitrates have been considered the primary type of nitrogen constituent contributed by agriculture. Agriculture has made significant strides in reducing its nitrogen applications to farmland, and we

believe that the science will support that nitrate contributions to coastal waterways from agriculture are declining over time. Also, there has been a lot of speculation regarding the cause of this shift in coastal waters from a predominance of nitrate to a predominance of organic nitrogen. We reiterate the statement here -- that the cause of this is unknown, and speculation that some form of agricultural runoff is causing this is not warranted at this time.

However the impact of legacy nitrate from groundwater, much of which can be decades old, cannot be ignored. This legacy nitrogen can be from past agriculture and from other land uses. We particularly appreciate that the document recognizes that a potential cause of increases in nitrogen to the Chowan River is the shift to land application of wastewater by all of the wastewater treatment plants (WWTPs) in the Chowan River watershed. Frequently in other documents, the nutrient contributions of WWTPs that utilize land application is completely discounted to zero by stating that those point sources have been eliminated. This change to land application by the WWTPs in the Chowan was initiated to tackle the algae blooms that were occurring in the 1970s and 1980s. We recommend that the impact of that switch must now be studied to determine the connection between the switch to land application by WWTPs and the current increases in nitrogen in the Chowan River watershed.

#### **Page 65**

The final paragraph in 4.2.5 discusses the work of the Nutrient Criteria Development Plan (NCDP) Scientific Advisory Council (SAC). The document states, “Management actions will be focused on wastewater, agriculture, riparian buffer protection, stormwater runoff from new and existing development, and nutrient trading. Criteria will be regulatory goals for the waterbodies and are aimed at protecting designated uses such as aquatic life, using SAV habitat as a biological endpoint.” We request that this language be deleted from the document. **The SAC has not completed its work, nor has it issued any report or document stating where management actions will be focused or what, if any, criteria or regulatory goals it will recommend. The source of these statements is not documented and these statements are extremely premature. To maintain the integrity of the SAC and the NCDP process, these statements must be deleted from the draft Amendment.**

#### **4.2.6 - Other Contributing Factors**

##### **Page 65 – 70**

These pages discuss numerous other factors affecting loss of SAV besides nutrients – climate change, SAV pathogens, physical disturbances, and chemical control of aquatic nuisance species. Any of these could impact large acreages of SAV, some overnight, even if light penetration increases and nutrient loads are reduced. Therefore, in the Amendment, the goal of increasing SAV and the recommendations for doing so must not be tied only to light penetration increases and certainly not solely through nutrient load reductions. The comments of the NC Water Quality Association agree.

#### **4.3.2 Proposed Strategies**

##### **Page 71 - Support Water Quality Improvement Efforts**

Yet on page 71, the document states, “Because of observed links between nutrients, light limitation and SAV abundance, reducing nutrients by improving water clarity is the key objective to increase SAV abundance.” First, the phrase in this sentence “reducing nutrients by improving water clarity” seems to be written incorrectly. Second, if the sentence means “reducing nutrients to improve water clarity” this still ignores the tremendous impact of those items enumerated in 4.2.6. It is difficult to understand how, based on the fact that any of those could impact large acreages of SAV, some overnight, that the key objective to SAV abundance is solely nutrient reductions. Again, we believe that the goal of increasing SAV must not be tied only to light penetration increases and certainly not solely through nutrient load reductions. The comments of the NC Water Quality Association agree.

##### **Page 72 - Protect and Restore SAV**

This is where the decision to focus on nutrients is described. The document states, “However, it was decided to focus on nutrients since they were thought to be having a greater influence on water clarity and SAV, and nonpoint runoff strategies for nutrient loading reductions will also reduce sediment loading.” As mentioned in our

comments earlier, we are concerned about this focus solely on nutrient loading reduction strategies. The comments of the NC Water Quality Association agree. We also note that the reference for this statement is a “personal communication.” We feel that more than a personal communication reference is needed to explain and justify this decision to focus on nutrients.

**Page 73 - Adopt an interim SAV acreage goal**

The document states, “...multiple individual mapping events have been compiled to make up the historically known presence and known habitat suitable for SAV along NC’s coast, suggesting a historic extent of approximately 191,155 acres of SAV in public trust waters in coastal NC (Table 4.5; Figure 4.1- 4.9)... Therefore, the coastwide SAV protection and restoration goal is set as an interim goal of 191,155 acres.” This has SAV acreages and extent numbers that appear to be very precise and percentages down to the hundredths of a percentage. This is far more precise than the methodology supports. Numerous studies using varied methods to estimate SAV extent do not support the implied precision of these numbers. As stated in the NCWQA comments, because of the uncertainty in the summation of the historic acreages, we suggest the goal be rounded to 191,000 acres to avoid the perception of seeking a very specific target that is not necessarily supported.” Further we strongly recommend that these SAV acreage goals be non-regulatory.

**Page 73 - Adopt a light target of 22 percent for high salinity SAV and 13 percent for low salinity SAV to the deep edge of the SAV beds**

All of the references listed here to support the light target numbers are from studies in the Chesapeake Bay, Tampa Bay, and Indian River Lagoon, Florida. If studies have been done in the nine SAV regions in NC to determine that these light targets are correct for North Carolina, these NC studies must be cited in the document. If there are no such North Carolina studies, a recommendation that these very specific light target numbers be adopted for NC is problematic and premature, particularly if these light targets are to be used as a basis for a water quality management strategy and for regulatory nutrient reduction goals. We request that NC studies supporting the light targets be included in the document or, if they are not available, that this recommendation to adopt these very specific light targets be revised to something more general.

**Page 73 - 74 Validate a bio-optical model to define interim chlorophyll a targets for SAV waterbody regions**

The document states, “Results from this model can then be used to estimate chlorophyll a concentrations necessary to maintain water clarity needed for seagrass growth as it relates to 22 percent incident light to a depth of 1.7 m for high salinity SAV and 13 percent incident light to a depth of 1.5 m for low salinity. These concentrations can then be used as light penetration targets.” And “In the high salinity waters, turbidity rather than chlorophyll a was the main light attenuating substance in the water.” And “For the high salinity locations which included Bogue Sound, Core Sound, Back Sound, and eastern Pamlico Sound, a median chlorophyll a concentration of 10 µg/L would meet the 22 percent light target for SAV protection.” We feel strongly that it is premature to develop chlorophyll a targets for NC for SAV protection and request that specific chlorophyll a targets not be included in the document. The very specific light targets appear to be derived from studies that were not conducted in NC, but in Chesapeake Bay, Tampa Bay and Indian River Lagoon, Florida (see our comments above). The paper cited with the chlorophyll a concentration developed using those light targets (reference 135 listed on page 83) is a paper that is still “in review” and therefore subject to possible revision. Again, we do not support specific chlorophyll a targets being included in this document.

**Page 74 - Assess existing North Carolina water quality standards for chlorophyll a supporting sufficient light penetration for SAV growth and reproduction**

The document states, “Using the statistical, probability distribution of chlorophyll a from estuaries throughout NC waters, a 10 µg /l median value corresponds to a 90 percent quantile of 26 µg/l, significantly less than the current 40 µg/l standard. Comparisons of chlorophyll a concentrations to revised standards will help identify regions where nitrogen load reductions are necessary to protect SAV. Relationships between nutrient loading and chlorophyll a will need to be determined and will help manage sources of nutrient loads by SAV waterbody region and ultimately throughout coastal NC.” First, the numbers discussed from the reference 135 listed on page 83 that is still “in review” are for high salinity SAV habitats. Second, this section presupposes that standards are going to be revised. “Revised standards” are not needed to make comparisons of chlorophyll a concentrations to identify where nitrogen load reductions may benefit SAV. That can be done now. It is unnecessary to revise standards across the entire state or to revise standards for every water in coastal NC to benefit SAV. This is particularly concerning because these standards would be applicable to those waters, whether or not those waters ever supported SAV historically. References to pre-assumed revised standards should be deleted from this document.

**Recommended Actions for SAV**

**Beginning on Page 75**

**4.4** – We appreciate the inclusion of the Soil and Water Conservation community in this recommendation, however we feel that this recommendation should not have a specified target of 50% and this recommendation should be revised accordingly. That target may be correct for some programs, but not for others. We speak more specifically about the Soil and Water Conservation programs later in these comments.

**4.7** – This recommendation states that the SAC “will evaluate” whether to propose a light penetration standard to the Environmental Management Commission. We feel strongly that this evaluation should be based on North Carolina studies regarding light penetration and SAV, as stated earlier in our comments.

**4.8** - This recommendation states that the SAC “will evaluate” whether to propose a chlorophyll a standard for SAV protection. We feel strongly that this evaluation should be based on North Carolina studies on light penetration and SAV, before chlorophyll a standards are proposed to increase light penetration to the proposed light penetration targets. Further it is unnecessary to revise standards across the entire state or to revise standards for every water in coastal NC to benefit SAV. This is particularly concerning because these standards would be applicable to those waters, whether or not those waters ever supported SAV historically.

**4.9** – We strongly oppose the recommendation that the EMC consider adopting nitrogen and/or phosphorus criteria. See the comments of the NC Water Quality Association, on nutrient concentration criteria, which we incorporate as our comments also.

**4.12** – This recommendation is that DWR will request the NC Policy Collaboratory to investigate the impacts of agricultural practices and land use change on water quality within SAV waterbody regions, to determine types and location of BMPs needed to effectively improve water quality. We request that agricultural practices not be the only land use practices listed here for study, but also development and

other practices should be listed. Further we feel that the phrase “land use changes” should specifically cite the land use change from existing land uses to development.

## **Chapter 5 - Wetland Shoreline Protection and Enhancement with Focus on Nature-based Solutions**

### **Tables 5.5 and 5.6**

#### **Pages 92 and 93**

These tables show that the conversion of all wetlands to agriculture has decreased over the twenty year time period, and for the period 2011 -2016 is zero acres for every category. However, on **page 96** the document states that “...conversion of wetlands for forestry and agriculture has been a major source of wetland loss historically and in more recent decades.” This document should acknowledge that conversion of wetlands to agriculture has consistently decreased in recent decades, and that it was zero for the last five years cited in the tables. We request that a discussion of why that has occurred – primarily due to the impact of the Wetlands Conservation Provisions (the Swampbuster provisions) of the 1985 Farm Bill – be added to the discussion on **page 96**.

#### **Page 96 - Current and Future Threats**

The document states “However, in areas designated as NSW and having nutrient management rules (i.e., Neuse, Tar-Pamlico), agricultural nutrient loading requirements are included.” We feel strongly that this paragraph should be expanded to discuss the tremendous accomplishments of the agricultural community in complying with the nutrient reduction mandates in the Neuse and Tar-Pamlico River Basins. The nitrogen reduction mandates for agriculture in each Basin are 30%.

In the Neuse Basin, “In CY2020, agriculture collectively achieved an estimated 48% reduction in nitrogen loss from agricultural lands compared to the 1991-1995 baseline, continuing to exceed the rule-mandated 30% reduction.” Source: Neuse CY 2020 report at:

<https://www.ncagr.gov/SWC/watershed/documents/2021AnnualProgressReportCropYear2020ontheNeuseAgriculturalRule15ANCAC2B.0712.pdf>

In the Tar-Pamlico Basin, “In CY2019, agriculture collectively achieved an estimated 55% reduction in nitrogen loss compared to the 1991 baseline, continuing to exceed the rule-mandated 30% reduction.”

Source: Tar Pamlico CY 2019 report at:

[https://www.ncagr.gov/SWC/watershed/documents/Final\\_Tar-Pam\\_CY2019\\_Annual\\_Report.pdf](https://www.ncagr.gov/SWC/watershed/documents/Final_Tar-Pam_CY2019_Annual_Report.pdf)

### **Appendix A – Public Comment from the Pew Charitable Trusts and the North Carolina Coastal Federation**

NCFB participated in a stakeholder workgroup coordinated by the Pew Charitable Trusts and the North Carolina Coastal Federation. Through this workgroup, members identified voluntary measures that may result in the reduction of sediment, pollutants and pathogens entering our waterways. The summary of that work is included as Attachment A to the Draft CHPP Amendment Document. The North Carolina Farm Bureau supports several of the initiatives proposed in the Pew/Coastal Federation document:

1. Providing support and assistance to government entities, private non-profits and mitigation companies to establish voluntary programs that financially support adoption of best management practices that will reduce nutrients and other pollutants harmful to fishery habitats.
2. Include the protection of coastal fishery habitats as a priority in the conservation plan for North Carolina adopted by the USDA Natural Resources Conservation Service (NRCS). Coastal fishery habitats are not currently included in NRCS’s conservation plan as a specific priority for conservation funding.

3. As outlined in Appendix A, NCFB supports the CHPP's initiatives to implement cost-effective, nature-based strategies such as living shorelines to reduce nutrient inputs, as well as other nature-based strategies that can reduce flooding impacting farms. Natural infrastructure practices are gaining a lot of support due to their potential to reduce downstream flooding, and many of these practices fit well in the agriculture landscape. NCFB generally supports these efforts, especially those that work to assist agriculture with these practices, while taking other concerns of agricultural and forest landowners into account, such as financial constraints and their ability to continue to have adequate land to operate profitably.
4. The North Carolina Farm Bureau supports a public-private partnership that will work with stakeholders to implement voluntary actions that can reduce nutrient and pollutant loading. The Resource Conservation Partnership Program (RCPP) through NRCS is an example of an effort to establish these partnerships.

### **Marine Fisheries Commission Advisory Committees' Recommendations**

An NCFB staff member attended (virtually) each of the five Advisory Committee public meetings where the CHPP was presented and discussed. Each Advisory Committee passed motions regarding the draft Amendment. We would like to address two recommendations of these Committees regarding agriculture.

Although not addressed in the Draft CHPP Amendment Document, a recommendation by the MFC's Northern Regional Advisory Committee would propose to add a recommended action to the CHPP to address and reduce nitrogen loading to the atmosphere from livestock waste lagoons as a means to restore SAV. The amount of atmospheric deposition of nitrogen from swine lagoons in NC is largely unknown, and the amount of those emissions that would be deposited into the estuary is even more uncertain. Tying these emissions to SAV loss (or restoration) is even more problematic. Until such time that nitrogen emissions from swine lagoons and their impact are better understood, NC Farm Bureau opposes the inclusion of this recommendation into the Draft CHPP Amendment Document.

The MFC's Finfish Advisory Committee passed a motion that the draft CHPP amendment recommend working with the Division of Soil and Water Conservation to introduce buffer zones installed on farmland in the coastal region and near river waterways. NCFB appreciates that the Finfish Advisory Committee recognizes the work of the Soil and Water Conservation community in NC.

Installation of buffers and similar best management practices (BMPs), such as field borders, are already an ongoing part of the cost-share programs administered by the Division of Soil and Water Conservation (DSWC) through the local Soil and Water Conservation Districts. The North Carolina Agriculture Cost Share Program for Nonpoint Source Pollution Control (NCASCP) is the primary state program providing cost share funding for voluntary implementation of BMPs by farmers. The Program funds numerous BMPs that benefit water quality, as does another cost-share program that the Division administers – the Community Conservation Assistance Program (CCAP) for installation of non-agricultural BMPs.

These programs are voluntary and it is important that they remain so. This is supported by the fact that far more farmers and landowners request funding for installation of buffers and other water quality best management practices than receive the funds. "While the soil and water conservation districts are well-positioned to implement the programs, they are chronically underfunded. In fiscal year 2019, cost-share programs funded by the State could only support 18% of eligible conservation assistance applications." Source: NC Climate Risk Assessment and Resilience Plan – Appendix B - North Carolina Natural and Working Lands Action Plan accessed at: <https://files.nc.gov/ncdeq/climate-change/resilience-plan/Appendix-B-NWL-Action-Plan-FINAL.pdf> citing the Soil and Water Conservation Commission Cost Share Programs Annual Report Fiscal Year 2019.

Additionally the staff of the NC Conservation Reserve Enhancement Program (CREP) discussed on page 118 of the draft Amendment is housed in the NC Division of Soil and Water Conservation. The North Carolina CREP is intended to improve water quality, reduce soil erosion, reduce the amount of sediment, phosphorous and other

pollutants entering waterbodies, improve wildlife habitat and restore wetlands. The draft only discusses this as a USDA program. In fact, USDA and the State of North Carolina are partners in implementing the CREP. USDA provides federal funds for the program but those funds must be matched by state funds. In addition to staffing the CREP, the DSWC is responsible for seeking the state matching funds required for NC to continue to offer this program.

These cost-share programs that fund agriculture and stormwater BMPs, and the CREP, are located in the NC Department of Agriculture and Consumer Services. Even though this is an NC DEQ document, it is important that the document indicate support for funding of these vital programs that protect and enhance water quality. This will show strong, cross-agency support for funding of agricultural and urban BMPs to protect and enhance water quality.

**We request that the draft Amendment specifically recommend increased funding for the state cost-share programs administered by the NC Division of Soil and Water Conservation and delivered by the local Soil and Water Conservation Districts. We also request that the document specifically recommend continued state funding of the state match for the Conservation Reserve Enhancement Program.**

Thank you for the opportunity to comment on the draft CHPP amendment. If you have any questions, please do not hesitate to contact me at 919-782-1705.

Sincerely,

Anne Coan  
Director of Environmental Affairs

**Lower Neuse Basin Association® Neuse River Compliance Association®**  
**Post Office Box 1410**  
**Clayton, North Carolina 27528 – 1410**

October 20, 2021

Email: [publiccomments@ncdenr.gov](mailto:publiccomments@ncdenr.gov)

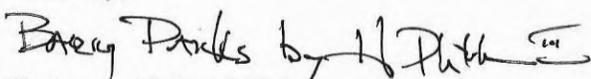
CHPP 2021 Amendment Comments  
P.O Box 769  
Morehead City, N.C. 28557

Mr. Jimmy Johnson, Coastal Habitats Coordinator APNES:  
Ms. Anne Deaton, Habitat Program Manager Habitat and Enhancement Section

Thank you for the opportunity to provide comments on the Draft 2021 Amendment to the Coastal Habitat Protection Plan (CHPP General Statutes § 143B-279.8.). It is understood that the CHPP is a long-term strategy to improve coastal fisheries through habitat protection and enhancement efforts. As such, the history of the lofty CHPP document (since the 1997 Fisheries Reform Act followed by the initial CHPP in 2005) provides information on habitat distribution, abundance, ecological functions and importance to fish production, status and trends, threats to habitats, and includes recommendations to address those threats. We note that all of the previous CHPP documents have been massive collections of information supplemented with lofty ideals and extensive recommendations. Perhaps it is time to consider a change. The incorporated comments from the independent stakeholder workgroup convened by the NC Coastal Federation (Federation) and The Pew Charitable Trusts (Trusts) offers an approach that targets and identifies real actions that have a practicable opportunity to make incremental improvements in key coastal habitat areas. The Federation/Trusts comments identify a set of voluntary water quality improvement actions that would support CHPP goals, could be taken over the next five years, and help minimize the need for regulatory actions. Overall, we find these comments and recommendations to be realistic, potentially achievable, and locally capable of implementation. Rather than recreating and reconstructing the massive CHPP document on five-year intervals, it is suggested that the 5-year amendment simply identify needed changes to the previous CHPP, and set recommendations and achievements for a five year time period. The comments offered by the Federation and the Trusts are realistic and digestible. Conversely, we note the lack of an Executive Summary and the extent of the massive 2021 Draft document (~250 pages) challenge us to understand the proposed changes and priorities offered in the 2021 Amendment. Simply stated, the comprehensive size of the document/references diminishes the opportunity for decision makers to prioritize realistic actions.

On behalf of the LNBA/NRCA Associations, I respectfully submit the attached comments on the Draft 2021 Amendment to the North Carolina CHPP. Our comments are generally focused on recommendations for the protection and restoration of SAV through Water Quality Improvements. Our Associations appreciate the monumental challenges placed upon the many contributors to the CHPP process. Thank you for the opportunity to submit these comments. If you require additional information or have questions about our comments, please contact me or Haywood Phthisic, LNBA/NRCA Executive Director.

Sincerely,

  
Chairman LNBA/NRCA

cc: LNBA/NRCA Boards

## LNBA/ NRCA Comments on 2021 Amendment to the Coastal Habitat Protection Plan

1. The historical extent of NC's SAV habitat is apparently dominated by observation from areas north of Cape Lookout along the western shore of the Outer Banks. These areas are extremely remote by distance, dilution, denitrification, assimilation, and hydrology from the influences of nutrient contributions from most of the inland areas of the state. None-the-less, the document continues the tradition of targeting the low-hanging fruit of regulatory recommendations for chlorophyll-a, nitrogen, and phosphorus. State-wide standards for chlorophyll-a, nitrogen, and phosphorus regulatory thresholds are not appropriate due to the site-specific influences of hydrology, wind, currents, tides, flow velocity, light availability, climate, extreme weather events. Nutrient concentrations are poor predictors of biological responses. Despite general acceptance of nutrient pollution as a problem, understanding the ways that SAV and other biological communities respond to nutrients is complicated, in part because conditions in estuaries, streams and rivers are quite variable. Chlorophyll a, a pigment in primary producers, is used to estimate algal biomass however the response of chlorophyll a to nutrients is dependent on the local environmental context. The CHPP document inadequately distinguishes significant differences between inorganic, organic, and algal turbidity. We support the (CHPP 2021 Appendix) Coastal Federation and Trusts' recommendations for voluntary "nature based" recommendations – i.e., living shorelines. Adopting additional rules and regulations for state-wide numerical criteria for chlorophyll-a, nitrogen, and phosphorus will not reliably protect the goods and services provided by designated uses. Rather, additional state-wide regulatory standards for chlorophyll and nutrients are not scientifically supported and they excessively and erroneously impact the economy.

*Colored dissolved organic matter (CDOM) is primarily leached from decaying detritus and organic matter and gives water a brownish color. Light penetration is greatly reduced in waters with high CDOM concentrations. In general, CDOM concentrations are higher in fresh and oligohaline waters compared to polyhaline waters. In the Neuse River estuary, CDOM is increasing and may be linked to the salinity regime. As such, declines in water quality for this region could be harder to manage because they are not just directly related to nutrient enrichment.*

2. Although the LNBA/NRCA may not agree with the "fact-based findings" assembled by the Coastal Federation and Pew Trusts' stakeholders, we concur with the recommendations of the Coastal Federation and the Pew Trusts stakeholders' consensus recommendations for an array of non-regulatory actions. Significant progress has been made by the LNBA/NRCA to reduce the point source loads of nutrients into the Neuse Estuary, but progress made in reducing our point source pollution is overshadowed by the impacts of nonpoint source pollution. New rules and regulations on point sources will not achieve a condition of algal nutrient growth limitation. If non-point sources contribute 75% of the nutrient load problem, regulating only 25% of the nutrient sources (point sources) will not achieve significant reductions in algal growth.
3. The LNBA/NRCA supports the widespread use of voluntary nature-based strategies that protect water quality, help reduce flooding, and make coastal communities more resilient to climate extremes. Federal and state climate resiliency strategies could expand financial incentives and technical assistance to encourage local communities to voluntarily prepare local watershed management and restoration plans. These plans enable public and private landowners to implement cost-effective, nature-based projects that protect, restore and mimic natural hydrology to reduce runoff, flooding, and restoration coastal fishery habitats such as SAV.



October 15, 2021

Jimmy Johnson  
N.C. Department of Environmental Quality  
Albemarle-Pamlico National Estuary Partnership  
217 West Jones Street  
Raleigh, NC 27604

Re: Proposed Comments by the N.C. Beach, Inlet and Waterways Association Regarding the Draft Amendment and Stakeholder Recommendations for the North Carolina Coastal Habitat Protection Plan

To Whom it May Concern:

The N.C. Beach, Inlet and Waterways Association (NCBIWA) is a 501(c)(3) non-profit tax-deductible association founded in 1998. Its Mission is to work on behalf of North Carolina's coast, and those who love it, by seeking to encourage government action and funding, educate and advocate for effective Federal and State policy, and facilitate environmentally sound scientific and engineering solutions for our threatened beaches, inlets and waterways.

Every five years the Coastal Habitat Protection Plan (CHPP) is updated by the N.C. Environmental Management Commission, N.C. Coastal Resources Commission, and N.C. Marine Fisheries Commission. These three commissions will update the plan this year to address management needs for coastal fish habitats over the upcoming five years.

Although the CHPP was initially developed in response to fishery concerns, the topics encompassed within the documents are wide ranging and address issues such as water quality, erosion, flooding and aesthetics, all of which are important topics to NCBIWA and our coastal community members.

Local governments along with engineering firms and other stakeholders are actively working to make coastal communities more resilient to storms and flooding by using nature-based stormwater measures. Anticipated upcoming appropriations by the N.C. General Assembly to support nature-based flood mitigation projects constructed by local governments means that our members will be on the forefront of management efforts to not only reduce flooding, but to make water quality improvements sought by the CHPP. In addition, in our more rural counties work is also progressing within the farms, forests and wildlife refuges in places like Hyde County to devise nature-based active water management infrastructure that concurrently addresses flooding and water quality needs.

NCBIWA supports the work of its members and endorses the direct integration of these local government projects into the CHPP recommendations. The CHPP needs to clearly support local

government initiatives that will be the backbone of meaningful actions taken to reduce existing and future coastal water quality problems. NCBIWA is particularly supportive of forming a public/private partnership so that stakeholders can be directly engaged in supporting and implementing this updated plan. We do not believe the plan will be successful if state agencies and the commissions do not immediately form this working partnership with key stakeholders (such as our member local governments and engineering firms) to help achieve the plan's goals.

NCBIWA strongly encourages the state to develop a plan for the Beneficial Use of Dredge Material (BUDM) to help enhance and restore fisheries habitats as well as for estuarine shoreline and oceanfront beach renourishment that optimizes sustainability. Current State policy for BUDM is challenging for local governments to undertake such projects. Safe and effective use of fine-grained dredge spoils for the restoration of marshes and thin layer placement is being widely used in other states throughout the Country in order for marshes to keep up with rising sea levels.

NCBIWA members are willing to engage in the work of the CHPP as it is implemented and offer to regularly feature highlights and discussions of the CHPP in our organizational meetings and communications.

Please contact me if you need more information about these comments.

Sincerely,

A handwritten signature in black ink, appearing to read 'Kathleen Riely', with a long, sweeping horizontal line extending to the right.

Kathleen Riely  
Executive Director, North Carolina Beach, Inlet and Waterway Association



PO Box 188 • 30 Oyster Creek Road, Swan Quarter, NC 27885 • [info@nccatch.org](mailto:info@nccatch.org)

October 2, 2021

Jimmy Johnson,  
Coastal Habitats Coordinator  
Albemarle-Pamlico National Estuary Program  
943 Washington Square Mall  
Washington NC, 27889

RE: Comments regarding the draft Coastal Habitat Protection Plan 2021 Amendment

Dear Mr. Johnson,

As you know, NC Catch is a nonprofit organization dedicated to consumer education about North Carolina seafood. We serve as the umbrella organization for regionally specific seafood-branding groups Brunswick Catch, Carteret Catch, Pamlico Catch, Outer Banks Catch, and Ocracoke Fresh. We respectfully submit the following comments on the draft Coastal Habitat Protection Plan (CHPP).

We believe in collaborative efforts and applaud the CHPP Steering Committee for supporting the formation of a stakeholder workgroup and the NC Coastal Federation and Pew Charitable Trusts for convening and facilitating the process. We are especially encouraged by the workgroup's recommendation that the CHPP Steering Committee and DEQ staff form a public/private partnership to focus on implementing recommendations once the amended plan is adopted.

We reviewed the stakeholders' findings, conclusions, and voluntary pollution-reduction strategy and find them to be reasonable and important. We recognize that recommended actions require strong collaborative partnerships and alignment with existing and emerging programs to address water quality degradation and storm resiliency. In short, we support the findings and recommendations of the stakeholder workgroup and appreciate the hard work they put into the process. We need more collaborative efforts of this sort.

We also urge you to adopt recommendations listed in Table 4.2 of the draft Amendment cited in North Carolina Fisheries Management plans (e.g. blue crab and bay scallop), particularly measures to reduce stormwater runoff. Improving water quality and the health of SAVs are key factors in ensuring productive fisheries and a robust seafood industry. In the interest of seafood consumers and the North Carolina commercial fishermen who provide their access, we urge the state to adopt these impactful measures to better protect our public resources.

Sincerely,

Barbara Garrity-Blake  
President, NC Catch



## North Carolina Conservation Network

234 Fayetteville Street  
5<sup>th</sup> Floor  
Raleigh, NC 27601  
919.857.4699

October 21, 2021

CHPP 2021 Amendment Comments  
N.C. Department of Environmental Quality  
[publiccomments@ncdenr.gov](mailto:publiccomments@ncdenr.gov)

### **Re: Comments on the Coastal Habitat Protection Plan – 2021 Amendment**

Dear CHPP authors and leadership team members:

Thank you for the opportunity to comment on the proposed 2021 Amendments (the plan) to the Coastal Habitat Protection Plan (CHPP). The NC Conservation Network is a statewide environmental advocacy organization that works with our partners and allies to protect North Carolina’s environment and public health. Our supporters across the state include tens of thousands of North Carolinians who live in or visit the coastal region, and who rely on coastal habitats for employment, recreation, or quality of life. We’re offering the thoughts below in hopes that they may help the CHPP better achieve both the statutory goal of ‘long term enhancement of the coastal fisheries associated with coastal habitats’ and also the general health of all the public trust resources you identify in the coastal region.

#### **1. The proposed plan amendments are smart and needed to protect North Carolina’s coastal habitats.**

The NC Conservation Network strongly supports the 2021 plan amendment you have assembled. It’s a work of policy depth and scientific rigor. The authors’ love for North Carolina’s coastal habitats shines through the data and the text.

Reading it, three takeaways stand out. First, North Carolina has an ecologically rich and varied coastal region, and the six focal habitats – the water column, shell bottoms, wetlands, hard bottom, soft bottom, and submerged aquatic vegetation – are key to the region’s future health. Second, those habitats are threatened by direct physical impacts, ongoing pollution, and new stresses arising from climate change and sea level rise. Finally, damage to the six focal habitats will impose real costs on the coastal economy and human communities, not just through loss of fisheries, but via loss of other functions as well, including loss of buffering from storms and degradation of recreational water quality.

We believe the CHPP, as updated by the proposed 2021 amendments, offers an impressively comprehensive strategy to carry our coastal habitats through the challenges ahead. We urge the Environmental Management Commission, the Coastal Resources Commission, and the Marine Fisheries Commission, to adopt the proposal, ideally with the following additions.

## 2. The proposed plan should be strengthened by adding a discussion of environmental justice.

The proposed Plan does not discuss environmental justice, disparities in the current distribution of pollution or risks, or the implications of the plan for those disparities. It mentions equity once (at 171), in the context of water affordability – very much an equity issue – part of a thoughtful discussion about the need to maintain aging water infrastructure. The Plan would be strengthened by applying that lens across the document.

We suspect that the omission reflects a conception of the Plan as science-based and focused closely on the six coastal habitats. Yet, how those six habitats sink or thrive implies an uneven distribution of impacts – some varying by income, some by race, some both – for coastal communities and residents. Outcomes in the Plan with environmental justice implications include, for example, the capacity of fish and shellfish stocks to support commercial fishing and shellfishing (income); the degree to which marshes can continue to buffer coastal communities from storms and sea level rise (income and race); to degree of access to healthy fish and shellfish populations for subsistence and recreational fishing (income and race). If any of the six habitat types fail, coastal residents of all income levels will suffer, low-wealth coastal residents will suffer more. In addition, many coastal residents of color live in conditions of heightened exposure or vulnerability to pollution or natural disasters as a direct legacy of historic discrimination formerly enforced by state and federal law. To recognize existing disparities and the potential for action items in the Plan to improve or to amplify them is wholly appropriate.

Moreover, addressing environmental justice in the Plan is pragmatic. Federal law – Title VI of the Civil Rights Act of 1964 – prohibits discrimination on the basis of race, color, or national origin in any program in any program that receives federal funds.<sup>1</sup> Executive orders in place since 1994 require each federal agency to make “achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.”<sup>2</sup> Moreover, Executive Order 14008, issued this year, directs federal agencies to “make achieving environmental justice part of their missions by developing programs, policies, and activities to address the disproportionately high and adverse human health, environmental, climate-related and other cumulative impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts.”<sup>3</sup> To implement that, the Biden administration has issued guidance establishing a goal that at least 40% of the benefits of a broad sweep of federal investments flow to disadvantaged communities.<sup>4</sup>

The Plan calls both for regulatory actions that will invoke state authorities under federal law and for investments for which North Carolina will want to draw on federal dollars. To maintain clear access to both, the Plan should explain how it addresses environmental justice in an overarching way.

If you add a new section to the final Plan to address environmental justice, we recommend that it:

- (1) note the wide existing disparities in disaster vulnerability and pollution exposures among coastal communities and residents. Much of this analysis has already been compiled in detail in North

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<sup>1</sup> Civil Rights Act of 1964, Title VI, 42 USC 2000d *et seq.*

<sup>2</sup> [Exec. Order No. 12898](#), Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, § 1-101, 59 Fed. Reg. 7629 (Feb. 16, 1994), as amended by Exec. Order No. 12948, 60 Fed. Reg. 6381 (Feb. 1, 1995).

<sup>3</sup> [Exec. Order No. 14008](#), Tackling the Climate Crisis at Home and Abroad, 86 Fed. Reg. 7619 (Jan. 27, 2021), at §219.

<sup>4</sup> Memorandum, [Interim Implementation Guidance for the Justice40 Initiative](#), July 20, 2021.

Carolina's Climate Risk and Resilience Plan, Chapter 4. It would be fairly easy to reference that and crosswalk those disparities with the benefits provided by the six core habitats of the Plan.

- (2) mention the core touchstones of environmental justice: *meaningful involvement* and *fair treatment*.<sup>5</sup> Traditionally, the first implies full procedural equity, with attention paid to ensure that all residents can participate in government processes and decisions. The second implies substantive equity in the outcomes for residents – as the US EPA describes it, ‘the same degree of protection from environmental and health hazards’.<sup>6</sup>
- (3) describe how the action steps of the Plan will be implemented in ways that assure consideration of environmental justice and compliance with the goals of meaningful involvement and fair treatment. With respect to meaningful involvement, the Plan may find it helpful to reference DEQ's 2020 Public Participation Plan and Limited English Proficiency Plans.<sup>7</sup> Both include a lot of ‘may’ statements and are not codified in state rules, but they do outline measures that, if followed conscientiously, could help Plan actions stay aligned with federal environmental justice expectations, at least in terms of supporting meaningful involvement.
- (4) offer a vision of what a more equitably-protected and restored coast will look like, expressed as five-year benchmarks. The use of five-year benchmarks – with reporting on whether they were met as a part of the next Plan iteration – is one of the most functional features of the CHPP, chapter 2 in the proposed draft. It embodies the axiom that what isn't measured, doesn't get managed. We recommend that the final version of this Plan identify specific equity benchmarks to give the agency and Commissions clear targets to aim at to demonstrate progress towards fair treatment.

### **3. The stakeholder-derived watershed planning framework in the NC Coastal Federation/Pew letter merits adoption as a CHPP strategy.**

In addition to the proposed Plan amendments, we have reviewed the comments submitted jointly by the NC Coastal Federation and the Pew Charitable Trusts, reflecting the conclusion of a group of stakeholders pulled together for discussions running concurrently with the drafting of the Plan. While the stakeholder process generated several recommendations for action by various state entities, we read the core thrust of the comment letter as asking that the CHPP endorse the development of local partnerships that will identify projects to benefit coastal habitats and then seek available state funds to advance those projects.

We think it makes a lot of sense to for the CHPP to endorse this. It is not duplicative of the existing action items, either funding or rulemaking, that the Plan tasks DEQ and the Commissions to achieve. We do not think it requires a commitment from DEQ (or across the administration) to give the projects identified by these stakeholders an absolute priority for conservation, infrastructure, or resilience funding streams. But on a practical level, projects that arrive at state funding agencies with strong buy-in across local interest groups have a higher chance of securing a local match (where required) and of being smoothly implemented. We think it makes a lot of sense to welcome these projects, and for the Plan to encourage local communities to pursue these coordinated solutions.

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<sup>5</sup> EPA, webpage: [Environmental Justice](#), accessed October 20, 2021.

<sup>6</sup> *Ibid.*

<sup>7</sup> NC DEQ, [Public Participation Plan](#), revised December 2020; NC DEQ, [Limited English Proficiency Plan](#), February 2020.

#### **4. The proposed amendments are right to tackle nutrient pollution to protect SAV.**

We appreciate the proposed Plan's discussion of the need to address excess nutrient pollution for the sake of conserving submerged aquatic vegetation (SAV) in chapter 4, and the concomitant action steps listed at the end of that chapter. In particular, we strongly support the recommendations for rulemaking: establishment of a light penetration standard (4.7), revisions to the chlorophyll-a standard for the estuaries (4.8), and development of nitrogen and phosphorus criteria (4.9). It would be worth adding to the latter development of a periphyton standard, which would enable the agency more easily to tackle excess nutrient pollution in flowing waters before they reach the estuaries.

It appears to us that action item 4.10 – determining “the loading and sources of nutrients and sediments, their quantitative linkages to chlorophyll a concentrations, and their effect on water quality and SAV” – comprises the same steps that would be necessary to update the watershed and estuary models that underpin the existing nutrient management strategies for the Neuse and Pamlico estuaries. We support that action item. We encourage the agency to make sure that the very real contributions of ‘non-discharge’ facilities are not left out of the modelling and calculations this time, as they unfortunately were in the late 1990s. Updating the nutrient management strategies themselves would presumably require another action item, under rulemaking, and we would support that as well.

#### **5. The Plan should address persistent toxics by setting a goal to eliminate their direct and indirect release to North Carolina's coastal habitats.**

Nearly five years ago (December 2016) researchers at NC State discovered very high concentrations of GenX and other perfluorinated compounds (PFAS) in the Cape Fear River, flowing down to coastal waters. While PFAS are not the only persistent toxics in North Carolina's coastal waters, they have rapidly become the premier class of persistent toxics needing state attention.

PFAS present a serious threat to coastal ecosystems, lasting for timescales ranging from decades to centuries.<sup>8</sup> Many – perhaps most – are toxic to animals and humans.<sup>9</sup> Some bioaccumulate and can biomagnify up the food chain; others are highly mobile, taken up quickly by plants and spread quickly through groundwater.<sup>10</sup> PFAS have been found in high concentrations in striped bass and alligators in North Carolina's coastal region,<sup>11</sup> in estuarine turtles along the South Carolina coast,<sup>12</sup> and in juvenile seabirds in the Lower Cape Fear region.<sup>13</sup> Just this week, test results have become public showing PFAS in beach foam.<sup>14</sup> Some of those samples were collected near where construction equipment was moving sand,<sup>15</sup> raising the

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<sup>8</sup> Ian Cousins, Jamie DeWitt, Juliane Gluge, et al, [The high persistence of PFAS is sufficient for their management as a chemical class](#), *Environ Sci Process Impacts*, December 2020, 22:12, 2307-2312. doi: 10.1039/d0em00355g.

<sup>9</sup> Interstate Technology Regulatory Council, factsheet: [Human and Ecological Health Effects and Risk Assessment of Per- and Polyfluoroalkyl Substances](#), 2020.

<sup>10</sup> *Ibid.*

<sup>11</sup> Adam Wagner, [Wilmington-area gators, fish show high levels of contaminants](#), *Wilmington StarNews*, April 9, 2019.

<sup>12</sup> Jacqueline Bangma, Jared Ragland, Thomas Rainwater, et al, [Perfluoroalkyl substances in diamondback terrapins \(\*Malaclemys terrapin\*\) in coastal South Carolina](#), *Chemosphere*, January 2019, 215, 305-312, 10.1016/j.chemosphere.2018.10.023.

<sup>13</sup> Anna Robuck, Mark Cantwell, James McCord, et al, *Legacy and Novel Per- and Polyfluoroalkyl Substances in Juvenile Seabirds from the U.S. Atlantic Coast*, *Environ. Sci. Technol.* October 2020, 54:20, 12938, DOI: 10.1021/ace.est.0c01951.

<sup>14</sup> Lisa Sorg, [PFAS-contaminated foam found at Caswell Beach, Oak Island](#), *NC Policy Watch*, October 18, 2021.

<sup>15</sup> Emily Donovan, personal communication, October 19, 2021.

question of whether PFAS has accumulated in beach sand and submerged sediment and can be re-released into the environment through human activity, reshaping in storms, or bioturbation.

The draft Plan does not mention PFAS or the broader problem of persistent toxics. The closest we see in the document is the discussion of plastic pollution (at 118), which is a related but distinct issue – microplastic particles can serve as a vehicle to spread PFAS and other pollutants further. We recommend that the final Plan include a discussion of persistent toxics in relation to the six core habitat types.

We note that the state and federal policy framework for curbing releases of persistent toxic pollutants continues to evolve rapidly. Just in the final week of this comment period, EPA released its far-reaching PFAS roadmap, with action items for the next three years.<sup>16</sup> NC DEQ is drafting a parallel state PFAS strategy, an early preview of which was shared with the Secretaries' Science Advisory Board in early October.<sup>17</sup> Unfortunately, so far both the federal and state frameworks suffer from a lack of clarity on the ultimate goal. Is it to phase out the non-essential use of PFAS? To allow broad use but prevent releases into the environment? To allow a steady release of persistent toxics into the environment at a rate the environment can absorb? – but because they are persistent, is there such a level that makes any kind of ecological sense?

Given that the Plan is not itself a regulatory document, but rather a blueprint for actions needed to maintain the health of the coast – and because the regulatory framework continues to evolve rapidly – we recommend that the final CHPP lay down two markers. First, it should note that from the perspective of the six core habitat types, there is little capacity to absorb toxics that take decades to centuries to break down. Already these habitats are biologically sensitive, and they are under increasing stress from a rapidly changing climate; we cannot calculate a capacity for them to absorb persistent toxics with any margin of safety. Second, we recommend that the Plan articulate a goal of eliminating the direct and indirect release of persistent toxics into the coastal environment.

We recognize this update of the Plan may not be able to name specific regulatory action steps to achieve that goal. So far, in the case of PFAS, the agency has aimed too low, focusing on Chemours while taking no final action to address other sources of these chemicals. Within the regulatory programs, the traditional way of thinking about pollution control – find a sustainable level of release for a pollutant, and regulate to that – continues to drive policy development. It doesn't work for persistent toxics, but muscle memory is strong. So it could be hard to achieve the internal buy-in to add appropriate regulatory action steps to the final Plan. But a science-based Plan can and should mention the lack of carrying capacity in the coastal habitats for persistent toxics and express the need to curb loadings.

## **6. We support the CHPP's foregrounding of nature-based approaches to coastal resilience.**

We support the CHPP's emphasis on nature-based approaches – floodplain restoration, on-site management of stormwater, living shorelines – to strengthen the resilience of coastal habitats and community. Chapter 5, Wetland Shoreline Protection and Enhancement with Focus on Nature-Based Solutions, is particularly strong on this, and there's nothing we can add to that excellent section.

One place where the Plan might benefit from an expanded mention of nature-based approaches is chapter 4, Submerged Aquatic Vegetation Protection and Restoration Through Water Quality Improvement. The draft FY21-22 state budget, currently in conference between the NC House and NC Senate, includes some

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<sup>16</sup> EPA, [PFAS Strategic Roadmap: EPA's Commitments to Action, 2021-2024](#), October 2021.

<sup>17</sup> DEQ Asst. Sec. Sushma Masemore and Frannie Nilsen, presentation recording: [DEQ Emerging Contaminants Framework](#), October 4, 2021, from 28:15 to 1:19:30. The slideshow should eventually be posted [here](#).

\$300 million for resilience strategies. Most of these are focused on protecting communities from flooding. The bill embraces both nature-based solutions and gray infrastructure (dams, levees, channelization), and at least some of the funding could be spent in either direction. In general, the nature-based options have the potential to offer far greater collateral benefits to water quality than do the concrete and steel options. It would be helpful for the Plan to emphasize the opportunity for nature-based solutions adopted for flood management to provide significant water quality benefits to downstream waters, including the estuaries. We suspect the best place to raise this is at or near the end of chapter 4, and to add two related action items (which we've modeled on similar items at the end of chapter 5):

#### *4.4.x Conservation*

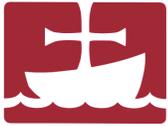
- 4.x By 2022, DEQ will ensure that Division (of Mitigation Services, of Water Infrastructure) consider ways to achieve water quality improvements as a collateral benefit of investments in nature-based flood resilience.
  
- 4.x By 2022, DEQ will provide information to NC legislators regarding the opportunities for nature-based flood reduction strategies to improve water quality in the coastal zone, thus advancing estuarine protection at the same time.

#### **Conclusion**

Once again, we are grateful for the expertise and the months of care that have gone into drafting the proposed Plan. We encourage the Commissions to adopt it. We appreciate the chance to offer the suggested additions above, and will be glad to answer questions or provide any additional help we can to strengthen the final Plan.

Sincerely,

Grady McCallie  
Policy Director  
NC Conservation Network



# North Carolina Council of Churches

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E-mail: [info@ncchurches.org](mailto:info@ncchurches.org)  
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Mr. Jimmy Johnson  
North Carolina Department of Environmental Quality  
217 W Jones St  
Raleigh, NC 27603

Dear Jimmy Johnson,

The North Carolina Council of Churches (NCCC) was founded in 1935. We are a statewide ecumenical organization promoting Christian unity and working towards a more just society. We are comprised of 26 distinct judicatories from 18 denominations. Across the state, our members have over 6,200 congregations with about 1.5 million congregants. The Council enables denominations, congregations, and people of faith to impact our state on issues such as economic justice and development, human well-being, equality, compassion and peace, following the example and mission of Jesus Christ. The NC Interfaith Power and Light (NCIPL) program of NCCC NC is the only statewide organization that addresses issues of climate change as a faith-based initiative. NCIPL at its core provides a hope-filled response to climate change by advocating with compassion.

In North Carolina, a hope-filled response to climate change begins with ensuring that coastal communities and habitats are protected and prepared for sea level rise, storm surge, and other climate-driven disasters. We already see these effects fracturing our communities and see the Coastal Habitat Protection Plan as an important piece to building a safety net of support for the human and nonhuman coastal communities affected by climate change.

In particular, NCCC/NCIPL supports the recommended public-private partnership, which would engage stakeholders in watershed planning and resiliency. Faith communities are a key constituency in coastal communities and they must be at the table for resilience and watershed-level planning conversations. A stakeholder-driven public/private partnership is the best mechanism for engaging all residents in understanding and planning for the challenges that lie ahead. We look forward to working with DEQ to implement the partnership, connecting local faith leaders with planning programs and opportunities.

We also recognize that protecting and restoring God's creation yields benefits for coastal communities. NCCC/NCIPL supports the CHPP recommended actions to protect and restore natural habitats, and increases climate resilience through the restoration and protection of wetlands and living shorelines. Nature-based solutions like wetlands are essential because they can hold back record-breaking rain, reducing flooding and pollutants entering estuaries. By protecting these parts of God's creation, we are protecting our human communities.

Sincerely,

Susannah Tuttle, M.Div  
Director, North Carolina Eco-Justice Connection & North Carolina Interfaith Power and Light



October 21, 2021

CHPP 2021 Amendment Comments  
P.O Box 769  
Morehead City, N.C. 28557

The North Carolina Coastal Federation has supported the Coastal Habitat Protection Plan (CHPP) since it was first conceived as part of the Fisheries Reform Act in 1997. After authorization of CHPP by the N.C. General Assembly, we worked with the CHPP steering committee and agency staff to plan and conduct a public engagement campaign that ultimately supported the approval of the first edition of CHPP. Working in partnership with the Secretary of DEQ, the federation organized public meetings all over the coast and state, produced printed outreach materials, organized a fisheries summit where Governor Jim Hunt spoke in Raleigh, and helped to focus the final CHPP recommendations into an actionable strategy for habitat protection.

Our engagement in CHPP continued since that initial work. We have encouraged continued focus on habitat and water quality protection and were pleased to work with CHPP implementation teams to take actions that resulted in much more widespread acceptance and use of living shorelines instead of bulkheads and other hard stabilization.

Based upon these previous positive outcomes, we strongly support the proposed amendments and stakeholder recommendations that are suggested for this latest five-year update. There is now real urgency to reduce nutrients flowing into our coastal estuaries that are harming people, fish habitats, fish and wildlife. All along our coast, there are already too many estuaries where algae blooms (some toxic) are occurring. N.C. may soon experience the same terrible problems that now occur in estuaries in Florida that this summer have experienced massive fish kills and widespread public health advisories.

N.C. has negotiated a nutrient reduction plan with the U.S. EPA to get a handle on these loadings into our estuaries. These discussions date back to 2001, and the state is significantly behind in implementing milestones in these agreements. It is clearly time to put a renewed focus on reducing nutrients running off into our coastal waters.

Past efforts by the state, local governments, and landowners to control nutrients have helped to reduce inputs from point source discharges as well as agriculture. However, increased population growth resulting in more intensive land uses of all types combined with more extreme weather events means that the nonpoint sources of nutrients in runoff are on the rise, and we need renewed and expanded strategies to address these nonpoint sources.

The stakeholders convened by the federation and The Pew Charitable Trusts outlined numerous immediate, voluntary actions that can be taken to start to address nutrient inputs. These stakeholder actions need to be incorporated directly into the CHPP and carried out to see how much reduction can be achieved through voluntary measures with adequate cost-share funding. Experience shows that we must enlist the support and cooperation of landowners and local governments to effectively reduce nutrient loadings across the landscape.

The CHPP will not be successful unless the private sector becomes its champion. As recommended by the stakeholders, CHPP should include a recommendation to form a public-private partnership that takes ownership of its implementation. The federation is ready to help with this partnership and lend our expertise as we have done with the Oyster Steering Committee since 2003. That effort has resulted in significant progress in protecting and restoring oysters in N.C., including helping to achieve a ten-fold increase in funding to carry out those initiatives.

Going forward, it will take a focused and inclusive rule-making process by the N.C. Environmental Management Commission (EMC) to devise changes and additions to the state's water quality standards that will be sufficient to set achievable goals to reduce nutrient concentrations in our coastal waters. Responsibility to protect water quality and the existing fishery uses that rely upon productive fisheries habitat not harmed by pollution falls squarely on the EMC with support from its agency staff, and the plan should clearly reflect this in terms of which governmental bodies need to be in a leadership role on these matters.

The current lack of comprehensive water quality monitoring for chlorophyll a in many of our coastal rivers and estuaries is a fundamental problem that the CHPP should explicitly recommend be corrected. Without this data, even rivers such as the Chowan that have extensive and highly visible algae blooms are not listed as "impaired" by the state's 303(d) list of impaired and threatened waters under the Clean Water Act. This lack of data means that obvious impairments are not documented, and the legal obligations and basis for obtaining more resources to address these water quality problems are lacking. We strongly recommend that CHPP include a specific recommendation to establish an adequate number of water quality sampling stations for chlorophyll a throughout our coastal waters to form the foundation for future management actions. University research and monitoring for chlorophyll is already occurring through the University of North Carolina's ModMon and FerryMon monitoring program, and should be incorporated directly into this monitoring network.

The primary focus of efforts to reduce nutrients in coastal waters needs to be on addressing non-point sources of nutrients. N.C. already has a dissolved oxygen water quality standard that can be used to devise measures to control nitrogen and phosphorus loadings. The state's existing chlorophyll a standard for coastal waters is widely understood to be set much too high to prevent eutrophication of coastal waters. Establishing a more accurate chlorophyll a standard is necessary but that will take years to adopt through the existing rule-making process. In the meantime, the EMC needs to act quickly to put in place a management framework that allows it to use its existing narrative water quality standards (such as Antidegradation under the Clean

Water Act) to protect and restore water quality to protect fisheries habitats such as submerged aquatic vegetation based upon watershed management plans and programs. There is an immediate need to begin lowering nutrient inputs, and the EMC needs to ensure that such impairments are fully recognized in its 303(d) listings and that it has mechanisms in place to use its water quality management planning authority to direct financial assistance for cost-share and other manage programs effectively to nutrient impaired coastal waters.

It is critical to move forward quickly with meaningful actions that demonstrate that the CHPP is an effective blueprint to protect and restore fishery habitats. North Carolina can learn from the work done by our neighbors in Virginia on how to reduce pollutants in the Chesapeake Bay. Leaders within government, NGOs, and private interests brought together many stakeholders to meet dissolved oxygen, nutrient, and light penetration goals. It is clear from the success of this initiative that working alongside stakeholders is a viable path that can result in mutual co-benefits for environmental and commercial interests. The federation stands ready to work with the CHPP partners to seek funding and other policy and political support that is vital for this effort to succeed. We look forward to the three commissions revising and adopting this plan so we can all get to work protecting and restoring water quality needed to maintain healthy and productive fishery habitats all along our coastline.

Sincerely,



Todd Miller  
Executive Director  
North Carolina Coastal Federation



Kelly Garvy  
Coastal Habitat Coordinator  
North Carolina Coastal Federation

North Carolina Fisheries Association, Inc.  
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252-726-6232 (NCFA) [www.ncfish.org](http://www.ncfish.org)

October 1, 2021

CHPP 2021 Amendment Comments  
P.O Box 769  
Morehead City, N.C. 28557.

The North Carolina Fisheries Association (NCFA) strongly supports the protection and restoration of our coastal fish habitats and water quality which are vital to our state's productive fisheries. We strongly support the decision by the N.C. Department of Environmental Quality (DEQ), N.C. Environmental Management Commission, N.C. Coastal Resources Commission, and N.C. Marine Fisheries Commission to focus much of the update of the existing North Carolina Coastal Habitat Protection Plan (CHPP) on how to protect and improve water quality that is essential to healthy and vibrant fish habitats.

Our coast is home to some of the most productive fisheries in the world as a result of its unique location and abundance of fishery habitats such as salt marshes, submerged aquatic vegetation, fish spawning and nursery areas, and still fishable and swimmable water quality in many places. However, fishermen and industry participants have seen the warnings that water quality has declined and fisheries habitats have been negatively impacted. Our fishermen and citizens continue to lose access to shellfish waters due to stormwater runoff. Shellfish closures have become more frequent and last longer even though they are supposed to be protected by the government. Severe outbreaks of fish diseases, often resulting in fish kills, have been occurring in our Neuse and Pamlico estuaries since 1984. North Carolina's river herring fishery, historically one of our state's most important fisheries, has been closed to fishing since 2007, yet the population has not recovered. North Carolina bay scallop fishery, one of the largest on the east coast, has been essentially closed or non-existent since 2006 due to a population collapse after a red-tide bloom in 1987. Striped bass populations are not successfully spawning or surviving in the Cape Fear River; the fisheries in that river have been closed since 2008. Eutrophication of coastal estuaries have grown worse, including toxic algae blooms now common in many of our coastal waters such as the Chowan River and Albemarle Sound which used to be prime river herring habitat. Scientific experts from NOAA, UNC, UNC-W, NCSU, ECU and other institutions warn that our water quality is not adequately protected. Upward trends in loadings of nutrients, pathogens, and exotic chemicals combined with more extreme weather events is causing more coastal water quality problems. Clearly, it is urgent that we take effective actions as soon as possible to protect and restore water quality to support our fisheries and the use of those waters by the public, which provide much economic benefit to North Carolina.

Over the past several decades, our state's regulatory commissions and agencies have taken effective steps to control physical and direct disturbances and damages to our coastal fish habitats. Many critical fish habitats have been closed to types of fishing gear the last 30 years in

order to protect those areas. Also, numerous restrictions have been placed on fish harvest by our fishermen through state/federal agencies to try to provide sustainable fisheries and fish populations. These measures were implemented as part of the Fisheries Reform Act in 1997, which also authorized the development of the North Carolina CHPP, which was the cornerstone of the FRA to protect critical fish habitat and ensure water quality was adequate in those habitats to support fisheries.

However, there still has not been similar effective actions taken to protect and restore coastal water quality in these critical fish habitats the last 30 years. Agreements setting deadlines for stronger water quality management actions to address nutrient and algae blooms were first initiated in 2001 between the U.S. Environmental Protection Agency and DEQ. Unfortunately, these agreements have failed to result in any meaningful water quality management reforms to date for our coastal estuaries. Yet our fisheries are restricted continually, even when harvest is at very low levels. We need to immediately move forward with effective actions to confront these water quality and fisheries habitat issues.

The Association supports the intent of the actions in the CHPP amendment, but the trends regarding fisheries habitat and water quality point to action being needed sooner than later. We request that some of these actions be revised and improved so that progress in accomplishing them is not totally contingent on receiving new funding from the N.C. General Assembly in the form of "recurring" appropriations. This requirement as stated in the draft plan is much too limiting, and does not reflect the opportunities to use existing funding, seek funding that is not "recurring," or to find funds for this work from federal, state and private agencies such as the National Fish and Wildlife Foundation or the various trust funds administered by state agencies and commissions. The importance of our fisheries and our resources dictate that our state does something as soon as possible besides restricting fishing.

Our legal advisor, Steve Weeks, participated in the stakeholder group that was formed to identify immediate voluntary actions that can be taken to jump start implementation of the plan. These recommendations need to be fully incorporated into the CHPP when it is adopted. A key stakeholder recommendation is to form a public-private partnership to help the three commissions and DEQ implement the CHPP much like the ongoing Oyster Steering Committee now works. We believe this partnership is vital to build the stakeholder understanding and support that is going to be essential to obtain public funding and management actions that are being recommended. The Association is ready to participate in such a partnership once it is formed.

Please do not hesitate to contact me if you have any questions about any of these recommendations and comments.

Sincerely,

John Glenn Skinner, Jr  
North Carolina Fisheries Association, Inc. - Director



## COMMENTS OF THE NORTH CAROLINA WATER QUALITY ASSOCIATION ON THE NC COASTAL HABITAT PROTECTION PLAN 2021 AMENDMENT

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The North Carolina Water Quality Association (NCWQA) is a statewide coalition of public water/sewer/stormwater utilities representing a significant majority of the sewered population of North Carolina. Water quality regulations and policy are an important topic for NCWQA. For decades, our members have worked with the North Carolina Department of Environmental Quality (NC DEQ) and other stakeholders to achieve necessary water quality controls in a predictable and cost-effective manner. Our comments below pertain to the submerged aquatic vegetation (SAV) issue paper (Chapter 4) of the 2021 amendment to North Carolina's Coastal Habitat Protection Plan (CHPP).

1. NCWQA supports the CHPP's intent to protect and restore SAV. SAV is a valuable ecological resource both in its own right and for the maintenance of other species. It is therefore appropriate that the CHPP identify ways to better protect and restore SAV. NCWQA supports most of the SAV-related strategies presented in the document, although with several important caveats as noted in comments below.
2. SAV acreage goals should be non-regulatory. As described in the draft amendment, the proposed interim SAV goal (191,155 acres) was obtained by summing the acreage estimated by various individual projects over 40+ years. Many of the mapping projects were very limited in area and time. There appears to be inadequate information to quantify the interannual variability in the total acreage, or the maximum extent that was ever achieved in a single year. For these reasons, although NCWQA concurs that the historical mapping mosaic is useful information, we recommend that the interim goal remain non-regulatory. Because of the uncertainty in the summation of the historic acreages, we also suggest the goal be rounded to 191,000 acres to avoid the perception of seeking a very specific target that is not necessarily supported. We support the CHPP's recommendation to improve SAV monitoring in North Carolina. A possible future outcome of such a program is more confidence in the area suitable for SAV habitat, and the direct use of mapped SAV acreage to demonstrate use support.
3. Water clarity should be the primary parameter for SAV-related water quality targets, with application depths tailored based on local environment, and natural "no grow" zones recognized. NCWQA concurs with the recommendation to adopt light targets for SAV beds, expressed as percent incident light. The draft amendment cites the depths of application as 1.7 m in high salinity areas and 1.5 m for low salinity areas. NCWQA recommends against assuming that the appropriate depth of application is constant by salinity zone statewide. Rather, the appropriate depth of application should be based on segment-specific considerations including historical depths of growth, sediment type, and hydrodynamic conditions. In some areas, the realistic depth of SAV will be less than the depths cited in the draft amendment, and some shallow areas are unsuitable for SAV colonization due to factors such as natural sediment resuspension and deposition. Variable application depths and delineation of no-grow zones are consistent with the USEPA-approved approach that Maryland and Virginia adopted for the Chesapeake Bay and tidal tributaries.
4. North Carolina's SAV protection strategy should not focus only on nutrients nor underemphasize the importance of other stressors including inorganic turbidity. Some portions of the draft amendment show an overemphasis on nutrient controls as an SAV protection strategy, to the

exclusion of other stressors that might be more important in some areas. For example, on p. 72 the amendment includes a figure (4.10) of the process for restoring SAV, and this figure incorrectly implies that nutrients are the only stressor or management variable for SAV. The accompanying text states: “Addressing suspended sediments can also aid water clarity. However, it was decided to focus on nutrients since they were thought to be having a greater influence on water clarity...”.

In fact, APNEP’s work with the biooptical model shows that in many coastal waters (especially high salinity areas), “turbidity dominates [light] attenuation, and “chlorophyll-a was a minor component of [light] attenuation” (Hall, 2020). In these waters, a focus on nutrient/chlorophyll would be ineffective for SAV restoration. We recommend that Figure 4.10 and the associated text be deleted from the amendment, and replaced with a broader conceptual framework. The framework should acknowledge the need to evaluate stressors/controls on SAV to determine the appropriate management strategies for different regions. Although nutrients/chlorophyll should be included in the framework, it should also include other stressors and strategies related to sediment, colored dissolved organic matter (CDOM), filter feeders, and physical disturbance.

5. *The individual components of light attenuation should be used for region-specific diagnostic purposes rather than water quality criteria.* NCWQA supports the recommendation to validate a biooptical model that quantifies the individual components of light attenuation such as chlorophyll-a, turbidity, and CDOM. The relative importance of these factors will be spatially variable, and so the biooptical model can be useful for determining which management strategies are likely to be effective in different coastal segments. We also anticipate spatial variability in the chlorophyll-a targets that would support SAV in different regions. In some regions, chlorophyll-a will not be a useful management variable.

With this background, NCWQA believes it is premature to assume that broadly-applicable revisions to chlorophyll-a criteria will be necessary or appropriate. By comparison, the states of Maryland and Virginia established water clarity criteria for the protection of SAV, but did not consider it necessary or beneficial to adopt chlorophyll-a (or turbidity) criteria for SAV. Rather, the water clarity criteria are considered sufficient to identify water quality conditions that support or do not support SAV growth, and factors such as chlorophyll-a and turbidity are used to diagnose causes/solutions for specific coastal segments. NCWQA recommends that the draft amendment acknowledge this successful approach as a possible outcome for North Carolina.

NCWQA supports the recommended efforts to explore the utility of broader revisions to the existing chlorophyll-a criterion for SAV protection. However, such revisions should only be made if a thorough analysis demonstrates that chlorophyll-a is a principal component of light attenuation across most of NC’s coastal waters, and that chlorophyll-a targets would be similar across those areas.

6. *Nutrient concentration criteria should not be adopted.* Figure 4.10 displays the setting of nutrient load or concentration targets (nutrient criteria) as a major step in restoring SAV. NCWQA concurs that setting nutrient load targets may be necessary for some segments, if research demonstrates that algal light attenuation is a major stressor on SAV and that nutrient controls would be necessary to meet designated uses. However, we strongly recommend

against the presumption that nutrient concentration criteria will be necessary or desirable. In the conceptual cause-effect chain of nutrient concentrations → chlorophyll → light attenuation → SAV limitations, nutrient concentrations are the furthest component from the actual aquatic life use, and therefore have the most uncertainty with respect to identifying targets. In general, nutrient concentrations are poor predictors of biological responses. With reference once again to the Chesapeake Bay, Maryland and Virginia determined that nutrient concentration criteria for SAV protection were unnecessary. We recommend that the authors delete references to nutrient concentration criteria while retaining discussion of the potential importance of nutrient load reductions in some settings.

NCWQA appreciates the opportunity to provide these comments. We look forward to working with DEQ to protect our coastal waters. Thank you for your time and consideration.

### **References**

Hall, N.S. 2020. Progress Update: Development of scientifically defensible chlorophyll a standards for protection of submerged aquatic vegetation in the Albemarle-Pamlico Estuarine System. Presentation to NC Science Advisory Council.  
[https://files.nc.gov/ncdeq/Water%20Quality/Environmental%20Sciences/ECO/NutrientCriteria/Presentations/SAC\\_presentations\\_2020-10-30.pdf](https://files.nc.gov/ncdeq/Water%20Quality/Environmental%20Sciences/ECO/NutrientCriteria/Presentations/SAC_presentations_2020-10-30.pdf)



October 19, 2021

Dear Jimmy Johnson,

Please accept these comments on the 2021 Amendment to the North Carolina Coastal Habitat Protection Plan (CHPP) on behalf of The Pew Charitable Trusts. The CHPP contains recommendations that align with Pew's environmental conservation and flood resilience priorities. We appreciate the collaborative and comprehensive approach taken in updating the CHPP and look forward to helping implement measures that promote sustainability for North Carolina's coastal resources and communities.

We are pleased that the Department of Environmental Quality (DEQ), Marine Fisheries Commission (MFC), Environmental Management Commission (EMC), and Coastal Resources Commission (CRC) prioritized the protection and restoration of Submerged Aquatic Vegetation (SAV) and coastal wetlands in the 2021 CHPP Amendment. We appreciated the opportunity to assist in convening technical workshops on these issues in 2020 and, in partnership with the NC Coastal Federation, to convene a CHPP Stakeholder Workgroup May-July 2021 that developed complementary recommendations for voluntary actions to improve water quality; these appear in Appendix A.

Pew's priorities in North Carolina include protecting coastal habitat, restoring river ecosystems, and flood preparedness at the community and state level. We have worked with a variety of stakeholders to advance these priorities, including development of the 2021 NC Oyster Blueprint, the 2021 Action Plan for Nature-based Stormwater Strategies, the 2020 Coastal Management Program and National Estuarine Research Reserve Federal Program Evaluation, and the 2020-2022 Triennial Review for Surface Water Standards undertaken by the EMC.

The process to draft the 2021 CHPP Amendment was rigorous and thoughtful. Recognizing that it is already a strong document, we ask that you consider some modest but important modifications and move it toward final approval and effective implementation. We offer the following recommendations for clarity, ease of implementation, and to increase public engagement:

1. Facilitate the formation of a new public/private partnership to increase stakeholder involvement in CHPP development, implementation, funding, and decision-maker support.
2. Modify RA 4.1 to expand SAV protection and restoration funding opportunities and minimize delays in implementing RAs to protect and restore SAV through water quality improvements.
3. Modify RA 4.7 to strengthen and streamline the process for establishing a water quality standard for light penetration that is critical for meeting photosynthetic needs of SAV.
4. Modify RA 4.8 to strengthen and streamline the process for establishing a water quality standard for chlorophyll a that is critical for meeting photosynthetic needs of SAV.
5. Prioritize RA 5.6 and RA 5.7 to participate in the development of a new Southeast Regional Salt Marsh Conservation Plan and protect marsh migration corridors.

Recommendation 1. Facilitate the formation of a new public/private partnership to increase stakeholder involvement in CHPP development, implementation, funding, and decision-maker support.

We urge DEQ to spearhead a meeting or series of meetings to determine how best to form a new public/private partnership that can assist with implementing the 2021 CHPP Amendment and with developing the next one. This critical enterprise will help elicit and incorporate meaningful public input, optimize stretched state resources, and build on decades of agency work to achieve CHPP goals.

Stakeholder engagement is a priority for a variety of natural resource managers in North Carolina. For example, the 2020 Natural and Working Lands Action Plan, 2012-2022 Comprehensive Conservation and Management Plan for the Albemarle-Pamlico National Estuary Partnership, and 2021 update to the North Carolina Oyster Blueprint all made the solicitation of stakeholder feedback a key component of their development process. The importance of engaging the public and a variety of different agencies is a theme that runs throughout the 2021 CHPP Amendment and appears in 13 RAs in the form of new workgroup formation, collaborative research, outreach, and training (RA 4.3, 4.4, 4.13, 5.3, 5.6, 5.7, 5.10, 5.11, 6.3, 6.4, 6.5, 7.3, and 8.1).

The 2021 CHPP Amendment explicitly acknowledges the value of multi-stakeholder working groups that bring together partners from multiple state and federal agencies, nonprofits, and academia. Most notably, the Amendment acknowledges the value of the NC Oyster Steering Committee in developing the NC Oyster Blueprint, a plan whose generation and implementation for a key coastal habitat has proven so successful as to obviate the need for an oyster-focused chapter in the 2021 amendment. As noted by DEQ staff during CHPP presentations given during August and September 2021 MFC, EMC, and CRC meetings, so great is the value of the Blueprint and its collaborative development and implementation - which, like the CHPP, happen on a 5-year cycle - that CHPP developers did not include oysters as an explicit priority in the 2021 amendment to avoid duplication of efforts and focus resources on other priority habitats.

The process of convening the CHPP Stakeholder Workgroup in collaboration with NC Coastal Federation demonstrated the value of engaging communities that will be impacted by CHPP RAs in the process of shaping water quality improvement strategies. Two lessons stand out from that experience. The first is the efficiency of having a small group of representatives from different coastal habitat constituencies learn about a CHPP priority issue (water quality) through a thoughtfully designed process of information sharing and analysis and disseminate those results among their constituencies. The second lesson is how resource-intensive designing such a process can be in terms of staff time, even when it is relatively focused in its scope of work, timeline, and target stakeholder groups.

While the Stakeholder Workgroup was intended as a discrete initiative to inform the 2021 CHPP Amendment in its final stages of development, it turned out to be a useful pilot project for how DEQ could, working with partners, develop a broader initiative to increase stakeholder involvement in future CHPP updates from start to finish. It has been useful to compare the Workgroup to the Oyster Steering Committee as a model for operationalizing stakeholder engagement to highlight the potential for a longer-term effort to solicit and incorporate meaningful input to the CHPP from diverse communities who are or could be impacted by the management actions it contains.

Recommendation 2. Modify RA 4.1 to expand SAV protection and restoration funding opportunities and minimize delays in implementing RAs to protect and restore SAV through water quality improvements.

Recommended Action 4.1 states:

*By 2023, the North Carolina Department of Environmental Quality (DEQ) will obtain recurring funding that includes the adequate amount of staff to successfully evaluate and meet the submerged aquatic vegetation (SAV) acreage goals and implement all of the SAV recommended actions that contribute to meeting the goals.*

We suggest replacing “obtain” with “pursue”, striking “recurring”, and adding “from state, federal, and private sources” after “funding” so that the new RA would read:

*By 2023, the North Carolina Department of Environmental Quality (DEQ) will pursue funding from state, federal, and private sources that includes the adequate amount of staff to successfully evaluate and meet the submerged aquatic vegetation (SAV) acreage goals and implement all of the SAV recommended actions that contribute to meeting the goals.*

Securing recurring funding should not be an obstacle to moving forward on RA implementation. There are numerous opportunities to secure funds to pay for coastal habitat restoration and conservation from federal, state and local government agencies, as well as private funders. Key to accessing recurring funding is strong public and private partnerships that demonstrate engagement by stakeholders who are essential to implementing CHPP RAs. The NC General Assembly is more likely to appropriate funding at levels sufficient to implement the RAs if there is significant and vocal public support. In addition, even non-recurring funding is easier to obtain when it is leveraged with other non-state funding.

The federal government can be a strategic partner in financially supporting the CHPP if thoughtfully engaged. In particular, the National Oceanic and Atmospheric Administration (NOAA), US Fish and Wildlife Service (USFWS), Environmental Protection Agency (EPA), US Department of Agriculture (USDA), and US Army Corps of Engineers (US ACE) all have grant programs that can and have been effectively leveraged to support SAV restoration efforts throughout the US. In the Chesapeake Bay, for example, the federal government had between \$460 million and \$570 million per year in budget authority for restoration activities in the Bay between FY2014 and FY2017.<sup>1</sup> The National Fish and Wildlife Foundation, the Department of Defense, N.C. Land and Water Fund also are all potential sources of government dollars, and research dollars can be secured from funders such as the National Science Foundation by working with university scientists and engineers.

According to NOAA, one of the largest federal funders of coastal habitat restoration projects, North Carolina ranks 16<sup>th</sup> among coastal states for the number of projects the agency funds, ranking behind numerous states with appreciably less coastline and acreage of estuarine waters.<sup>2</sup> Given increasing federal attention on coastal resiliency, the state may be able to access significantly greater federal investment in our coastal ecosystems and communities than it has in the past. To increase the

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<sup>1</sup> Lipiec, Eva, “Chesapeake Bay Restoration: Background and Issues for Congress”, *Congressional Research Service*, 2018.

<sup>2</sup> <https://www.fisheries.noaa.gov/resource/map/restoration-atlas>.

agency's ability to develop and submit competitive proposals that are submitted it needs to proactively engage new partners and stakeholders and give them a sense of ownership in the CHPP itself. It also needs to strategically leverage state resources to serve as matching funds, evidence of which many proposals require. Increased funding for staff and projects requires strong forward momentum in building excitement and engagement by lots of stakeholders to implement CHPP RAs. It is essential to create this momentum to obtain the funding levels ultimately sought through RA 4.1.

Recommendation 3. Modify RA 4.7 to strengthen and streamline the process for establishing a water quality standard for light penetration that is critical for meeting photosynthetic needs of SAV.

Recommended Action 4.7 states:

*By 2022, the Nutrient Criteria Development Plan (NCDP) Scientific Advisory Council (SAC) will evaluate recommending the Environmental Management Commission (EMC) establish a water quality standard for light penetration, with a target value of 22 percent to the deep edge (1.7 m) of SAV for all high salinity SAV waterbody regions, and a light penetration target of 13 percent to the deep edge (1.5 m) for all low SAV waterbody regions (Table 4.5; Figures 4.1-4.9).*

We suggest making the EMC the subject of the sentence so that the new RA 4.7 would read:

*By 2022, the Environmental Management Commission (EMC) will receive guidance from the Nutrient Criteria Development Plan (NCDP) Scientific Advisory Council (SAC) on establishing a water quality standard for light penetration, with a target value of 22 percent to the deep edge (1.7 m) of SAV for all high salinity SAV waterbody regions, and a light penetration target of 13 percent to the deep edge (1.5 m) for all low SAV waterbody regions (Table 4.5; Figures 4.1-4.9).*

Given the importance of protecting and restoring SAV to support important ecosystem services like carbon sequestration, and the increased economic losses that will result from any delay, it is appropriate for the EMC, with its broad authority for activities affecting water quality, to assume responsibility for RA 4.7 and to task the Division of Water Resources (DWR), the SAC and others, as appropriate. The SAC is a critical body with extensive expertise that should be called upon and leveraged by the EMC in its oversight role of enacting rules related to water quality.

Establishing a water quality standard for light penetration is on the critical path for meeting the interim goal of protecting and restoring 191,155 acres of SAV coastwide as described in RA 4.2. It is the first step in the successful approach to SAV restoration used for the Chesapeake Bay, as described in the draft CHPP 2021 Amendment<sup>3</sup>, p. 62:

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<sup>3</sup> <https://files.nc.gov/ncdeq/Marine-Fisheries/coastal-habitat-protection-plan/CHPP-2021-Amendment-Draft-20210806-Commissions.pdf>.

*In order to achieve these SAV restoration goals, water clarity criteria were developed by the Chesapeake Bay Program partners<sup>4</sup> and published by the EPA on behalf of the partnership based on:*

- 1. Light requirements for underwater grasses*
- 2. Factors that contribute to light attenuation*
- 3. Epiphyte contribution to light attenuation on leaf surface*
- 4. Minimal requirements for light penetration through the water column and leaf surface*

The causal chain from SAV acreage goals to light penetration to chlorophyll *a* to nutrient load/concentration targets is further elaborated in the CHPP 2021 Amendment Draft<sup>5</sup>, Figure 4.10, p. 72.

According to a recent study on the economic impacts of SAV loss in the Albemarle-Pamlico conducted by researchers from NC State and Duke Universities, the aggregate losses attributable resulting from impacts to fisheries productivity, residential property value, and carbon sequestration ecosystem services are conservatively estimated to be \$1,290 per acre over the next decade.<sup>6</sup> Seagrasses are globally recognized for their ability to capture carbon dioxide and store the resulting “blue carbon” in their vegetation and soils. However, their degradation, through development or poor water quality, releases this stored carbon.<sup>7</sup>

The EMC can also advocate more effectively than the SAC for any additional funding and trained personnel needed to keep RA 4.7 on schedule. Putting the EMC in charge is in keeping with its mandate as noted in the draft CHPP 2021 Amendment<sup>8</sup>, p.3:

*The EMC has authority over activities affecting water quality, such as point and nonpoint discharges, wastewater, alteration of wetlands, and stormwater. The EMC’s rules are implemented by different DEQ agencies, including the NC Division of Water Resources (DWR), the NC Division of Air Quality (DAQ), and the NC Division of Energy, Mineral, and Land Resources (DEMLR).*

Recommendation 4. Modify RA 4.8 to strengthen and streamline the process for establishing a water quality standard for chlorophyll *a* that is critical for meeting photosynthetic needs of SAV.

Recommended Action 4.8 states:

*By 2022, the NCDP SAC will evaluate the chlorophyll *a* water quality standard and as needed, recommend it be revised by the EMC to ensure*

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<sup>4</sup> The Chesapeake Bay Program Partners “Bring together expertise, authority and resources from a broad range of organizations” including six states, the District of Columbia, 19 federal agencies, and others.

<sup>5</sup> CHPP 2021 Amendment Draft.

<sup>6</sup> <https://deq.nc.gov/news/press-releases/2021/05/25/new-research-measures-economic-losses-further-declines-submerged>

<sup>7</sup> There are currently efforts underway to evaluate greenhouse gas fluxes in North Carolina’s seagrasses and emergent coastal wetlands. This work will ideally enable DEQ to incorporate coastal wetlands into the State’s Greenhouse Gas Inventory, and help managers understand and evaluate the carbon impacts of protecting and restoring these ecosystems.

<sup>8</sup> <https://files.nc.gov/ncdeq/Marine-Fisheries/coastal-habitat-protection-plan/CHPP-2021-Amendment-Draft-20210806-Commissions.pdf>.

*protection of SAV in high and low salinity waterbody regions, beginning with the Albemarle Sound and Chowan River, and continuing with other waterbodies that support SAV (Table 4.5; Figures 4.1-4.9).*

We suggest putting the EMC in charge of this action so that the new RA 4.8 would read:

*By 2022, at the request of the EMC, the NCDP SAC will evaluate the chlorophyll a water quality standard and as needed, recommend it be revised by the EMC to ensure protection of SAV in high and low salinity waterbody regions, beginning with the Albemarle Sound and Chowan River, and continuing with other waterbodies that support SAV (Table 4.5; Figures 4.1-4.9).*

It is appropriate for the EMC to assume responsibility for RA 4.8 and to task the DWR, the SAC and others as appropriate. The EMC can also advocate more effectively than the SAC for any additional funding and trained personnel needed to keep RA 4.8 on schedule, especially in light of the NCDP (2019)<sup>9</sup> statement on p.5:

*. . . our greatest challenge is to maintain sufficient funding and trained personnel to complete the tasks outlined in this plan. Nothing in this plan obligates the DWR [under which the SAC is established<sup>10</sup>] to a course of action in the absence of program resources.*

The EMC should use its authority to ensure that schedules are met or accelerated for tasks established in the CHPP and in the NCDP pertaining to SAV and to related chlorophyll a water quality standards and nutrient criteria for the Albemarle Sound, Chowan River, and estuaries statewide, building on the progress made in developing a site-specific chlorophyll a surface water quality standard for the High Rock Lake Reservoir<sup>11</sup>.

In addition to the 2021CHPP Amendment, relevant schedules appear in the 2019 NCDP (2019), such as:

- By October 2021, concurrently with activities in the Albemarle Sound, the DWR will “Prioritize specific estuaries for nutrient criteria and confirm approaches proposed in the Albemarle Sound nutrient criteria development process with SAC involvement.” (p.19, Task No. 7)
- By April 2022, nutrient criteria recommendations for the Chowan River and Albemarle Sound are scheduled to be “developed and documented in a phase II report” (p. 14, Task No. 12)

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<sup>9</sup> <https://files.nc.gov/ncdeq/Water%20Quality/Environmental%20Sciences/ECO/NutrientCriteria/North-Carolina-NCDP-v2-05162019-final.pdf>.

<sup>10</sup> <https://files.nc.gov/ncdeq/Water%20Quality/Environmental%20Sciences/ECO/NutrientCriteria/Nutrient-SAC-Approved-Charter-10302019.pdf>.

<sup>11</sup> <https://files.nc.gov/ncdeq/Environmental%20Management%20Commission/EMC%20Meetings/2021/july2021/pwrpoints/A/G21-19-CVENTALORO-HRL-Rulemaking-ForReview-1.pdf>.

The EMC should also ensure the provision of timely public notice and opportunities for stakeholder involvement in the implementation of CHPP RAs and related NCDP initiatives.<sup>12</sup>

**Recommendation 5. Prioritize RA 5.6 and RA 5.7 to participate in the development of a new Southeast Regional Salt Marsh Conservation Plan and protect marsh migration corridors**

Officially launched in May 2021 by the Southeast Regional Partnership for Planning and Sustainability (SERPPAS), the South Atlantic Salt Marsh Initiative (SASMI) aims to conserve over 1 million acres of salt marsh habitat from North Carolina to Northeast Florida. These coastal wetlands provide habitat for approximately 75% of North Carolina’s commercial and recreational fish species, stabilize shorelines, protect against storm surge, and absorb floodwaters. These coastal resilience benefits are valued at approximately \$1.8 million per kilometer<sup>2</sup> each year.

Salt marshes are also effective carbon sinks, storing far greater amounts of carbon than they natural release. According to research by Duke University,<sup>13</sup> North Carolina’s coastal marshes and seagrass together currently store about 80 million metric tons of CO<sub>2</sub>e and sequester an additional 308,000 metric tons each year. When marshes drown or erode, this stored carbon is emitted back into the atmosphere – in scenarios with the highest sea level rise, for North Carolina alone the lost carbon sequestration potential is approximately equal to the greenhouse gas emissions from 4.4 million cars in one year.<sup>14</sup> Further research by NOAA<sup>15</sup> has also demonstrated that salt marsh are able to continually build carbon stores as sea levels rise - if there is space for marsh to move inland. This research further underlines the importance of continued conservation and protection of marsh migration corridors.

Modelled on the proven success of America's Longleaf Restoration Initiative, SASMI brings together federal, state, and local government officials, conservation groups, academics, and community leaders in pursuit of a common goal of conserving and restoring the regions valuable salt marshes. North Carolina is already taking a leadership role in SASMI planning begun in 2021 by virtue of DEQ leadership participation in the SASMI steering committee. Through development of a regional salt marsh conservation plan, this diverse group of partners will identify key strategies to protect marsh migration corridors, remove or modify barriers that may prevent future marsh migration, and restore marsh where it currently exists. In addition to the benefits this will provide to fish, birds, and other wildlife, this plan will ensure the resilience benefits the marsh provides to neighboring communities, military installations, transportation routes, and critical infrastructure persist into the future.

As watershed and marsh migration corridors transcend jurisdictional (state) boundaries, regional collaboration is key to achieving meaningful salt marsh conservation and restoration outcomes. Continued active participation in the SASMI represents an opportunity to benefit from and contribute to

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<sup>12</sup> <https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/nutrient-criteria-development-plan>.

<sup>13</sup> <https://nicholasinstitute.duke.edu/sites/default/files/documents/Coastal-protection-and-blue-carbon-North-Carolina--fact-sheet.pdf>.

<sup>14</sup> <https://nicholasinstitute.duke.edu/sites/default/files/documents/Coastal-protection-and-blue-carbon-North-Carolina--fact-sheet.pdf>.

<sup>15</sup> <https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2019JG005207>.

the pooling of diverse expertise in the Southeast region. Further, doing so would represent meaningful action towards embracing a consensus recommendation to pursue partnerships at a regional level to ensure coordination as noted in the 2012 Climate Ready North Carolina: Building a Resilient Future report and, more recently, reemphasized in the 2020 Climate Risk Assessment and Resilience Plan.

This innovative multistate partnership has already begun to bring much needed attention to an ecosystem of national, regional, and local importance and, through the coalescing of expertise from throughout the region, will facilitate the identification and leveraging of synergies between jurisdictions. Furthermore, as other regional initiatives (e.g. America's Longleaf Restoration Initiative, The Gulf of Mexico Alliance, The Chesapeake Bay Program) have shown, these partnerships represent attractive funding opportunities for both public and private grants.

Once the 2021 CHPP Amendment is approved, and as other collaborative opportunities such as the NC Oyster Blueprint, Action Plan for Nature-Based Stormwater Strategies, Climate Risk Assessment and Resilience Plan, and the SASMI become implemented in the coming years, we look forward to working with North Carolina's leaders to implement CHPP RAs and CHPP Stakeholder Workgroup recommendations to conserve the mosaic of SAV, coastal wetlands, river ecosystems, and human communities so they are resilient and thrive and adapt even as the climate changes and sea levels rise.

Thank you for considering these comments. We look forward to working with you to protect and restore North Carolina's coastal habitats for the benefit of coastal ecosystems and communities today and future generations tomorrow.

Sincerely,



Leda A. Cunningham  
Officer, The Pew Charitable Trusts



# The Town of Pine Knoll Shores

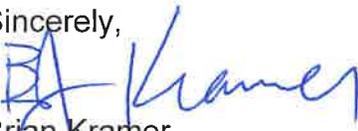
October 6, 2021

CHPP 2021 Amendment Comments  
P.O Box 769  
Morehead City, N.C. 28557.

The Town of Pine Knoll Shores works hard to protect and restore coastal fish habitats which are vital to our productive fisheries. As Town Manager, I participated in a stakeholder group that made ten recommendations for immediate voluntary actions that can be taken as part of the Coastal Habitat Protection Plan (CHPP) to enhance and sustain the fishery productivity of our coastal estuaries. Please include our group's recommendations as a key part of the updated CHPP. I feel strongly that the actions we are proposing will encourage and expedite efforts by local governments such as mine to maintain living shorelines and prevent stormwater pollution so that the fish habitats within our estuaries are protected and restored.

One of our major recommendations encourages the formation of a partnership with local governments and private stakeholders to help the three regulatory commissions and DEQ staff to implement the CHPP. This partnership with key stakeholders is vital to build public understanding, support and ultimately more funding for management actions included in the CHPP and by the stakeholders. I'm proud that our town had the foresight to devise a watershed management plan that has enabled us to strategically raise and invest millions of federal, state, and local dollars in environmental projects that protect fishery habitats. As a result of this plan, we have installed numerous projects that reduced stormwater pollution and related flooding, and that also prevent shoreline and salt marsh erosion by installing living shorelines. Based upon our direct experiences in protecting fish habitats, we would welcome the opportunity to work with the DEQ and commission CHPP leadership to encourage other local governments to follow in our footsteps.

Sincerely,



Brian Kramer  
Town Manager



Mr. Jimmy Johnson  
North Carolina Department of Environmental Quality  
217 W Jones St  
Raleigh, NC 27603

Dear Jimmy Johnson,

I am the Co-Pastor of St. Paul African Methodist Episcopal Zion Church in Aurora, NC. I am also a marine biologist and have spent my career studying the North Carolina coast. In other words, I am intimately familiar with the realities of coastal degradation and the need for healthy habitats, improved water quality, and nature-based solutions. These don't just matter to the fish of the sea and the birds of the air, though that's important. They don't just matter to the human communities along the coast and further inland, though we are important. They matter to God, because as we read in the Bible, "the earth is the Lord's and the fullness thereof" (Psalm 24).

My church is on the frontlines of climate change. We sit right on the Pamlico River, so storm surge and sea level rise are a constant threat. We've experienced major flooding twice in the past decade, from Hurricane Irene and from Hurricane Florence. We've flooded before, and we'll flood again. But the devastation is not inevitable. With support, St. Paul and communities like ours can better prepare for the realities of climate change, building social and physical resilience so that when the next Florence does come we can recover more quickly.

To this end, I want to emphasize the importance of including the public-private partnership program in the Coastal Habitat Protection Plan. As a pastor, I know that the most sustainable change happens not when I single-handedly take on a project, but when I share it with the congregation. The Oyster Blueprint was a stunning example of the importance of staking up a big tent and inviting all the stakeholders to a fish fry underneath it. We need to build up the capacity for community organizations to engage meaningfully with state agencies involved in coastal and resilience planning. A stakeholder-driven public/private partnership is the best mechanism for engaging all residents in understanding and planning for the challenges that lie ahead.

Second, I want to emphasize the importance of the Coastal Habitat Protection Plan's recommended actions that protect and restore natural habitats, and increase climate resilience through the restoration and protection of wetlands and living shorelines. These resources are a critical factor for protecting our natural habitats while also providing important benefits including flood mitigation, wave reduction, carbon sequestration and water filtration. God has provided us with incredible ecosystems that benefit both our health and the health of the world. We ought to be investing in protection and restoration of those places.

The CHPP isn't just about economy or ecology. It's also about justice. To invoke the words of the Prophet Amos, we want justice to roll down like waters; clean, protected, restored, and resilient waters.

Sincerely,  
Rev. Gerald Godette  
Associate Pastor, St. Paul AME Zion Church  
Aurora, NC

October 21, 2021

CHPP 2021 Amendment Comments  
N.C. Department of Environmental Quality  
[publiccomments@ncdenr.gov](mailto:publiccomments@ncdenr.gov)

*Re: Comments on Draft Coastal Habitat Protection Plan 2021 Amendment*

The Southern Environmental Law Center submits these comments on the 2021 Amendment to the North Carolina Coastal Habitat Protection Plan (“Draft Amendment”) on behalf of North Carolina Wildlife Federation, Sound Rivers, the Pamlico-Tar Riverkeeper, and the Neuse Riverkeeper. We applaud the authors of the amendment for providing a clear-eyed assessment of the challenges our coast faces, particularly regarding our coast’s declining water quality. From climate change to stormwater, the amendment provides a well-documented and devastating assessment of the future of our coast unless we collectively act now. The Department of Environmental Quality (“DEQ”) has a legal obligation to use its existing authority to better protect our estuaries and to establish new standards to be used as a tool to protect existing uses. As discussed below, we support the adoption of the Draft Amendment with revisions to encourage the use of additional authority as well as consideration of additional items to improve our water quality, and in turn, our coastal resources.

**I. DEQ can improve water quality through better use of existing authority as well as adopting proposed standards.**

As the Draft Amendment recognizes, water quality affected by sources in the upper coastal plain and the piedmont affects the ability of submerged aquatic vegetation (SAV) to thrive. The amendment makes clear that current water quality is not adequate, that enforcement is ineffective, and that our coastal resources suffer as a result. We encourage DEQ to look at all of the watersheds that flow into our coastal system and use the full breadth of its authority to protect water quality. We cannot keep our estuaries clean without controlling pollution sources throughout the watersheds.

**A. The legal imperative to protect SAV.**

Protecting SAV is not only important for the reasons identified in the Draft Amendment, it is a legal imperative. Under the Clean Water Act, North Carolina is responsible for ensuring that its laws serve the purpose of restoring and maintaining “the chemical, physical, and biological integrity” of its waters.<sup>1</sup> North Carolina’s rules embody that concept in the antidegradation rule, which states:

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<sup>1</sup> 33 U.S.C. § 1251(a).

The [Environmental Management] Commission shall protect existing uses . . . and the water quality to protect such uses by classifying surface waters and having standards sufficient to protect these uses.<sup>2</sup>

Existing uses include “uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards.”<sup>3</sup> In coastal waters, the minimum protections are for the use of waters for “aquatic life propagation, survival, and maintenance of biological integrity (including fishing, fish, and Primary Nursery Areas (PNAs)); wildlife; secondary contact recreation as defined in Rule .0202 in this Section; and any usage except primary contact recreation or shellfishing for market purposes.”<sup>4</sup>

As a result, protecting estuarine habitats, including SAV, is necessary to meet DEQ’s legal obligation to ensure that each of its permitting processes and other actions contribute to ensuring that there is no loss of existing uses in our coastal ecosystems.

B. New standards are needed to improve protections.

We agree with the Draft Amendment’s recommendation to set SAV acreage goals and to establish nutrient and clarity standards to protect SAV. Setting these new benchmarks will allow DEQ to more specifically identify problematic areas and measure changes in water quality.

To supplement the proposed new standards, DEQ should evaluate and adopt ecological flow standards. The Division of Water Resources has extensive experience with evaluating ecological flows and the detrimental effects of having too much, or too little, water flowing into a stream.<sup>5</sup> Because sediment and pollutants identified as threats to SAV are often carried by stormwater, setting ecological flow standards that can be used to inform the stormwater permitting program could provide additional protection.

C. DEQ must enforce existing laws during the permitting process.

The state can and should consider implementing new protections for SAV, but it should not overlook existing tools. Development of SAV acreage goals and standards to help achieve those goals will take time. The Division of Water Resources’ (“DWR”) and the Division of Energy, Mineral, and Land Resources’ (“DEMLR”) permitting processes allow DEQ to improve water quality now. Existing laws that are underutilized include: requiring disclosure and control of pollutants discharged by point sources, prohibitions on stream and river pollution through groundwater, protections for aquatic life uses, and stormwater authority.

*NPDES Program*

DWR’s National Pollutant Discharge Elimination System program can make significant improvements in water quality simply by enforcing two requirements: that all

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<sup>2</sup> 15A N.C. Admin. Code 2B.0201(b).

<sup>3</sup> 15A N.C. Admin. Code 2B.0202

<sup>4</sup> 15A N.C. Admin. Code 2B.0220

<sup>5</sup> N.C. Department of Environmental Quality, Instream Flow Unit, *available at* <https://deq.nc.gov/node/82948>.

dischargers disclose what is in their discharge and apply available technology to control pollution.<sup>6</sup> The law is based on a simple premise: that if a discharger can keep pollution out of our streams and rivers, it must. DWR, however, typically focuses on water quality standards, allowing pollution so long as the water quality standard is not violated. As a result, permits allow unnecessary pollution to be discharged. That is critical for our coastal systems, which sit at the end of rivers that receive waste from many wastewater treatment plants and industrial dischargers. Unless DWR begins requiring disclosure and use of available technology to control pollution into the rivers that run from the piedmont to the coast, our estuarine ecosystems will continue to deteriorate from the downstream consequences of impaired water quality.

### *Point Sources Discharging Through Groundwater*

Last year, the U.S Supreme Court clarified an additional tool that DEQ has for controlling indirect pollution of streams, rivers, and estuaries. In *County of Maui v. Hawaii Wildlife Fund*, the Court recognized that discharges of pollution from point sources to surface waters through groundwater are prohibited by the Clean Water Act.<sup>7</sup> DEQ, however, continues to issue “non-discharge” permits that allow the application of waste without assessing whether or not that waste contaminates groundwater that then pollutes surface water. There is evidence that land applied wastewater,<sup>8</sup> biosolids,<sup>9</sup> and animal waste<sup>10</sup> contribute to surface water pollution. DEQ must either permit these facilities based on their pollution of surface waters through groundwater or include monitoring requirements that ensure they do not.

### *Sediment and Erosion Control Permits*

Similarly, DEQ should emphasize the importance of complying with existing water quality standards when issuing sediment and erosion control permits. As recognized in the Draft Amendment, off-site sedimentation continues to be a significant problem nearly 50 years after the passage of North Carolina’s Sediment Pollution Control Act and the federal Clean Water Act.

One recent example of DEQ enforcement in western North Carolina represents authority that the agency must use more frequently to meet the legal mandate to protect

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<sup>6</sup> See 15A N.C. Admin. Code 2H.0105(a) (requiring application for pollutants to be discharged); 2H.105(j) (requiring disclosure of toxic pollutants); 2H.0118 (requiring effluents and limits required by Clean Water Act); 02B.0406(b)(3) (requiring case-by-case technology-based limits).

<sup>7</sup> 140 S.Ct. 1462 (Apr. 23, 2020).

<sup>8</sup> See N.C. Division of Water Resources, *Chowan River Basin Water Resources Plan* at Ch. 7, p. 6 (2021) (recommending increased monitoring to “provide for more accurate assessment of surface water impairments resulting from groundwater discharges in the Chowan River basin and enable the state to make sound permitting judgments.”), available at <https://deq.nc.gov/about/divisions/water-resources/water-planning/basin-planning/water-resource-plans/chowan/chowan>.

<sup>9</sup> See Showers, W. et al., *Evaluation and Remediation of Nitrate Flux from Biosolid Application Fields to Surface Waters in the Neuse River Basin*, North Carolina’s Section 319 NPS Program: Final Report for EW07015 (Feb. 15, 2007).

<sup>10</sup> See U.S. Geological Survey, *Surface-Water Quality in Agricultural Watersheds of the North Carolina Coastal Plain Associated with Concentrated Animal Feeding Operations*, Scientific Investigations Report 2015-5058 (2015).

existing uses in our coastal waters. In Surry County, DWR issued a notice of violation for uncontrolled sediment pollution into a trout stream, specifically citing the “negative impacts to aquatic biology.”<sup>11</sup> In addition, the agency cited impacts to wetlands from “sediment runoff and accumulation.”<sup>12</sup> DEQ should clarify during the permitting process that sedimentation of wetlands, creeks, rivers, and estuaries will be treated not only as violations of sediment and erosion control requirements, but also as daily violations of aquatic life water quality standards, and that liability for such violations could be penalized on a daily basis under state or federal law until the sedimentation is remedied.

### *Municipal Separate Storm Sewer Systems Permits*

DEQ must also fully implement its authority to control stormwater from municipal separate storm sewer systems (MS4s)—both for municipalities and the N.C. Department of Transportation. Most of our coastal rivers have municipalities with MS4 permits in their watershed and all have N.C. DOT infrastructure subject to that agency’s MS4 permit. These permits present a significant opportunity to meaningfully address stormwater that degrades water quality across the state. According to the most recent assessment posted on DEQ’s website, of the 46 MS4s analyzed in November 2020, only 5 were in compliance and 36 had received a notice of violation.<sup>13</sup> The clearest demonstration of the stormwater program’s shortcomings, however, is the growing extent of impaired waters. Shellfish closures are steadily growing. For example, shellfish closures in the Newport River have steadily increased over the last several years. If effectively implemented, the MS4 permitting program could be a valuable tool for improving coastal water quality.

## **II. The current water infrastructure system does not meet the state’s needs.**

We agree that fixing the water infrastructure system is critical to protecting our coastal ecosystems. The Draft Amendment correctly recognizes the challenges caused by inflow and infiltration as well as climate change; however, it underestimates the degree of change that must take place to address those problems.

As recognized in the amendment, the existing system sets as a goal that utilities will function as “self-sufficient business enterprises.”<sup>14</sup> That is not feasible for many, perhaps most, utilities. Maintaining and upgrading water infrastructure systems is expensive. As the Draft Amendment recognizes, the state needs to invest approximately \$1 billion each year.<sup>15</sup>

According to the Environmental Finance Center at the University of North Carolina, a cost recovery ratio of 1.2 “allows utilities to account for day-to-day operations and

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<sup>11</sup> Letter from J. Graznak, DWR, to M. Bottomley, Bottomley Evergreens & Farm, Re: NOV-2021-SS-0007 at 4 (June 30, 2021).

<sup>12</sup> *Id.*

<sup>13</sup> N.C. Department of Environmental Quality, *NPDES MS4 Permitting Program Update* (Nov. 2020), available at [https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Stormwater/MS4\\_Documents/PRESENTATION-MS4-Program-Update-20201102.pdf](https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Stormwater/MS4_Documents/PRESENTATION-MS4-Program-Update-20201102.pdf)

<sup>14</sup> Draft Amendment at 153, 154.

<sup>15</sup> *See id.* at 152 (citing need for \$17 billion in investment over 20-year period).

maintenance expenses, as well as for future capital costs.”<sup>16</sup> In 2021, only 19 percent of utilities evaluated by the Environmental Finance Center had a cost recovery ratio of 1.2 or greater.<sup>17</sup> Many of the utilities with low cost recovery ratios serve less than 10,000 customers and have little potential to fund multi-million infrastructure upgrades.<sup>18</sup>

In addition to being inadequate, the revolving loan funds often exclude small communities and communities of color. A recent analysis of drinking water state revolving funds found that only 7.1 percent of eligible utilities received assistance.<sup>19</sup> The study found that smaller communities were less likely to receive funding, perhaps due to “limited capacity to apply for assistance or take on debt.”<sup>20</sup> The authors also determined that “communities with larger white populations are slightly more likely to receive . . . assistance.”<sup>21</sup>

By proposing a dedicated state funding source, the Draft Amendment course corrects—recognizing that water is a shared resource and requires a shared commitment. The health of rivers and estuaries that belong to all North Carolinians and are held in public trust by the State should not depend on the successful operation of hundreds of underfunded, wholly independent utilities.

Funding alone cannot repair our infrastructure system. We suggest that the CHPP also recommend:

- **Regional Planning.** Careful planning is essential to wise investment. The CHPP should recommend that the legislature create a uniform process to guide regional water planning.
- **Incentives for Regionalization.** Small utilities cannot sustainably build, maintain, and operate water infrastructure of the future without building an integrated network. The CHPP should encourage the legislature to provide incentives for creation of efficient, consolidated utilities that expand water access.
- **Consolidation of Failing Systems.** North Carolina is caught in a cycle of rescuing “distressed” utilities; an intentional, programmatic consolidation effort is essential to ensuring long-term water quality improvements.
- **Customer Assistance Programs.** Even with more efficient, state-supported infrastructure, some customers will not be able to afford their water and sewer bills. Providing customer assistance options can decrease revenue losses from utilities while ensuring access to clean water for all North Carolinians.

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<sup>16</sup> UNC School of Government-Environmental Finance Center, et al., *2021 North Carolina Water and Wastewater Rates Report* at 12, available at [https://efc.sog.unc.edu/wp-content/uploads/sites/1172/2020/04/NC\\_WaterWastewaterRatesReport\\_2021.pdf](https://efc.sog.unc.edu/wp-content/uploads/sites/1172/2020/04/NC_WaterWastewaterRatesReport_2021.pdf).

<sup>17</sup> *Id.*

<sup>18</sup> *Id.*

<sup>19</sup> Environmental Policy Innovation Center, *Drinking Water Equity: Analysis and Recommendations for the Allocation State Revolving Funds* at 3, available at <https://www.policyinnovation.org/publications/drinking-water-equity>.

<sup>20</sup> *Id.* at 16.

<sup>21</sup> *Id.* at 17.

### III. The Draft Amendment should consider additional issues.

#### A. Climate change requires updating design storms.

We appreciate the Draft Amendment's inclusion of a discussion about climate change, which is an important and necessary backdrop for all sections of the CHPP. With regard to the Draft Amendment's focus on water quality concerns, climate change, will likely cause the coastal plain to experience more frequent and more intense storms.<sup>22</sup> In turn, the Draft Amendment should recommend that DEQ update its design storm values to reflect these changes.

As the Draft Amendment recognizes, "it is likely that the frequency of severe thunderstorms and the annual total precipitation in NC will increase," and "[i]t is very likely that extreme precipitation frequency and intensity in NC will increase due to increases in atmospheric water vapor content."<sup>23</sup> According to the 2020 North Carolina Climate Science Report, while annual rainfall averages have not changed across the state, North Carolina has already experienced an increase in the number of extreme rain events seen each year across its regions.<sup>24</sup> As the atmosphere warms, the amount of water vapor the air can hold increases, creating conditions for storms to release more rainfall. 2015-2018 was one of the wettest periods in the record (since 1895) across the state. Even under a climate scenario with slightly reduced emissions, the report states it is virtually certain (99%-100% chance) that the number of extreme rain events will increase across the state.<sup>25</sup>

Those higher volume storms are likely to result in increased loading of nitrogen, phosphorus, and other pollutants from agricultural and urban environments. To deal with the increased storm intensity, the state must update 10- and 25-year design storm values used to calculate necessary stormwater control measures. As DEMLR has recognized, "the historical data no longer accurately reflects the size of storm events going forward."<sup>26</sup> DEQ should update 10- and 25-year design storm values to reflect future storm events as accurately as possible.

#### B. Habitat impacts from bottom-disturbing activities.

The CHPP should provide a clearer path forward to identifying the most harmful effects of bottom disturbing equipment and activities on estuarine habitats. As the Draft Amendment recognizes, "[b]ottom disturbing gears can potentially affect primary productivity through the connection of bottom and water column processes."<sup>27</sup> It states that "[e]xcessive suspended sediments from bottom disturbing fishing gear and propeller wash

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<sup>22</sup> Draft Amendment at 34.

<sup>23</sup> Draft Amendment at 30.

<sup>24</sup> A day with rainfall totaling 3 inches or more qualifies as an extreme rain event in this report. North Carolina Institute for Climate Science, *North Carolina Climate Science Report* at 6 (Sept. 202), available at [https://ncics.org/wpcontent/uploads/2020/10/NC\\_Climate\\_Science\\_Report\\_Full\\_Report\\_Final\\_revised\\_September2020.pdf](https://ncics.org/wpcontent/uploads/2020/10/NC_Climate_Science_Report_Full_Report_Final_revised_September2020.pdf).

<sup>25</sup> N.C. Climate Science Report at 21.

<sup>26</sup> N.C. Department of Environmental Quality, Flooding Guidance, <https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-rules/stormwater-program/flooding-guidance>.

<sup>27</sup> Draft Amendment at 67.

can bury SAV and reduce water clarity, resulting in decreased SAV growth, productivity, and survival.”<sup>28</sup>

We support the Draft Amendment’s recommendation that “[f]ishing gears, practices, and areas should be evaluated regularly to ensure there are no additional impacts to SAV.”<sup>29</sup> We recommend that the CHPP propose research into the effects of bottom-disturbing gear and activities identified in the Draft Amendment and methods to reduce harmful effects, if those effects are documented.

C. North Carolina wetland rules.

The Environmental Management Commission has released for public comment revisions to state wetland rules to provide a permitting system for wetlands that were excluded from federal jurisdiction under the U.S. Environmental Protection Agency and Army Corps of Engineers’ 2020 “Navigable Waters Protection Rule.”<sup>30</sup> Because of their critical role in protecting coastal water quality, the CHPP should support the proposed wetland rules.

**IV. Conclusion.**

The challenges facing our coastal ecosystems are significant. Climate change, poor water quality, and development pressure would, independently, make protecting our coastal resources difficult. North Carolina must face them in combination. We appreciate the Steering Committee’s efforts to summarize those challenges in the Draft Amendment and believe that the recommendations presented will advance coastal habitat protection in the state. We recommend a greater focus on DEQ’s existing authority and the need for protective discharge and stormwater permits in addition to increased enforcement. The CHPP should also recommend more sweeping changes to our state’s water infrastructure system—changes that allow for equitable distribution of infrastructure funding, more efficient provision of drinking and wastewater services, and less water pollution from failing or overrun systems.

Thank you for considering these comments. If you have any questions, please contact me at

Sincerely,



Geoffrey R. Gisler  
Senior Attorney

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<sup>28</sup> *Id.* at 67.

<sup>29</sup> Draft Amendment at 67.

<sup>30</sup> See N.C. Department of Environmental Quality, 401 Program: Public Notice for Public Comment Period for Permanent Rules 15A NCAC 02H .1301 (Revision) and 15A NCAC 02H .1400 (.1401 through .1405), available at <https://deq.nc.gov/news/events/401-program-public-notice-public-comment-period-permanent-rules-15a-ncac-02h-1301>.

Dear Jimmy Johnson,

I am writing in support of the 2021 Coastal Habitat Protection Plan Amendment. I have been involved with North Carolina's management of fisheries and environmental resources for over forty years. I was involved in drafting legislation authorizing the CHPP in the Fisheries Reform Act (FRA) and worked intensively on the first edition of the CHPP in the late 1990's. The CHPP was meant to be the cornerstone of the FRA for protection of critical fish habitat and the water quality in those habitats.

Having a career in the Division of Marine Fisheries, serving on the Marine Fisheries Commission, and university instructor on coastal issues and as an active community member, I can speak directly to the importance of protecting our natural coastal resources for our enjoyment and for future generations. Numerous restrictions have been implemented on fish harvest as part of the FRA the last 25 years to attempt to keep our fish stock and fisheries sustainable. Yet, landings from our commercial fishermen have declined to some of the lowest levels since the 1950's. Our fishing communities have noted the changing nature of our fisheries, have felt pressure from numerous sides for additional restrictions, and as a result our state is seeing declines in younger people entering commercial fishing and declines in the number of people commercial fishing. Local, sustainable seafood is an important economic driver for the coast, and it's important to our state's culture and heritage. Our spawning and nursery habitats are integral to both commercial and recreational fisheries, and it is clear that water quality is of the utmost importance to providing healthy critical fish habitats.

In addition to fisheries, water quality is critical for our tourism industry. Tourism is the lifeblood of many of our coastal economies, and yet we continue to see water quality declines. Scientific experts note that eutrophication problems are increasing, with toxic algal blooms occurring in many coastal waters. Albemarle Sound and the Chowan River have experienced intense blooms in recent years; these areas once served as critical habitat for river herring. The river herring fishery was once one of our most important fisheries; harvest was prohibited in the early 2000's, yet the population has not recovered. Striped bass in the area are now considered overfished even though significant harvest restrictions have been in place since the 1990's to keep the stock healthy. Science has shown these species are highly dependent on adequate critical fish habitat and good water quality during spawning and for their nursery areas. The need to address water quality is urgent and only growing.

I applaud the CHPP for addressing the issue of water quality. It is also encouraging to see the CHPP recommend forming public/private partnerships to develop watershed management plans. I recommend that DEQ go one step further, and expand the scope of the public/private partnership. As a member of this community for forty years, I know that working with community members and stakeholders is the key to building support and seeing results. This partnership should help to plan and implement more than watershed management plans. The partnership should help to seek additional sources of funding that might not be available to DEQ to implement water quality actions, such as those recommended by the stakeholder workgroup in Appendix A. It is my experience, that such partnerships facilitate development of meaningful actions that have strong likelihood of producing results in natural resource issues that are in the public domain.

The CHPP has taken on a herculean task, but one that is necessary. With buy-in from stakeholders, the CHPP will be much more likely to overcome obstacles and implement actions with broad support. I look forward to seeing the CHPP put into action.

Sincerely,

Jess H. Hawkins III

Hi,

My name is Mandy Uticone. I am an oyster farmer in Sneads Ferry, North Carolina. I am writing this letter in regards to the Coastal Habitat Protection Plan, and the meeting discussing this and water quality concerns in North Carolina.

I have been oyster farming for 6 years, 2 years ago I decided to start my own farm after working on farms and enjoying it. I have always valued the environment and marine life teaching kids for 15 years- water quality was always one of my favorite topics to teach about because I do believe it is very important, but there are definite concerns with water quality in NC.

With so much development, and increasing population in NC along the coast, I do worry and have seen changes in water quality. Stormwater runoff after a lot of rain and hurricanes has always been an issue, but with increased development I have seen an increase in closures after heavy rainfall. I worry about this because being an oyster farmer when we get closed after heavy rains it puts a lot of pressure and stress on farmers that do this for a living. Last year in November we were closed for one of the busiest times of the year for oysters, Thanksgiving. Financially that puts a strain on a lot of us, but it is also concerning for the future of the industry. I've always been a big advocate for clean waterways, and I got into oyster farming because I believe it is one of the most sustainable ways to farm. Oysters are such good filters, and with increasing water quality issues we need to get oyster shells back in the water to increase wild populations. We also need to continue educating people on the importance of oysters for clean water, and figure out ways to keep our waterways clean so we can provide safe seafood to our local restaurants and consumers.

When we close down for a week or two at a time, I worry I am going to lose my restaurant accounts to areas that are a little closer to the ocean, that may flush out quicker. I feel I shouldn't have to worry about these things if we had healthy clean waterways. Reducing runoff with increased wetlands to act as a sponge, and increasing natural oyster reefs to help clean the water, and watershed planning in areas with a lot of development could be very beneficial. I know many of these things are being worked on, I am grateful that people recognize this, but I am also concerned for some oyster lease locations that struggle with being closed several times of the year for extended amounts of time because of water quality. I truly enjoy my job and being able to support the local economy with fresh seafood, I would love to continue this in the future, and hope we take the right actions to keep our waterways clean.

Thank you for your time,  
Mandy Uticone  
Carolina Beach Oyster Co.

## Comments for the Coastal Habitat Protection Plan 2021

From: Cynthia M. Holda

**October 19, 2021**

My Comments:

To: Coastal Habitat Protection Plan 2021  
Amendment Comments  
P.O. Box 769  
Morehead City, NC 28557

As a native North Carolinian, and having spent a career in various locations through-out the country with the National Park Service, upon retiring and returning to my home state, it became acutely apparent to me how precious and vitally important our coastal natural resources are, NOT ONLY to North Carolina, but to our nation as a whole, for a variety of reasons. For a healthy, thriving, booming economy in the Great North State and for the very quality of our lives, protection of and ensuring that our coastal waters and the good health of the ecosystems, where we live, work and play, are critical to our citizens and to our healthy nation.

My father (Mann) worked as a commercial fisherman in his early days to supplement his income and feed his growing family. My maternal grandfather (Perry), uncle (Perry) and other relatives owned and operated charter boats, guided for duck hunters in the early days, served as US Coast Guardsmen (Harris). My parents also owned and operated many businesses associated with the growing tourist industry in Dare County from the 1940s to early 1990s. My families' lives have been tied to the healthy ecosystems of the state of North Carolina for five generations. Fishing was critical to every aspect of this way of life and an important daily topic at the dinner table.

After retiring in 2015, and to educate myself further, I joined an organization, the North Carolina Coastal Federation, whose primary mission is to help ensure that we leave healthy coastlines for generations to come. I have learned a great deal about the complexity of my

beautiful homeland marshes, shorelines and the bodies of water surrounding these dynamic barrier islands that form a protective buffer to the mainland for over 300 miles along the North Carolina coast and provide habitat for healthy fish and shellfish species that begin their lives in these waters.

For brevity sake, I will list (with brief summary) the comments and points I would like to make in your CHHP plan but first and foremost I would like to say “Thank You” for the opportunity to comment. In the future, please make this “standard procedure” that the taxpaying permanent residents and “native sons and daughters” of this wonderful state are given the opportunity to read and educate ourselves as to how state managers plan a strategy to manage our state resources. Please allow our voices and opinions to be heard through a public comment process when making decisions on how the natural resources of this state are managed within the confines of the most current and “peer-reviewed science available.”

#### Additional Comments:

- 1) North Carolina Watersheds, where so many rivers drain from the mountains, the coastal plains and join the Atlantic Ocean waters in our coastal regions, do NOT recognize state boundaries. Does the CHPP address multiple state impacts to the watersheds that drain into the Atlantic Ocean? Or from one state’s watershed to another? Is there a designated committee to work across state lines with Virginia and South Carolina to ensure the watersheds of North Carolina are not adversely impacted by pollution from neighboring states? And that we North Carolinians are ensuring that **OUR** watersheds are not adversely impacting **THEIR** watersheds?
- 2) State managers would be wise to fund regional conservation partnerships programs and efforts to collaborate on successful completion of watershed projects such as the Lake Mattamuskeet Watershed Restoration Plan. Fund and develop strategies to tackle plans to resolve issues for coastal environments, to ensure healthy habitats for the fish populations, shellfish, crustaceans and aquatic mammals that live in those habitats and that **WE** feed upon, commercially harvest and sell for the benefit of the Great North State’s economy. The good work of the Lake Mattamuskeet Watershed Restoration Plan could be a role model for a variety of other planning issues in our coastal towns and communities to ensure success.
- 3) North Carolina State agencies of all divisions would be strengthened if they work alongside the public through public-private partnerships similar to the Oyster Steering Committee to move forward water quality goals and bring the perspectives and support of many different viewpoints and coastal communities. The Governor’s Beautification Highway efforts are another example. Citizens have a vested interest in keeping our state healthy and clean. Indeed, tourism and coastal fishing harvests **DEPEND** on it for a living.
- 4) Continue and adequately fund the NC Marine Debris Action Plan for removal of unsightly and pollution abandoned vessels, fishing gear, hurricane debris and waste. With human population increases, both resident North Carolinians and the influx of people moving to North Carolina, this ever- increasing and unsightly, dangerous form of waste and trash spoils the health of the coastal shorelines as well as the viewshed for residents and visitors alike. This overload of debris, trash, plastics, is not only unsightly but pollutes our waters with slowly leaking gasoline, oil and engine grease and untold forms of chemicals for decades. The “flushing” of coastal regions from hurricanes and high, lunar tides may be a healthy way to keep the coastal habitats thriving but the leaching of chemicals for household waste and construction debris in the aftermath of hurricanes needs to be addressed in some plan to prevent further contamination of our coastal waters for future generations.
- 5) Sponsor and fund education platforms for the citizens of this State so we can become a model State for the Nation when it comes to **PREVENTING** some of these

negatives impacts of human disturbance and usage. Conservation and recycling can be accomplished, useful, and even profitable with education and entrepreneur forward thinking.

6) Support and partner (cost-share) with organizations that are building living shorelines along our coastal communities for two all-important reasons: erosion control and to improve eco-friendly wetland habitat for sealife and oysters. Support funding and education for marine contractors and realty agencies who have a vested interest in a healthy coastline.

7) Support efforts to continue the Oyster Blueprint program (2012-2025) to continue to make NC Coastal areas a productive and pristine model for the world. Clean up of watersheds draining into our coastal waters and clean-up of abandoned debris/household debris from hurricanes/industrial pollutants from companies “upstream,” unhealthy and excess waste and fertilizers from commercial farming and hog and poultry production “upstream”.....all need to be closely monitored and regulated NOW to ensure the waste/excess does not flow downstream to pollute our coastal waters if we are ever to be successful in launching a world reknown Oyster Blueprint. Algae blooms are increasingly becoming a problem with warming climate change issues. We need to get a handle on these pollutants NOW to stop them from flowing into our environments.

8) October 11-15<sup>th</sup> is NC Oyster Trail week. Our coastal economies are seeing the benefits of promoting the tourism industry to enjoy and expand the trail. There are education opportunities associated with this endeavor for our visitors as well as the promotion of recycling oyster shells to rebuild more oyster sills and beds in the North Carolina oyster sanctuaries.

9) Support the COAST Anti-drilling Act. Drilling for oil offshore of our coastlines HAS ALWAYS HAD INHERIT DANGERS OF OIL SPILLS THAT FOUL OUR SHORELINES AND RUIN OUR ECONOMIES. JUST SAY NO TO OFFSHORE DRILLING.

To: NC Department of Environmental Quality  
Re: Comments in regards to the Coastal Habitat Protection Plan  
Date: October 18, 2020

As the former mayor of the Town of Wrightsville Beach and as a resident of the town for over 40 years I have first-hand knowledge of the importance of protecting our coastal environment. I have read the draft CHPP and it does an excellent job of identifying coastal issues and offering solutions for improvement, thus I am totally supportive of the CHPP.

There is no doubt that our state's coastal waters are in decline. The CHPP offers, on paper, a "long-term strategy to improve coastal fisheries through habitat protection and enhancement efforts." It provides concrete strategies to protect and improve our coastal environment. Yet, as great as the plan is on paper, the plan will only be successful if it is properly implemented. I have two suggestions that will I feel will increase the likelihood of the plan's success.

First, it is crucial that our state legislators provide the needed funding to ensure environmental compliance. Without appropriate funding for enforcement the plan will like so many other plans, result in minimal progress, sitting on the shelf collecting dust.

Second, it is critical that a variety of stakeholders are involved, creating a public-private partnership in order to ensure the plan's success. With robust funding and public buy-in the plan will be able to meet its goals of coastal habitat protection and enhancement.

Thanks for your consideration and I greatly appreciate the opportunity to comment on the CHPP,

David Cignotti

Mr. Jimmy Johnson  
North Carolina Department of Environmental Quality  
217 W Jones St  
Raleigh, NC 27603

Dear Jimmy Johnson,

I am a pastor and community leader in New Bern, NC. In the last decade, my community has seen impacts of climate-driven extreme weather. As a faith leader, I see firsthand the effects that climate disasters have on the physical, mental, and spiritual health of my community. With the 2021 Coastal Habitat Protection Plan, the Department of Environmental Quality and Coastal Resources Commission has the opportunity to make recommendations that will bring life, health, and wellbeing to God's people and God's planet.

For me, coastal resilience, restoration, and protection is a racial justice issue. As the pastor of a predominantly Black community, I see how disasters affect us first and hardest, and how we are often the last to receive the resources and support to recover. The CHPP's recommendation to establish stronger public-private partnerships is key to addressing the racial discrepancies of coastal resilience. By bringing folks from my community to a shared table, we can work collaboratively with local and state agencies to develop resilience strategies that are just, equitable, and sustainable.

The very fact that God chose to create this beautiful coastal creation means that the people and creatures that live there are important to God, and they should be important to us. If we don't take action to protect this creation, it could vanish before our eyes. That's why the CHPP recommendations on protecting and restoring natural habitats are indispensable. These recommendations would increase climate resilience through the restoration and protection of wetlands and living shorelines, yielding benefits for God's people and God's creation.

Sincerely,

Rev. Tangye Middleton  
Pastor, You Matter 2 God Church  
New Bern, NC

## **Healthy fisheries need healthy habitats**

We know we need clean water to survive, but it's just as important for our coastal fish habitats to have clean water for their productivity and health as well. These habitats not only need clean water, but they need water characteristics that they are adapted to, like proper light clarity and the proper mix of fresh and salt waters.

## **North Carolina's water quality is declining**

Unfortunately, North Carolina's water quality is in decline, and it's impacting our habitats. [Algae blooms are increasing](#). Some types of seagrasses, known as submerged aquatic vegetation, [are in decline](#). Fish kills were [recently reported in Pamlico Sound](#). Shellfish closures are increasing in our estuaries. Learn more about the issues facing our estuaries how the CHPP addresses them [here](#) **Healthy fisheries need healthy habitats**

We know we need clean water to survive, but it's just as important for our coastal fish habitats to have clean water for their productivity and health as well. These habitats not only need clean water, but they need water characteristics that they are adapted to, like proper light clarity and the proper mix of fresh and salt waters.

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Connie Raper

Restoration Systems, LLC  
1101 Haynes St. Suite 211  
Raleigh, North Carolina  
Ph: (919) 755-9490  
Fx: (919) 755-9492



Dear Jimmy Johnson,

I am writing to convey the support of Restoration Systems for the 2021 Coastal Habitat Protection Plan update and stakeholder workgroup appendix. Restoration Systems leads the environmental restoration and mitigation banking in the region and has more than 90 mitigation banks and restoration sites in nine states. As an organization committed to projects that promote ecosystem restoration, we are supportive of state efforts to mitigate the impacts of development on ecologically sensitive areas. We also recognize the benefits of an adaptive, multi-disciplinary approach to habitat protection/restoration.

I participated in the stakeholder workgroup convened by the Pew Charitable Trusts and the North Carolina Coastal Federation in the summer of 2021. The workgroup was a successful example of how to engage and work with a diverse set of stakeholders, many of whom have different goals and perspectives, but who share the same desire to live, work and play in a healthy coastal environment. The recommendations of the work group will increase the opportunities for people from a variety of backgrounds to support the goals of the CHPP in a timely and coordinated manner.

As a participant on the workgroup, I support the stakeholder recommendations and urge DEQ to adopt these recommendations in addition to the CHPP recommendations. The formation of a public-private partnership with oversight of the stakeholder recommendations will add significant momentum to the CHPP recommendations, and as they say, it takes a village.

To that end, we appreciate the work you all do, the natural resources our state provides, and the opportunity to comment. We look forward to contributing to the protection of our coastal resources.

Sincerely,

Barrett Jenkins  
Restoration Systems, LLC

I along with a lot of other recreational fisherman noticed the continually poor fishing and species diversity. I have been fishing in bardens inlet and had trawlers steer so close to me, I had to reel in my line to avoid losing them. They are rude and discourteous. I see the slicks of dead fish behind their boats. After they go through an area, you can't even catch a shark using a bloody menhaden. They have destroyed the inshore fishing in NC, and ultimately will cut their own throats. I sold my boat last year because it's no longer worth it. There are no fish to catch. NC had got to do something because what you are doing now isn't working.

Rob Hebert

This state has been Third World when it comes to managing and protecting our coastal fisheries and the habitat essential to fishery viability. In my 74 years of living in Carteret County I have seen a decline in virtually all species of fin fish and shellfish. It's way past time to get these trawlers and shellfish dredges out of our inshore waters. I hate to see the federal government get involved in anything but if the state continues to shirk it's responsibilities, maybe the feds should intervene.

Mick Brown

nutrient sources and control can not be monitored by once a month sampling in the chowan river basin with sample locations in the middle of the river. Sampling locations need to be located on the source feeder streams and sampling needs to be on a frequent basis. Both point and non point sources of nutrients need to be determined so they can be mitigated. These nutrients are creating a breeding ground for cyanobacteria blooms and the toxins created by such organisms. These toxins can work their way up the food chain.

Stephen Karl

I support the positive ideas in the 2021 CHPP Amendment. In addition, I support following the advice of the stakeholder workgroup on establishing a private/public partnership to increase stakeholder involvement in CHPP development, implementation, funding and decision-maker support.

Joanne McGrath

get the commercial fishermen out of our sounds

[j.lyndon](mailto:j.lyndon)

Please adapt to the CHPP techniques they encompass the correct practice and procedures. This is important, thank you for listening and complying. Regards, Catherine Whitney

- 1) Why is gill netting still allowed in this state's estuaries?
- 2) Is any agency watching our inshore waters at night to gather real statistical data on unreported catches and illegal fishing activity.

We talk about protecting and improving these habitats, but are allowing uncontrolled destruction of the fish that need them to survive and reproduce.

I reside near a creek that is part of the New Topsail Creek system in Hampstead. The creek/marsh wraps around a portion of my community of Olde Point. This year, I observed unattended gill nets in the channels, and as recently as this month (October '21), have seen late-night gigging from boats in the same waters.

What good does it do to protect and improve fish habitats, while the species that need them are being overfished, or killed as bycatch?

Ken Rice  
Hampstead, NC

Dear Jimmy Johnson,

My name is Sara Sutherland and I am an environmental economist at Duke University. I recently co-authored a report for the Albemarle-Pamlico National Estuary Program to evaluate the economic impact of submerged aquatic vegetation (SAV) to the state of North Carolina, and wish to submit a public comment in support of the Coastal Habitat Protection Plan's recommendations to protect and restore submerged aquatic vegetation.

Our research indicated that SAV has a significant economic impact on coastal communities through a number of avenues. SAV is a critical reproductive and nursery habitat for important recreational and commercial fisheries, including blue crab, red drum and spotted sea trout. The loss of SAV to these habitats would result in less abundance of these fisheries, resulting in decreased landings for commercial fisheries and a potential loss of revenue from recreational fisheries as recreational anglers seek better opportunities elsewhere. Total losses from the recreational fisheries for red drum and spotted sea trout over the next decade range from \$0.4 to \$3.3 million across the alternative SAV loss scenarios, while losses to the blue crab fishery range from \$0.7 to \$6.7 million.

We also found that SAV loss has an economic impact on local governments through declining property values. Our research suggests that local governments stand to lose from decreased property tax revenues, and a decline in ecosystem service provided by SAV including improved water quality and erosion control. SAV enhances property values through ecosystem services like improved water quality, increased fish and waterfowl populations, and reduced coastal erosion. We estimate coastal properties could lose \$2 to \$23 million in value over the next decade depending on the SAV loss scenario. Lower property values translates to lower property tax revenues for local governments. We conservatively estimate a decline in property tax revenues ranging from \$0.5 million to \$5 million over the next decade under different SAV loss scenarios.

SAV provides its most significant value in ecosystem services by mitigating the damages due climate change through carbon storage and sequestration. Carbon sequestration is the process of capturing and storing carbon from the atmosphere. This is particularly valuable because carbon dioxide is one of the main drivers of climate change, and SAV provides a natural vessel to sequester and store this carbon. Our recent study estimates the value of carbon stored by SAV to range from \$163 and \$419 million. We estimate reductions in SAV coverage between 5% and 50% over the next decade will result in lost carbon sequestration value ranging from \$5.5 to \$55 million over a ten year time period.

Overall, we conservatively estimated the value of SAV and found that a 0.5 percent annual decline in SAV acreage over the next decade will generate total economic losses of \$8.6 million in 2019 dollars. If SAV acreage loss were to accelerate to 5 percent per year, they estimate total economic losses of \$88.7 million.

As an environmental economist and researcher, I support the state's efforts to protect and restore SAV through water quality provisions.

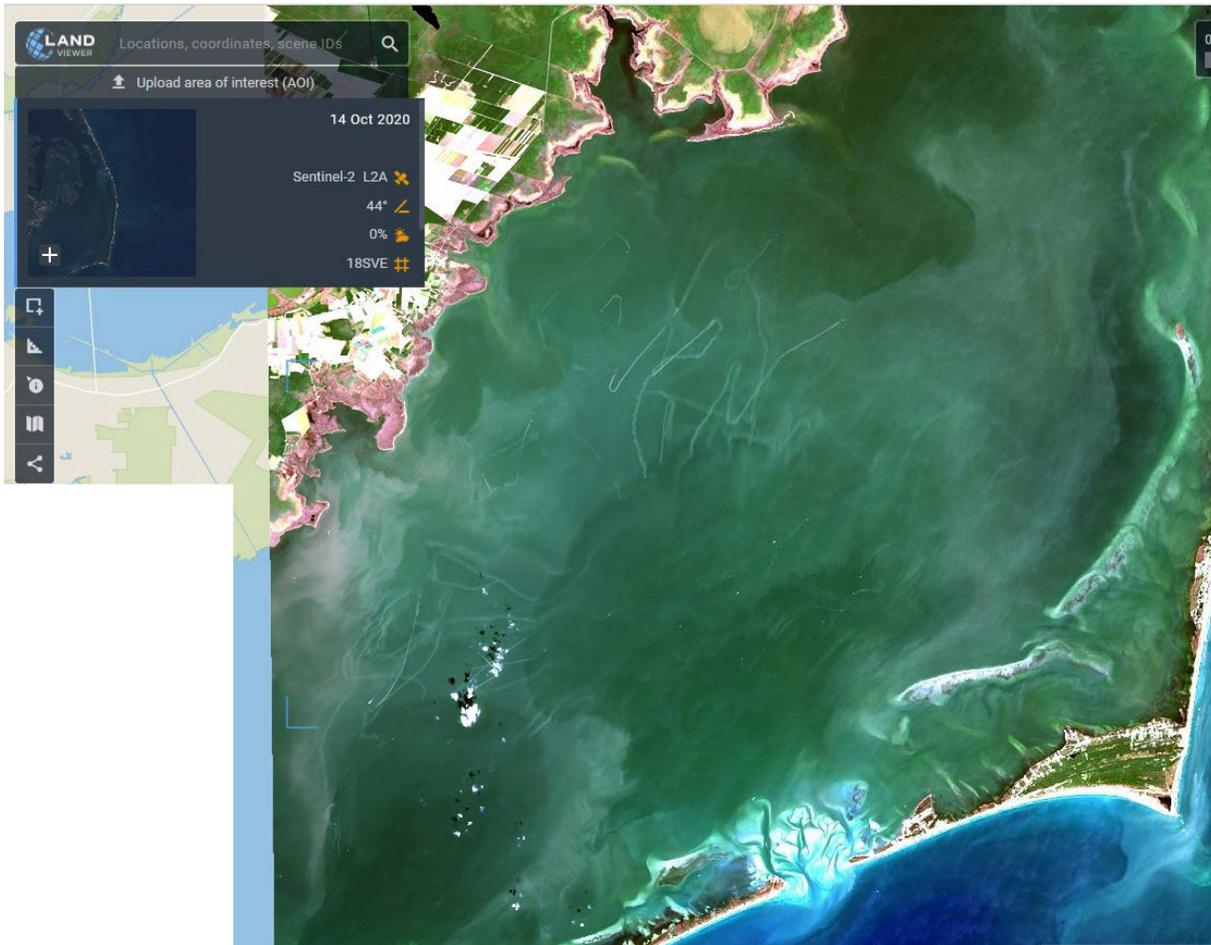
Sincerely,

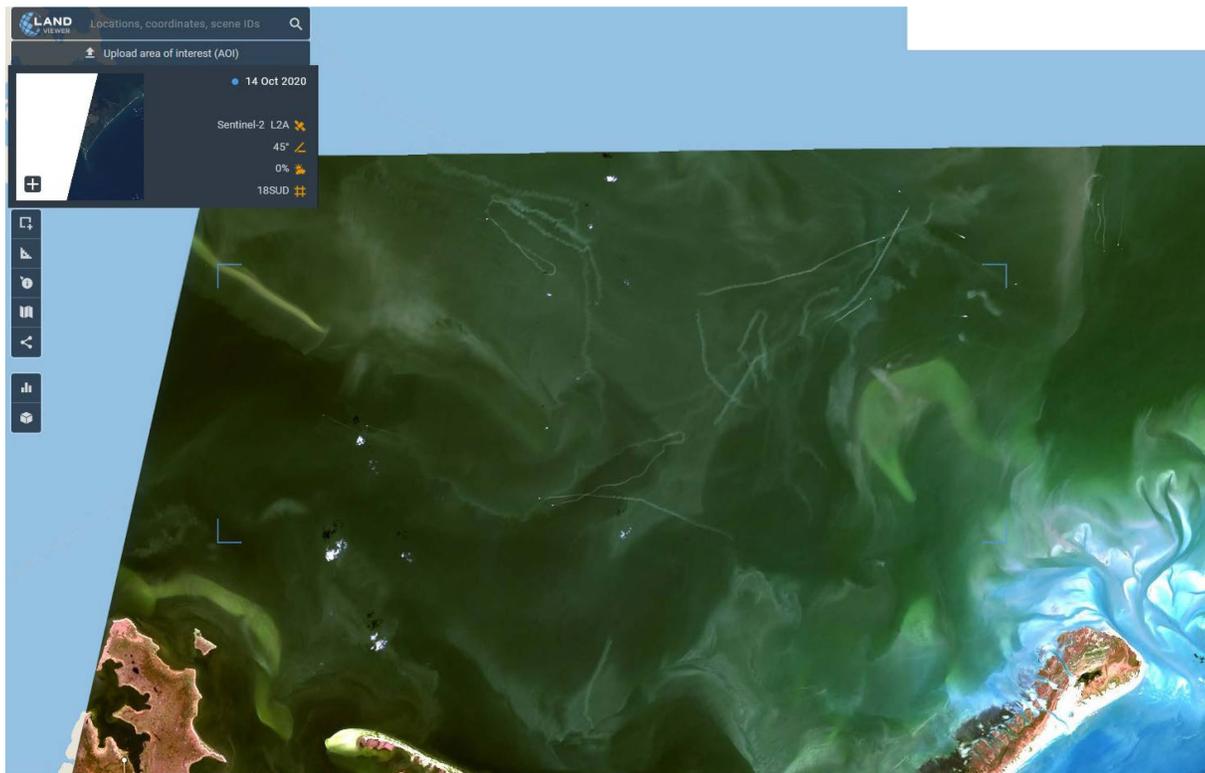
A handwritten signature in black ink, appearing to read 'Sara Sutherland', with a stylized, cursive script.

Sara Sutherland, Ph.D.

Please include my following comments, with images, as official public comment on the Draft CHPP 2021 Amendment.

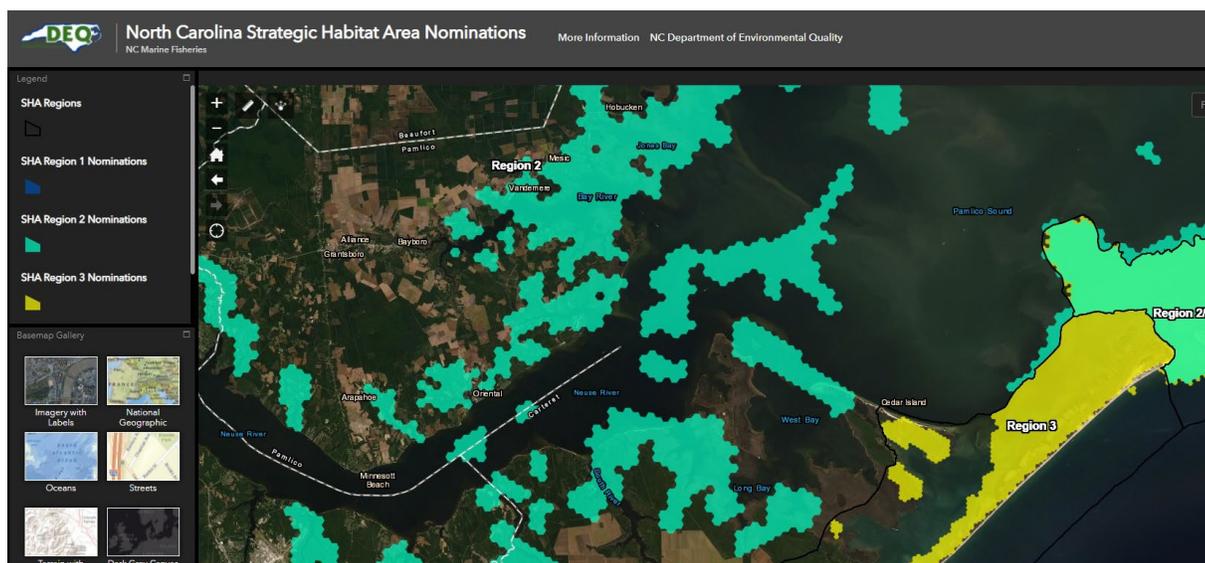
During the Tuesday, August 3rd, WebEx CHPP Steering Committee Meeting that I joined, I was disappointed that I never once heard the issue of highly destructive bottom disturbing fishing gears mentioned during the three-hour discussion. Shrimp and crab trawling, oyster dredging, clam kicking and hydraulic dredging are certainly issues that the CHPP Steering Committee should be bringing to the table in good-faith for honest discussions. The satellite images below from Oct 14, 2020 clearly show how extensive otter trawling in the Pamlico Sound is re-suspending sediment well in excess of the Secchi disk water clarity standard proposed during the August 3rd steering Committee meeting.



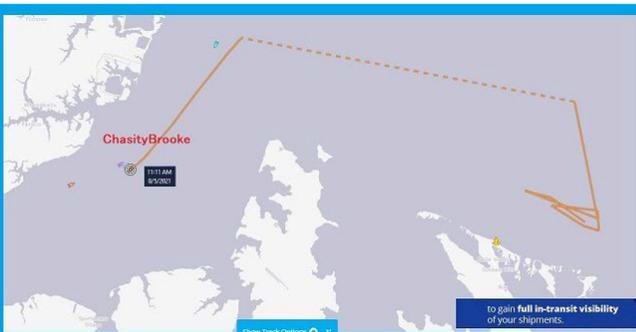
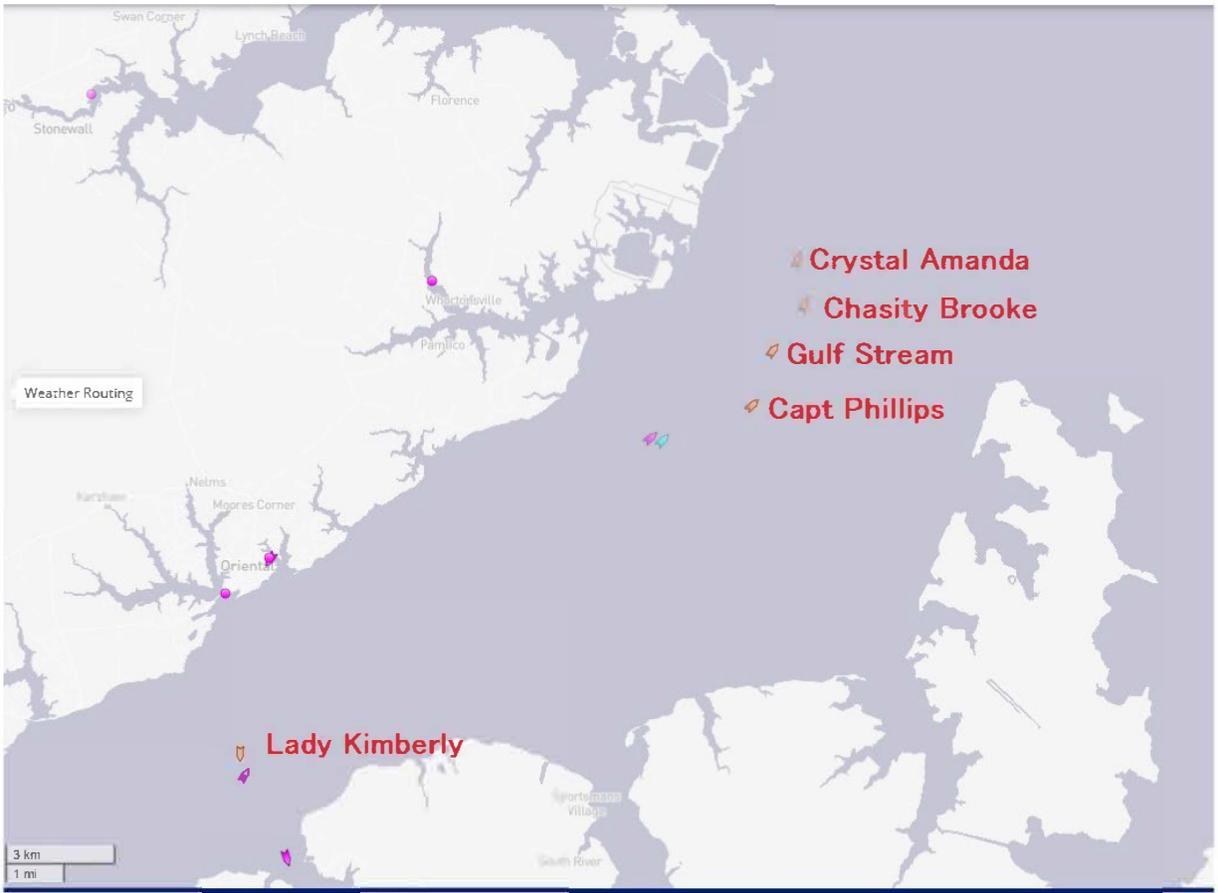


### Neuse River SHAs

Below are the last CHPP nominations for Region 2. To my knowledge, none of significance were approved. Please note the nominations in the area of Adams Creek.



Excessive rain fell in Eastern North Carolina in August which will move shrimp in search of higher salinity waters. On August 5th, using AIS tracking, I watched four large industrial trawlers move from the Pamlico Sound to the Neuse River in the heart of the areas nominated for SHA protection. There was a fifth trawler, the Lady Kimberly, that had been locked on a trawl pattern at the mouth of Adams Creek, and in the creek, for three weeks.





These are large industrial ocean-going vessels capable of pulling 220-feet of headrope, four-barrel rigs, pulling very large otter doors.



<b>Licensee Name</b>	
R.A.C.Seafood LLC 8260 Turner Rd Henrico, VA 23231	
<b>Ship Data</b>	
License Type	Regular
Official Ship #	681868
Ship Name	Crystal Amanda
Gross Tonnage	99 tons
Length	24 meters



This effort is unsustainable from habitat and bycatch perspectives. CHPPs have purposefully failed to identify and delineate SHAs in the Pamlico Sound, and adjacent rivers and creeks, that serve as secondary nursery areas for many economically important finfish and forage species under 15A NCAC 03N.0101.

And, it is not just finfish. Blue crabs are both overfished with overfishing occurring. In Kevin Brown's 2009 shrimp trawl bycatch characterization study of the Pamlico Sound, blue crab was the sixth most often landed species, by weight, behind Atlantic croaker, spot, weakfish, mantis shrimp and Atlantic brief squid. Yet, in the 2018 Blue Crab stock assessment, the division failed to address the impact of shrimp trawl bycatch on the blue crab stock- deja vu our depleted weakfish stock.

From page 42 of the blue crab stock assessment-

*This assessment did not include discards due to a lack of data. However, discards of blue crabs in North Carolina waters could be a significant source of mortality, especially in the commercial gill net fishery. This assessment, without discards considered, could be overestimating population size. Thus, it is important to establish data collection programs for fishery discards to help improve future stock assessments.*

It is well past time for the CHPP process to actively engage and address bottom disturbing gears and nursery area protection versus giving it lip-service in plan.

Sincerely,  
Rick Sasser

Thank you for the opportunity to comment on the CHPP. First, I would like to commend all the staff and their collaborators for the work that went into finalizing this draft plan. I have had the opportunity to observe and interact with the CHPP process since its inception and this plan, by far, has more focus and directed attention to issues demanding necessary and immediate actions more than ever demonstrated in previous CHPP plans. The previous cycle for the CHPP was extremely disappointing and I am pleased to see the significant improvements.

I wish I had the time to provide you with a comprehensive set of comments on the entire document, but that wasn't possible in the time allotted for public comments which conflicted with a busy schedule during the past month. I am encouraged to see that within the SAV Chapter and other narrative content related to SAV considerable evidence of my own contributions, in some cases, verbatim. I am, however, disappointed that my own engagement was very limited during the revision process. Soon, I do plan on providing you with a wider scope of comments on the entire document which you can consider as you see fit to adapt the plan. In the meantime, I am going to provide you with some detailed comments on the subject I am most familiar with, Submerged Aquatic Vegetation, Chapter 4. I also included a marked up copy of the draft PDF with some additional comments for your consideration.

I applaud the CHPP for the effort to address climate change and resiliency in Chapter 3. However, I strongly urge NCDEQ to consider more attention to the link between rising sea level, salt marsh stability and seagrasses regarding sediment storage and barrier island stability. The coupling of seagrasses and marshes and how sediments in our coastal waterbodies are distributed and stored is a critical element in back-barrier island dynamics and likely to be a major factor in affecting long-term resilience of our developed and undeveloped barrier islands in the face of sea level rise and increased storminess. Which, in turn, will have considerable relevance for understanding the future bio-physical conditions in our estuaries and the fish and wildlife that depend on them.

I agree that you can distinguish SAV habitat types into two salinity zones and it is very useful as a tool to spatially articulate our SAV communities for monitoring and assessment purposes. However, I would also submit that it is important to also distinguish the potential complexity and importance of the transition zones between high and low salinity. These can be very dynamic, intra- and interannually, and are very likely to become more important SAV zones in a future scenario of climate change. We are seeing this first-hand in the dynamics of the Chesapeake Bay SAV communities where once stable *Zostera marina* communities stressed by a combination high water temperatures and marginal water quality are being substituted with more ephemeral *Ruppia maritima* communities which may not provide the same scope and level of ecological services and resilience. I strongly recommend that you incorporate more thought and attention to higher frequency and greater spatial intensity of salinity monitoring in our coastal ecosystems and link these data to in-water monitoring of SAV distribution and abundance. High resolution monitoring and modelling of salinity should be a priority component of any plan that seeks to better understand how resilient SAV communities are now and what they could be in the future.

I have vigorously campaigned for decades that we should be managing potential SAV habitat and not just the habitat we identify in a snapshot. Tier 1 level maps of presence and absence of SAV habitat serve as useful tools for articulating the space where SAV occur at one point in time, but we also know from experience that this space fluctuates and moves around at intra-, interannual, and decadal scales. So, I am very pleased to see that the CHPP has adopted this concept in their delineation of known SAV

historic extent. Table 4.5 and the associated map figures codify a commitment on the part of NCDEQ to use this information to better understand the status of SAV in NC and to establish goals for conservation and restoration. I do think that the authors of this document need to define more clearly what they mean by “interim goal” as stated on page A-90. Is this goal temporary? Does this goal exceed reasonable expectations? What are the conditions with respect to whether this goal is met or not? Is there a performance standard related to time? Frankly, I don’t understand what an interim goal is.

The resilience discussion with respect to SAV on page A-83 is incomplete because it doesn’t incorporate the tropical species, Halodule, and how it may respond as a resilience factor in lieu of climate change. Halodule could very well replace Zostera in a warming scenario. The discussion in this paragraph is oversimplified and to some extent could be misleading.

The SAV research and monitoring discussion on page A-91 seems to ignore a plan already developed and approved by APNEP. Why not cite the existing collaboration?

I agree that the process by which the Chesapeake and Tampa Bay programs went about to address their SAV declines serve as good process models for NC to consider in developing a program approach. However, I would strongly recommend that DEQ take a closer critical look at the current conditions of SAV in both these waterbodies before declaring a direct relationship between process and desired outcomes. Are the most current SAV conditions in both waterbody case studies an acceptable outcome? I suggest you take a deeper dive into the current conditions in the Chesapeake and Tampa Bay.

For example, I draw your attention to some recent media reports.

Seagrass beds in Chesapeake Bay, a vital habitat for blue crabs and other species, declined by 38 percent in 2019, a trend researchers link to higher than usual river flows that year.

The federally funded Chesapeake Bay Program released findings from its annual survey July 8, reporting a mixed bag of results from across the bay region and its rivers. The overall 38 percent estimated decline is down from a 108,078-acre tally in 2018. Seagrass In Tampa Bay Declined 13 Percent In Recent Years

WUSF Public Media - WUSF 89.7 | By Cathy Carter

Published May 17, 2021 at 5:00 AM EDT

Tampa Bay Estuary Program

Between late 2019 and early 2020, Tampa Bay saw an estimated decline of 5,411 acres of seagrass, according to the Southwest Florida Water Management District.

Scientists say pollution from runoff and wastewater leaks adds nutrients to the bay, fueling algae growth that hurts seagrass beds.

Seagrasses provide shelter and food to a diverse community of animals, from small invertebrates to large fish, crabs, turtles, marine mammals and birds.

Provisional results released earlier this month by the Southwest Florida Water Management District (SWFWMD) show that Tampa Bay now harbors 35,240 acres of seagrass. That's a vast improvement from the 1990's when a plan was established to boost recovery of this vital part of the ecosystem.

But for the first time since 2012, the amount of seagrass in Tampa Bay fell short of the goal established decades ago.

WUSF's Cathy Carter spoke with Gary Raulerson, an ecologist with the Tampa Bay Estuary Program about the results of the latest seagrass survey.

The results are in from the latest seagrass survey and I understand Tampa Bay lost about 13% of its seagrass in the past few years.

That's correct, Cathy. Our partners at the Southwest Florida Water Management District do aerial reconnaissance of the seagrasses from Tampa Bay down to Charlotte Harbor every other year, and from the photo reconnaissance that they did late 2019 and early 2020, it did indicate that we experienced a significant loss of over 5,000 acres of sea grasses primarily in old Tampa Bay, which is that upper left fork of Tampa Bay proper.

You mentioned the years in which the survey was done but because of recent events, we should emphasize that this study was done before the emergency discharges from the Piney Point phosphate plant in Manatee County?

Yes, the aerial photography data that we have received was flown in late 2019, early 2020. It has no relationship with the recent releases from the Piney Point incident.

But would you say the Red Tide events of the past few years had an impact on seagrass?

We believe that's part of the issue, especially in the lower portions of the Bay. Red Tide did not get into say old Tampa Bay and in Hillsborough Bay quite significantly, but it definitely has an impact. Microscopic organisms can basically cloud the water and reduce the clarity that the seagrasses need to grow.

I draw your attention to these media reports because both examples have scientific documentation behind them in monitoring and assessment reports that you can read and review and are available on-line in both programs. They are very current. I would be extremely cautious drawing a direct line between a process to establish conservation and restoration goals and the existing outcomes. The outcomes appear to be a moving target which in both cases seem to be going in the wrong direction right now.

Related to this uncertainty regarding long-term outcomes, I agree that water quality targets should be an essential component of an SAV conservation and restoration plan and I applaud DEQ for incorporating this as a priority issue in the CHPP, as well as recognizing the need for enhanced and more comprehensive SAV and water quality monitoring programs needed to achieve the goals. However, I want to point out a need for reconsideration in setting the water quality goals as fixed targets; specifically, the two water clarity targets, 22% and 1.7 m for high salinity and 13% and 1.5 m for low salinity. Granted, these values are derived from several empirical studies using a range of observations, correspondence analysis, and experimental manipulations. However, there are also studies which demonstrate the SAV species in our system have a range of light requirements which can vary according to fluctuations in temperature and sediment composition. We also have species with complex life histories that also have different light requirements. I am concerned that these targets may constitute the "minimum requirements" for SAV under the past and perhaps, present conditions, and if the interim

goal is to expand (restore) SAV to historic extent or even something in between, then these targets may not be adequate. I would also submit that if we experience rising sea levels (deeper water column = less light) and storminess (increase turbidity + increased nutrient loads = more light attenuation) these fixed targets may not compensate for changing conditions. I recommend that you incorporate language in this section of the CHPP that recognizes a need to possibly adjust these targets as learned by future experience in the monitoring programs to ensure progress toward the interim SAV restoration and conservation goals. The targets need to be flexible (adaptive) and in favor of protecting the resource should conditions change in the future.

Preliminary information generated by the bio-optical model indicates that turbidity is a primary driver in light attenuation in high salinity SAV habitat, suggesting that we need to pay close attention to this water quality variable and recognize that there is very little allowance for chlorophyll to increase; therefore, management programs that reduce nutrient inputs into high salinity or salinity transition zones need to be prioritized. I recommend that the CHPP give this more detailed attention.

I endorse most of the recommended Actions in Chapter 4; however, I don't understand recommendation 4.5 under Mapping and Monitoring. This is already implemented under the umbrella of an approved APNEP plan. Why not specify enhancement of the existing program through more collaborative staffing and funding, rather than claim to be developing and implementing a full-scale program that already exists for a large portion of the high salinity SAV resource. This is what is really needed. I also see a significant need on the part of DEQ to become more involved and invested in the low salinity SAV monitoring and assessment program to supplement APNEP's ongoing activities. While I recognize that APNEP is housed in DEQ, it is my experience that there could be a much clearer understanding of APEPs leading role in the SAV monitoring and assessment program. APNEP, mostly working with volunteer experts, has demonstrated their capabilities and it is now time for DEQ to enhance these capabilities through commitments to funding and dedicated, competent staff and infrastructure support.

It would be helpful to all parties interested in recommendations related to Potential Rulemaking for water quality standards (4.7, 4.8) if the CHPP could explain how this process would be initiated and executed. Recommendations 4.7 and 4.8 are very important and quite ambitious and I am very encouraged by them but given where we are with the NCDP SAC process, it seems a bit premature. I can only hope that this plan and these recommendations accelerate a process that has stagnated for several months; 2022 is right around the corner.

J Kenworthy

# NORTH CAROLINA COASTAL HABITAT PROTECTION PLAN

## 2021 AMENDMENT

*ENHANCING COASTAL FISHERIES THROUGH HABITAT  
PROTECTION AND RESTORATION*



## Executive Summary

With over 2.9 million acres of estuarine and coastal waters and 12,000 miles of estuarine shoreline, NC's diverse coastal habitats provide the foundation for a healthy and sustainable seafood industry, a sound coastal economy, and resilient coastal communities. The need for coastwide habitat plans originated in the 1990s due to increasing concerns by resource managers, fishermen, and the public over fish populations, declining coastal habitats, and deteriorating water quality. The development of Coastal Habitat Protection Plans (CHPPs) and subsequent five-year reviews were required in the Fisheries Reform Act of 1997 (FRA; G.S. 143B-279.8). The legislative goal of the CHPP is "*...the long-term enhancement of coastal fisheries associated with coastal habitats.*" The law required the Department of Environmental and Natural Resources, now the Department of Environmental Quality (DEQ) to develop the plan, and for the Environmental Management (EMC), Coastal Resources (CRC), and Marine Fisheries (MFC) commissions to adopt and implement the plan, thus requiring a coordinated management approach.

There are increasing concerns about declining water quality and the influence that it is having on structured habitat such as submerged aquatic vegetation (SAV), shell bottom, and wetlands. Consequently, most of the selected priority issues in the 2021 CHPP Amendment include elements of improving water quality. The recommended actions are expected to not only improve these habitats but also strengthen coastal community and ecosystem resilience.

### **Protection and Restoration of Submerged Aquatic Vegetation (SAV) through Water Quality Improvements**

Submerged aquatic vegetation is critical for healthy fisheries, such as shrimp, blue crab, red drum, and flounder and provides valuable ecosystem functions. While NC has one of the largest SAV habitats on the east coast, water quality impairment coupled with the expectation of sea level rise (SLR) and increasing water temperatures associated with climate change will expose all SAV in NC to multiple stressors that can limit their growth, reproduction, and distribution. A comparison of low salinity SAV extent in 2014-2017 time-period to what occurred historically (1981-2015), indicated a 33 percent decline in Albemarle Sound, and Pamlico and Neuse rivers. The high salinity SAV extent also showed declines between 2006-2007 and 2013 in all waters, with Bogue Sound, the most developed watershed examined, having the largest decline of 10 percent. The major cause of SAV loss has been due to water quality degradation from nutrients and sediments, which reduce light penetration needed for grass survival. A series of steps to improve water clarity are required. An optical model is under development to determine the chlorophyll *a*, nutrients, and other parameter targets needed to achieve adequate light penetration. Once these targets are determined, new standards can be implemented and nutrient loading by source and location determined to provide direction on where to focus water quality improvements. The increasing use of nature-based best management practices (BMPs) can be a key tool to improving water quality. Monitoring of SAV and water quality is required to assess progress. The recommended actions for this issue include these steps and others needed to successfully improve water quality to levels that sustain SAV.

### **Protection and Restoration of Wetlands through Nature-based Solutions**

Wetlands are a critical nursery habitat for numerous species that occur throughout the estuarine system. They also provide valuable ecosystem services, such as water quality filtration and erosion and flood control. Losses to forested wetlands (i.e. bottomland swamp) continue to occur from land clearing and hydrologic alteration. Both forested wetlands and salt marsh are at increasing risk due to SLR,

saltwater intrusion, and erosion. Ghost forests and shrinking marsh islands are increasingly evident. One means of offsetting these losses while increasing coastal community resilience is using nature-based solutions, such as living shorelines, nature-based stormwater BMPs, hydrologic restoration, and wetland preservation.

Safeguarding wetlands, while allowing for sustainable development, depends on having comprehensive data on the distribution, characteristics, and condition of the different wetland types. Consequently, several actions to obtain updated wetland maps using new technology that can be faster and cheaper to coordinate mapping and monitoring among involved groups are included in this issue. The issue paper also describes different types of nature-based solutions which are a suite of strategies that use natural systems, mimic natural processes, or work in tandem with traditional approaches to address specific hazards. Communities across the state can incorporate nature-based solutions in local planning, zoning, regulations, and build projects to help reduce their exposure to flood and erosion impacts.

Recommended actions include planning and identifying uplands adjacent to marshes to conserve that will allow migration with SLR, collaborating with the Department of Defense to fulfill the Southeast US One Million Acres Salt Marsh Initiative, and determining if living shoreline projects can qualify for salt marsh or nutrient mitigation credits. Recommendations also include increasing use of BMPs to reduce runoff from roads, development, and agriculture while creating wetlands and restoring hydrology. The CHPP also supports many of the recommendations in the NC Risk and Resiliency Plan, and the Action Plan for Nature-based Stormwater Strategies.

### **Environmental Rule Compliance and Enforcement to Protect Coastal Habitats**

There is strong support from the public to enforce existing rules to improve effectiveness in wetland and water quality protection. This issue paper examines current known compliance rates with rules under the Divisions of Water Resources (DWR) and Energy, Mineral, and Land Resources (DEMLR) related primarily to 404 wetlands and stormwater management. Periodic compliance inspections and possible enforcement action have been shown to be a successful at keeping potential violators to adhere to the applicable rules and laws. Recommended actions focus on obtaining a few additional positions on the coast to allow for compliance monitoring and to increase outreach to stakeholders and the public so they are more aware of authorized activities and therefore able to comply with permits and rules.

### **Wastewater Infrastructure Solutions for Water Quality Improvement**

There are many contributing sources of water quality degradation. Sanitary sewer overflows (SSOs) from wastewater collection systems are one pollutant source that contributes to water quality degradation and impacts coastal habitats. Failing and deteriorating wastewater infrastructure, often referred to as inflow and infiltration (I & I), is a primary cause of SSOs. Untreated or incompletely treated sewage entering estuaries after a SSO can increase bacteria, nutrient, and toxin levels, potentially resulting in shellfish closures, algal blooms, fish kills, and contaminated water and sediment that can impair aquatic life. Given the coastwide distribution of over 500 wastewater treatment plants (WWTP), documented prevalence of I & I issues, and the magnitude of SSOs, improvements to wastewater infrastructure are needed for long-term water quality management. The issue paper supports recommendations in the State Water Infrastructure Authority Report and includes recommendations to prioritize repairs and maintenance near sensitive estuarine resources, develop strategies to flood-proof wastewater infrastructure, and consider additional requirements for deemed permitted collection systems to better prevent SSOs.

### **Coastal Habitat Mapping and Monitoring to Assess Status and Trends**

Understanding the status and trends of NC's coastal habitats is needed to assess both the long-term

changes to the habitats and the causative effects. Comprehensive mapping and monitoring of all of NC's coastal habitats are necessary to determine the success of existing management and restoration efforts, and whether more action is needed. With adequate spatial coverage and resolution, larger changes in the system can be detected and further investigated in the future. The first step for coastal resource managers is to raise awareness of the problems caused by degradation and destruction of the natural environment and identify contributing factors. This is followed by the need for regular standardized monitoring and assessments of these habitats to quantify their extent and condition using habitat and ecosystem indicators. Mapping and monitoring recommendations were included in the SAV and wetlands issue papers. Other recommended actions include forming interagency workgroups by habitat type to establish indicators and monitoring protocol, to initiate necessary sampling, and summarize the information in an ecosystem status report.

### **Public Comment**

During a one-month comment period, DEQ received an unprecedented amount of public input through email and an online survey, as well as at five MFC Advisory Committee meetings. There was overwhelming support for the recommended actions in the plan that will address improving water quality and enhancing SAV and wetlands, which will increase coastal resilience through nature-based solutions. All five advisory committees voiced support for the CHPP document verbally and in motions that passed unanimously. The advisory committee members and the public discussed what they saw as contributing to degraded water quality. Causes ranged from rampant development, to lack of buffers around farmlands, large-scale logging of wetlands, atmospheric deposition of nitrogen originating from animal waste lagoons. It was noted that clean water is essential for sustaining shellfish mariculture, fisheries, tourism, and thus the coastal economy. The online survey results, consisting of 93 respondents, indicated strong support for the recommended actions in all the issue papers.

There was strong support for a public/private partnership at all of the meetings from the AC and the public. It was noted that adding a public/private partnership would be beneficial due to increased collaboration and resources to implement CHPP recommendations, and increased public awareness and support. The public and private partners would be able to advocate for action with the General Assembly and others and broaden funding opportunities for implementation.

The DEQ received two petitions in strong support of the CHPP amendment and implementation of the recommended actions. NC Audubon submitted 461 signatures, and NC Conservation Network had 796 signatures, from NC residents.

The Department also received 40 letters through email on the CHPP amendment. The majority of the letters were highly supportive of the recommended actions in the plan, while the others supported the CHPP intent but requested changes, or just focused on changes. The CHPP Steering Committee (CSC) reviewed all of the public comment received, and made some wording adjustments to several recommended actions.

### **Recommended Actions**

The implementation of recommended actions will begin to address concerns raised in these issue papers as well as the overarching goals of the CHPP. It will take collaboration with other agencies, scientists, conservation organizations, local government, and stakeholder support to implement these recommendations to protect and preserve the coastal habitats of NC while also increasing coastal ecosystem and community resilience.

Although new priority issues were selected for the 2021 CHPP Amendment, the 2016 issues remain a

## Coastal Habitat Protection Plan 2021 Amendment

continuing priority. The NC Oyster Blueprint, of which DEQ divisions participate, serves as a guide for shellfish management, both from fishery and habitat perspectives. The plan is a successful example of how public-private partnerships, as recommended by the CSC, can result in synergistic benefits.

### Recommended Actions

Table ES.1. Actions recommended by the Coastal Habitat Protection Plan (CHPP) 2021 Amendment. SAV = Protection and Restoration of Submerged Aquatic Vegetation (SAV) through Water Quality Improvements, WET = Protection and Restoration of Wetlands through Nature-based Solutions, Comp = Environmental Rule Compliance and Enforcement to Protect Coastal Habitats, WW = Wastewater Infrastructure Solutions for Water Quality Improvement, MM = Coastal Habitat Mapping and Monitoring to Assess Status and Trends, and SR = Stakeholder Report.

Issue paper	Rec. #	Recommended Action
SAV	4.1	By 2023, the NC Department of Environmental Quality (DEQ) will pursue recurring funding as well as from state, federal, and private sources that includes the adequate amount of staff to successfully evaluate and meet the submerged aquatic vegetation (SAV) acreage goals and implement all of the SAV recommended actions that contribute to meeting the goals.
SAV	4.2	By 2022, DEQ will commit to protecting and restoring SAV to reach an interim goal of 191,000 acres coastwide with specific targets by SAV waterbody regions (Table 4.5; Figures 4.1-4.9).
SAV	4.3	By 2022, DEQ will form an interagency workgroup with non-government organizations (NGOs), and local governments to inform and guide development of watershed restoration plans to protect, restore or replicate natural habitats (i.e., SAV, water quality, coastal habitats) and hydrology through natural and nature-based solutions.
SAV	4.4	By 2022, DEQ will form a workgroup with NC Division of Water Resources (DWR), NC Division of Energy, Mineral, and Land Resources (DEMLR), Division of Soil and Water Conservation, local governments, and other partners to increase best management practices (BMPs) to the extent possible related to water quality within the SAV waterbody regions consistent with current funding level and request increased state cost-share funding.
SAV	4.5	By 2023, DEQ will develop and implement a full-scale assessment program to conduct coastwide SAV mapping and monitoring at regular intervals ( $\leq 5$ years).
SAV	4.6	By 2023, DWR will evaluate and prioritize the incorporation of shallow water sites (< 1m mean lower low water (MLLW)) that currently or historically contain(ed) SAV into the statewide ambient monitoring system.
SAV	4.7	By 2022, the NC Environmental Management Commission (EMC) will receive guidance from the Nutrient Criteria Development Plan (NCDP) Scientific Advisory Council (SAC) on establishing a water quality standard for light penetration, with a target value of 22 percent to the deep edge (1.7 m) of SAV for all high salinity SAV waterbody regions, and a light penetration target of 13 percent to the deep edge (1.5 m) for all low SAV waterbody regions (Table 4.5; Figures 4.1-4.9).
SAV	4.8	By 2022, at the request of the EMC, the NCDP SAC will evaluate the chlorophyll <i>a</i> water quality standard and as needed, recommend it be revised by the EMC to ensure protection of SAV in high and low salinity waterbody regions, beginning with the Albemarle Sound and Chowan River, and continuing with other waterbodies that support SAV (Table 4.5; Figures 4.1-4.9).
SAV	4.9	By 2024, EMC will adopt scientifically defensible nitrogen and/or phosphorus criteria if recommended through the NCDP process, to help protect and restore ~12,900 acres of low salinity SAV habitat in the Albemarle Sound SAV waterbody region and continuing with other waterbodies that support SAV.
SAV	4.10	By 2025, DWR will determine with assistance from research academia, the loading and sources of nutrients and sediments, their quantitative linkages to chlorophyll <i>a</i> concentrations, and their effect on water quality and SAV.
SAV	4.11	By 2022, NC and DEQ, through the Secretary of Emergency Management, will request more accurate estuarine bathymetry data from the National Oceanic and Atmospheric Administration (NOAA).
SAV	4.12	By 2022, DWR will request the NC Policy Collaboratory to investigate the impacts of agricultural practices and land use change on water quality within SAV waterbody regions, to determine types and location of BMPs needed to effectively improve water quality.
SAV	4.13	By 2022, DEQ Office of Education and Public Affairs will work with local governments and NGOs to start the development of public education and stewardship programs with social media campaigns and citizen

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		science monitoring to increase public awareness of SAV's importance for fish habitat and other co-benefits, as well as instill public commitment to SAV conservation.
<b>Wet</b>	5.1	By 2023, DEQ will obtain state matching funds for the NOAA Coastal Change Analysis Program (C-CAP) to map NC's Coastal Plain at 1m resolution and additional funding to expand coastal wetland monitoring conducted by DWR and other state agencies.
<b>Wet</b>	5.2	By 2024, DEQ will pursue the use of emerging technologies such as data fusion or deep learning neural networks, that rely on a combination of satellite imagery, drone imagery, and field verification for coastal wetland mapping and change analyses.
<b>Wet</b>	5.3	By 2022, DEQ will form an interagency workgroup to develop a coastal wetland mapping and monitoring plan, including a minimum set of standardized metrics and a potential centralized location to store relevant reports and information.
<b>Wet</b>	5.4	By 2026, DEQ will determine the status and trends of coastal wetland acreage, condition, and function, based on the additional mapping and monitoring data obtained.
<b>Wet</b>	5.5	By 2022, DEQ will provide information to NC legislators regarding the need for increased appropriated funds for the three state conservation trust funds to increase conservation of critical wetland properties and critical corridors that will allow for future marsh migration.
<b>Wet</b>	5.6	By 2022, DEQ will actively participate in and support the development of a Southeast Regional Marsh Conservation Plan, which is a partnership with the Department of Defense along with federal, state, and private groups that have been initiated by the Southeast Partnership for Planning and Sustainability (SERPPAS).
<b>Wet</b>	5.7	By 2026, DEQ will work with researchers, federal and local governments and NGOs to facilitate marsh migration through the conservation of migration corridors, including participation in the Pew Charitable Trusts-SERPPAS Salt Marsh Initiative.
<b>Wet</b>	5.8	By 2022, DMF will determine potential mechanisms to prevent harvesting from living shorelines constructed with oysters.
<b>Wet</b>	5.9	By 2025, DEQ will determine if living shoreline projects can be built in a manner that qualifies for salt marsh or nutrient mitigation credits.
<b>Wet</b>	5.10	By 2025, DEMLR and other divisions should increase education, outreach, and training to consultants, local government, and landowners for nature-based stormwater and watershed management strategies.
<b>Wet</b>	5.11	By 2024, DEQ should partner with other organizations to facilitate coastwide completion or enhancement of coastal vulnerability assessment tools, such as living shoreline siting, and marsh migration and wetland restoration prioritization.
<b>Wet</b>	5.12	Determine optimal parameters for thin layer sediment deposition to ensure wetland success.
<b>Wet</b>	5.13	Assess trends in salt marsh elevation, inundation, and distribution to prioritize areas for wetland restoration.
<b>Wet</b>	5.14	Determine the impact of degrading plastics and marine debris on wetlands, sediment, and the benthos.
<b>Wet</b>	5.15	Research the nutrient (nitrogen, phosphorus) reduction benefits provided by living shorelines and use that information to provide incentives for living shoreline projects.
<b>Wet</b>	5.16	Study the effects of silvicultural timber harvesting in palustrine (bottomland swamp) forests on hydrology, water quality, and wetland condition; include assessment on the efficacy of forestry BMPs to minimize ecological impacts.
<b>Wet</b>	5.17	By 2022, DEQ should support efforts to incorporate coastal wetlands into NC's Greenhouse Gas (GHG) Inventory.
<b>Comp</b>	6.1	By 2023, through legislative appropriations or budget reallocations, DEQ will increase staffing in DWR and DEMLR by a minimum of two staff (one per office, per agency) in the Washington and Wilmington regional offices.
<b>Comp</b>	6.2	By 2023, DEQ will seek funding through grants or other sources to supplement state-appropriated compliance efforts.
<b>Comp</b>	6.3	By 2022, DWR and DEMLR should work with the NC Division of Environmental Assistance and Customer Service (DEACS) to establish a public portal on DEQ's website that provides information on compliance issues, allows the public to submit complaints, and potentially highlights a list of repeat violators.
<b>Comp</b>	6.4	By 2023, DWR, DEMLR, and DCM should develop and hold outreach workshops for NGOs, home owner associations (HOAs), and other interested public, on rules related to land disturbing activities that affect

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Issue paper	Rec. #	Recommended Action
		wetlands and water quality, and how to identify violations to improve the effectiveness of public complaints.
<b>Comp</b>	6.5	By 2022, DEMLR will initiate and continue outreach to stormwater permit holders on rules and required maintenance of stormwater control measures and structures.
<b>WW</b>	7.1	By 2024, DEQ will request that funding programs under the purview of the SWIA give additional priority for projects with a direct benefit to sensitive estuarine waters, including SA waters, fish nursery areas, and impaired waters, particularly those adversely impacting estuarine fish and their habitat.
<b>WW</b>	7.2	By 2025, DWR will develop additional incentives to encourage improved maintenance of the collection system (e.g., incentivize owners and operators of wastewater lines for both existing systems and potential new systems to adopt construction designs that minimize the potential for sewer spills over the long-term).
<b>WW</b>	7.3	By 2025, DCM and DWR will work with NC Office of Recovery and Resiliency (NCORR) and local governments in the coastal counties to develop strategies regarding flood-proofing wastewater infrastructure; siting new and relocating existing infrastructure away from sensitive estuarine waters and floodplains; upgrading sewer infrastructure; and develop strategic priorities for public and natural infrastructure improvements
<b>WW</b>	7.4	By 2023, DWR will evaluate modifications of EMC rules to require deemed permitted collection systems under select criteria (e.g., 100,000 or more GPD) to have a certified operator as an Operator in Responsible Charge (ORC). DWR shall provide an update on this evaluation effort to the Water Quality Committee in approximately one year.
<b>WW</b>	7.5	By 2023, DWR will investigate modification of EMC rules to require deemed permitted collection systems to be cleaned annually on a systematic basis (e.g., 3 to 5 years). The DWR shall provide an update on this evaluation effort to the Water Quality Committee in approximately one year.
<b>WW</b>	7.6	Prioritize research on alternative wastewater collection system designs that may be better suited for coastal conditions (i.e., alternative sewer systems, composting toilets).
<b>WW</b>	7.7	Evaluate the feasibility of re-designing and re-engineering existing systems that are inadequately protecting ground and surface water quality.
<b>MM</b>	8.1	By 2022, convene interagency workgroups of DEQ agency staff, academics, and subject matter experts by coastal habitat type (i.e., water column, shell bottom, SAV, wetlands, hard bottom, and soft bottom) to define indicator metrics and identify data gaps and monitoring needs for the ability to determine long-term status and trends of coastal habitats and the estuarine ecosystem.
<b>MM</b>	8.2	By 2026, develop a document determined by the workgroups to communicate the ecosystem conditions of NC to the public.
<b>MM</b>	8.3	By 2023, DWR will evaluate and prioritize estuarine ambient monitoring system sites to address gaps in spatial, habitat, or parameter coverage.
<b>MM</b>	8.4	By 2022, DWR will update standardized procedures for algal bloom investigations and evaluate the potential to cross-train other DEQ divisions to perform estuarine and marine investigations.
<b>MM</b>	8.5	By 2023, DMF will develop a monitoring strategy to determine how best to map natural hard bottom reefs in NC state waters and monitor the condition of both natural and artificial reefs.
<b>MM</b>	8.6	By 2023, DWR will examine the feasibility of expanding the benthic macroinvertebrate sampling to address spatial gaps in assessing the estuarine soft bottom benthic community condition.
<b>SR</b>	9.1	By 2022, DEQ will support the formation of a public/private partnership that will engage a diverse group of stakeholders to assist in developing, implementing, and securing decision-maker support and funding for measures in this 2021 CHPP Amendment that protect and restore water quality.

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## 1. INTRODUCTION

### 1.1 Purpose

North Carolina contains the largest estuarine system of any single Atlantic coast state, with numerous estuarine rivers, creeks, sounds, inlets, and ocean bays creating a diverse system of over 2.9 million acres and 12,000 miles of estuarine shoreline (Figures 1.1-1.2). Located at the convergence of the Mid-Atlantic and South Atlantic biogeographical provinces, NC supports a mix of northern and southern fish species. This combination of species richness, extensive coastal waters (estuarine and marine waters), and the diversity and abundance of coastal habitats makes NC’s coastal fisheries among the most productive in the US.

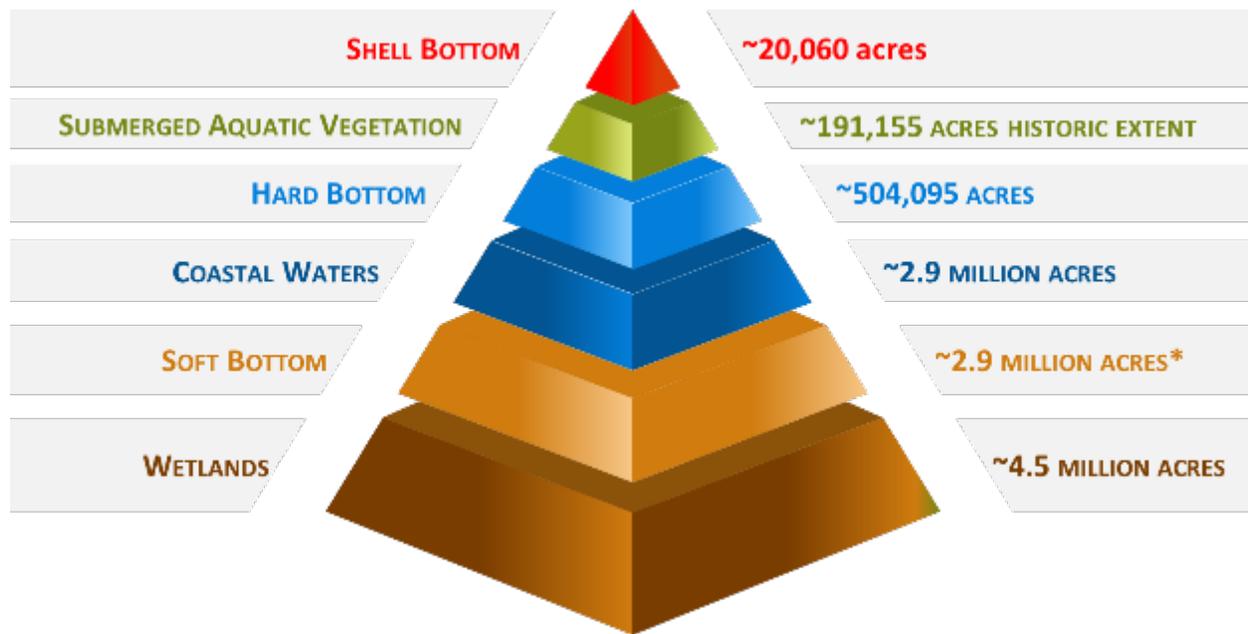


Figure 1.1. The coastal habitats of North Carolina are the foundation for healthy fisheries. \*Soft Bottom habitat is an over estimation due to overlapping regions of the data used for analysis.



Figure 1.2. North Carolina’s coastal habitats within the Coastal Habitat Protection Plan (CHPP) regions.

The need for a coastwide habitat plan(s) originated in the 1990s when fish populations, habitat, and water quality concerns were becoming increasingly more evident. Addressing habitat and water quality degradation was recognized by resource managers, fishermen, the public, and the legislature as a critical component for improving and sustaining fish stocks, as well as the coastal ecosystem. Developing Coastal Habitat Protection Plans (CHPPs) were required in the Fisheries Reform Act of 1997(FRA; G.S. 143B-279.8).

The legislative goal of the CHPP is “...the long-term enhancement of coastal fisheries associated with coastal habitats.” The law specifies that the CHPP identify threats and recommend management actions to protect and restore coastal habitats critical to NC’s coastal fishery resources. The plans must be adopted by the NC Coastal Resources (CRC), the NC Environmental Management (EMC), and the NC Marine Fisheries (MFC) commissions, to ensure consistency among commissions, as well as their supporting NC Department of Environmental Quality (DEQ) agencies. The FRA clearly required that recommendations of the management plans be implemented. The passage of the FRA and the initiation of the CHPP implementation process demonstrated the public’s desire and political will to better manage NC’s fisheries and coastal habitats.

### 1.2 Authority for Management and Protection of Public Trust Resources

The Public Trust Doctrine provides the overarching authority for the state to manage public trust resources. The doctrine states that “public trust lands, waters, and living resources in a state are held by the state in trust for the benefit of all the people, and establishes the right of the public to fully enjoy public trust lands, waters, and living resources for a wide variety of recognized public uses.” Public trust resources include the waters to the upstream extent of navigation, including navigation by small recreational boats, such as canoes or kayaks; submerged lands beneath the waters up to the normal high tide line (or normal water level in areas not subject to lunar tides); and the habitat and fisheries resources within those waters. Public trust rights include navigation, commerce, fishing, swimming, and hunting. State authority generally applies within the boundaries of NC, extending from internal creeks, rivers, and lakes downstream through coastal sounds, into the Atlantic Ocean for three nautical miles (nm) from the ocean shoreline. The DEQ and the NC Wildlife Resources Commission (WRC) have stewardship over NC’s public trust resources (G.S. 113-131) and G.S. 113-132 specifically gives MFC jurisdiction over the conservation of marine and estuarine resources. Authority is provided in G.S. 143B-279.8 for DEQ to develop CHPPs and requires the associated environmental commissions to implement recommendations from the plans.

While the MFC manages fishing practices in coastal waters through rules implemented by the NC Division of Marine Fisheries (DMF), several agencies manage activities affecting coastal habitats and fisheries resources. The EMC has authority over activities affecting water quality, such as point and nonpoint discharges, wastewater, alteration of wetlands, and stormwater. The EMC’s rules are implemented by different DEQ agencies, including the NC Division of Water Resources (DWR), the NC Division of Air Quality (DAQ), and the NC Division of Energy, Mineral, and Land Resources (DEMLR). The DEMLR administers rules adopted by multiple regulatory commissions, including the EMC, Sedimentation Control Commission (SCC), and the Mining and Energy Commission. The CRC enacts rules to manage development within and adjacent to public trust and estuarine waters, coastal marshes, and the ocean hazard area. The NC Division of Coastal Management (DCM) implements rules adopted by the CRC. The WRC, while not a participant in the CHPP process, has a direct role in the management of migratory coastal fisheries and habitats through the designation of Primary Nursery Areas (PNAs) and Anadromous Fish Spawning Areas (AFSAs) in inland waters, the review of development permits, monitoring and management of habitat, and the regulation of fishing in inland waters. There are many other state, federal, and interstate programs that directly or indirectly influence coastal fisheries resources and habitats in NC.

### 1.3 Coastal Habitat Protection Plan Process

The CHPP Steering Committee (CSC), which consists of two members from each environmental commission, recommends priority issues to address, provides policy oversight, reviews draft recommended actions, and serves as liaisons back to their respective regulatory commissions. They also meet to discuss cross-cutting habitat and water quality issues and solutions and receive updates on CHPP implementation progress. Increased communication across commissions benefits environmental management. The MFC, CRC, and EMC must review and approve the plans and adopted the first CHPP in 2004 with revisions in 2010 and 2016.

The CHPP is a DEQ document that requires all the DEQ divisions with authority over coastal habitat and water quality management to assist with drafting the plans. A CHPP Development Team, consisting of staff from the associated DEQ divisions is responsible for drafting the plans, participating at CSC meetings, and assisting with the implementation of recommended actions. The DEQ divisions that must participate are DMF, DCM, DWR, DEMLR, and the NC Division of Mitigation Services (DMS). Additionally,

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staff in the NC Forest Service and the Division of Soil and Water Conservation (DSWC), within the NC Department of Agriculture and Consumer Services (DA&CS) participate. Because the plans are developed with guidance from multiple agencies and commissions, recommended actions require broad support to be successful.

Similar to previous years, the CHPP includes four overarching goals for the protection of coastal habitats in NC (recommendations under these goals were reviewed and modified by the CSC):

1. Improve effectiveness of existing rules and programs protecting coastal habitats.
2. Identify and delineate strategic coastal habitats.
3. Enhance coastal habitat and protect it from physical impacts.
4. Enhance and protect water quality.

For the original CHPP and first update, recommendations were included in a single document, and bi-annual implementation plans were developed with specific actions to accomplish the plans recommendations. The CSC approved the implementation plans and met quarterly to discuss progress.

For the 2016 revision, the Plan was organized into two documents: the CHPP Source Document (ecosystem data) and the CHPP Summary Document, also referred to as the CHPPlet. The Source Document provides the science and data to support recommended actions and information on the ecological value, needs, and status of each coastal habitat and anthropogenic threats is summarized. The Source Document includes issue papers on selected priority issues from 2016 including restoring oyster reef habitat, encouraging use of living shorelines, reducing sedimentation impacts in estuarine creeks, and developing metrics on habitat trends and management effectiveness. The issue papers include specific recommended actions that replace the need for a separate implementation plan. The CHPPlet provides succinct information in a public-friendly format on past implementation progress, priority issues, and the recommended actions to be taken by the CRC, EMC, MFC, DEQ and its divisions.

To further streamline the CHPP process in 2021, rather than update the entire Source Document, the CSC decided to create an amendment to the 2016 CHPP Source Document and chose five priority issues to focus on (2021 CHPP Amendment). The literature in the Source Document continues to serve as supporting information for proposed coastal habitat protection and restoration efforts. Additional supportive science is included in each issue paper.

Although progress has been made to implement CHPP recommendations, water quality has generally shown a declining trend with concerns about degrading submerged aquatic vegetation (SAV), shell bottom, and wetlands. Many of the stressors to the structured habitats originate from declining water quality. Consequently, most of the selected priority issues in the 2021 CHPP Amendment includes elements of improving water quality and the recommendations will not only improve the coastal ecosystem, but strengthen community and ecosystem resilience.

The five priority issue papers in the 2021 CHPP Amendment include:

1. Submerged Aquatic Vegetation protection and restoration through water quality improvements
2. Wetland protection and restoration through Nature-based Solutions
3. Environmental rule compliance to protect coastal habitats
4. Wastewater infrastructure solutions for water quality improvement
5. Coastal habitat mapping and monitoring to assess status and trends

Although new priority issues were selected for the 2021 CHPP Amendment, the 2016 issues remain a continuing priority. Progress on oyster restoration will continue, and CHPP Team members will continue to participate on the Oyster Steering Committee (OSC) to ensure actions of the CHPP and NC Oyster Blueprint are implemented. The NC Coastal Federation (NCCF) serves as the lead organization for the

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OSC and NC Oyster Blueprint. The OSC, comprised of multiple state and federal organizations, nongovernmental organizations (NGOs), and researchers, work together to develop and implement recommendations for the NC Oyster Blueprint on five-year intervals. The OSC meets regularly to discuss progress on oyster restoration, which includes oyster enhancement, actions related to water quality, and living shorelines that can benefit oysters. Progress on living shorelines will continue through recommended actions in **Chapter 5 Wetland Protection and Restoration through Nature-based Solutions**, as well as the Living Shoreline Steering Committee and NC Oyster Blueprint. Degradation of water quality occurred over many years from multiple causes. Therefore, improving coastal habitats and water quality conditions will take time. Faced with continuing coastal development, the CHPP recommended actions are meant as a starting point for continuing strategic actions to restore NC's coastal habitats, and in doing so, increase coastal resiliency.

### **1.3.1. Coastal Habitat Status and Trends Summary**

To achieve the legislative goal of the CHPP, “*...the long-term enhancement of coastal fisheries associated with coastal habitats.*” the status and trends of the six coastal habitats must be monitored over time to assess quantifiable long-term changes. This information can then be used to educate the public on the condition of the coastal habitats, to inform protection and restoration decisions, and evaluate and adapt management actions and strategies. The following are general summaries of the status and trends of the six coastal habitats based on the best available data. For additional information, see **Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends**.

#### Water Column

The water column is the medium through which all aquatic habitats and the organisms that use them are connected, making it one of the most important habitats.<sup>1</sup> Water quality describes the condition of waters based on selected physical, chemical, and biological characteristics, usually with respect to its suitability for a particular purpose such as drinking, recreation, or supporting aquatic life. Fish species and other organisms, such as SAVs and oyster that also provide fish habitat, exhibit water quality threshold tolerances. Conditions of the water column that are outside the threshold tolerance are considered impaired, polluted, or otherwise not supporting aquatic life. Basic parameters of water impairment include: pH, temperature, dissolved oxygen (DO), turbidity, bacteria, and chlorophyll *a*. Additional parameters impacting water quality include nutrients, such as nitrogen and phosphorous. However, currently there are no nutrient standards used to assess for water quality impairment. Excessive nutrient-rich sediment from land-based activities can exacerbate eutrophication, decreasing DO and water clarity and increasing toxic contamination. Therefore, flow and movement of water play a vital role in distributing pollutants and degraded waters to other habitats and waterbodies.

An assessment of the Southeast Coastal Region (NC to FL) found less than 25 percent of the area in good condition based on the water quality index.<sup>2</sup> The assessment of water quality in NC, known as the Integrated Report (IR), indicates the general condition of NC's waters and identifies waters that are not meeting water quality standards where sufficient data exists.<sup>3</sup> The 2018 IR listed 15,889 acres (34 percent) and 482 miles (12 percent) of freshwater and 618,300 (20 percent) of saltwater in the CHPP regions as impaired. Across the NC coast, there are general trends of increasing nutrients entering the rivers and sounds. The four basins carrying the supplemental classification of Nutrient Sensitive Waters (NSW), the Chowan, Tar-Pamlico, Neuse, and New rivers saw improvements during the initial classification implementation, but continuing and emerging issues still need to be addressed. Overall, decreasing nutrients and other contaminants will improve water quality, and could decrease the amount of fish kills, algal blooms, recreational swimming advisories, and potentially increase the acres of open shellfish growing waters.

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### Shell Bottom

The eastern oyster (*Crassostrea virginica*) occupies a unique position in the estuaries of NC because it: 1) colonizes estuarine bottom creating a productive habitat that has ecosystem benefits, and 2) the animal itself is harvested as a food item which has economic benefits. Shell bottom in NC has seen dramatic changes since colonial times when oyster reefs were so extensive along the coast they were a hazard to navigation.<sup>4</sup> Due to the combined effects of habitat destruction, overfishing, disease, and deteriorated water quality, oyster populations have experienced tremendous declines world-wide, particularly within subtidal oyster reefs that occur along the Mid-Atlantic coastline of the United States.<sup>5, 6, 7, 8</sup> It has been estimated that 85 percent of oysters have been lost globally.<sup>9</sup>

Since the 2016 CHPP, mapping of shell bottom (12 ft depth) has been completed in all of NC's coastal waters. A total of 22,060 acres of subtidal and intertidal shellfish were mapped between 1990 and 2019. Most of NC's shell bottom resource can be found in the southern CHPP regions. The White Oak River basin (CHPP Region 3) is dominated by subtidal oysters while the Cape Fear River basin (CHPP Region 4) is dominated by intertidal oysters. In recent years, mariculture (marine aquaculture) landings from private/leased bottom have increased substantially, surpassing wild harvest landings for the first time in 2017 and continuing through 2020. However, even with several DMF monitoring programs, there are insufficient data to conduct a traditional stock assessment for the oysters in NC.<sup>10</sup> Therefore, population size and rate of removals from the wild oyster population are not known.

To combat the generally declining trends of shellfish, shellfish habitat restoration efforts have been occurring throughout NC's estuarine waterbodies for over half a century. The primary purpose of DMF's Cultch Planting Program is to enhance the oyster fishery by planting oyster shell and other materials for natural recruitment which provides temporary habitat value as well as fishery benefits. The goal of the Oyster Sanctuary Program is to create protected oyster habitat that provides broodstock to enhance larval output for wild oyster reefs, leading to a naturally sustainable oyster population. Both programs are housed in DMF's Habitat and Enhancement (HE) Section. These efforts also increase the co-benefits of the ecosystem services oysters provide, including water filtration and shoreline protection against waves and storms. As of 2020, DMF constructed 15 oyster sanctuaries in the Pamlico Sound, totaling 396 permitted acres, and annually deploys several thousand bushels of cultch material strategically throughout the estuaries of NC. Since standard record keeping began in 1980, DMF's HE Section has planted over 12 million bushels of cultch material.

### Submerged Aquatic Vegetation

Currently, NC is steward to one of the most productive and biodiverse SAV resources on the Atlantic seaboard.<sup>1, 11, 12, 13, 14, 15</sup> There are two distinctive groups of SAV ecosystems in NC distributed according to estuarine salinity. One group, referred to as low salinity SAV or underwater grasses, thrives in fresh and low salinity riverine waters ( $\leq 10$  parts per thousand; ppt). The second group, referred to high salinity SAV or seagrass, occurs in moderate to high ( $>10$  ppt) salinity estuarine waters of the bays, sounds, and tidal creeks. Collectively, they are referred to as SAV. When SAV beds are subjected to anthropogenic impacts (i.e., physical damage, water quality degradation), large-scale losses may occur. Natural stressors, such as storm damage and climate change can also impact SAV, with the latter an increasing concern for SAV survival due to predicted temperature, salinity, and wave energy changes. Globally, SAV abundance is declining at rates similar to the rainforest and coral reefs.<sup>16, 17, 18</sup>

In NC, various mapping and monitoring projects have been conducted by universities and state and federal agencies since the 1980s. Each of these mapping events produced shape files of SAV presence, that when compiled together, make up the historically known presence and suitable habitat of SAV

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along NC's coast (commonly referred to as the SAV mosaic), suggesting a historic extent of approximately 191,155 acres of SAV in the public trust waters of coastal NC. However, the extent of SAV loss has not been well quantified in NC. Anecdotal reports indicate SAV beds may be reduced by as much as 50 percent, especially on the mainland side of the coastal sounds.<sup>1, 19</sup> Based on the most recent hydroacoustic surveys of SAV extent in the Neuse, Pamlico and Albemarle rivers sub-estuaries, there has been an estimated 33 percent decline from the historical extent of low salinity SAV.<sup>20, 21</sup> Declines in the extent of high salinity SAV from Roanoke Island to Bogue Inlet have also been reported with the southern zone, where there is more development and higher population densities, declining by over 10 percent at a rate of 1.7 percent loss per year.<sup>22</sup> For more information, see **Chapter 4 Submerged Aquatic Vegetation Protection and Restoration Through Water Quality Improvements.**

### Wetlands

For the purposes of this paper, wetlands within the CHPP region include two broad classes: palustrine and estuarine.<sup>23</sup> Palustrine wetlands include all non-tidal wetlands, as well as any tidal wetlands where ocean-derived salinities are less than 0.5 ppt. Wetlands with ocean-derived salinities greater than 0.5 ppt are categorized as estuarine wetlands.

Wetland resources in the United States have declined considerably (>50 percent) since the colonial period.<sup>24</sup> It is estimated nearly half of NC's 11 million historical acres of wetlands were lost (physically or functional) between pre-colonial times and the 1980s.<sup>25</sup> The loss of NC's wetlands continues into the 21st century. Approximately 40 percent of total documented coastal wetland losses occurred between 1950 and 2000 with approximately 95 percent of NC's wetland resources in the state's Coastal Plain.<sup>26</sup> According to the most recent National Oceanic and Atmospheric Administration's (NOAA) Coastal Change Analysis Program (C-CAP) data, NC has 4.35 million acres of palustrine wetlands, of which 71 percent are forested wetlands, 23 percent are scrub/shrub wetlands, and 6 percent are emergent wetlands, as well as 235,425 acres of estuarine wetlands, of which 97 percent are emergent wetlands.<sup>27</sup>

While the value of wetlands is well documented, and rules are in place to protect them, permitted and unpermitted impacts continue. The DWR reported 17,984 acres of wetland impacts were permitted statewide through issuing 401 certifications (12,386).<sup>28</sup> The areas with the most impacted acres can be found in some of the coastal counties. The DWR permit data for the 20 coastal counties indicate that in the 1990s, most impacts were attributable to water dependent structures (marinas, docks, bulkheads), followed by dredging. From 2000 to 2010, there was a large increase in mining impacts and since 2010, most impacts were associated with transportation. For additional information, see **Chapter 5. Wetland Protection and Restoration through Nature-Based Solutions** and **Chapter 6. Environmental Rule Compliance to Protect Coastal Habitats.**

### Hard Bottom

Oceanic hard bottom is the primary structured habitat for offshore marine organisms on the continental shelf of NC.<sup>29, 30</sup> These exposed structures function as foundation for sessile invertebrates and algae, refuge for free moving benthic invertebrates and vertebrates, as well as juvenile, bait, and economically important fishes.<sup>31, 32</sup> Hard bottom in NC is limited to specific areas of the continental shelf with 90 percent of existing hard bottom occurring south of Cape Hatteras. Although limited information exists on the distribution of hard bottom off the NC coast, there is no regular monitoring in place to evaluate the status and trends of hard bottom habitat in state territorial waters.<sup>33, 34, 35, 36</sup> It has also been reported that live bottom reef comprises a larger area of the South Atlantic Bight.<sup>37</sup>

Anecdotal information from fishermen and residents in coastal NC suggests that many nearshore hard bottom sites in the mid-twentieth century are now covered by sand, reducing the abundance of fish in

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these areas. The observed declines in species abundance and richness lead researchers to conclude that the conflict between beach nourishment and hard bottom productivity is a serious conflict that will only worsen.<sup>29, 38</sup>

As of 2020, DMF's Artificial Reef Program manages 63 artificial reefs including 22 estuarine reefs, 15 of which serve as oyster sanctuaries, and 43 offshore reefs (13 in state waters ( $\leq 3$  nm) and 30 in federal waters (3-200 nm)) with the goal of supporting and functioning similarly to nearby natural reefs while providing user access opportunities. Although the purpose of the artificial reefs is to enhance fishing, they have been shown to support a similar community as natural reefs on multiple metrics.<sup>39, 40</sup> The artificial reefs also provide habitat for top predators and fishes at the edges of their distribution ranges.<sup>41, 42</sup>

### Soft Bottom

Marine sediments constitute one of the largest habitat types on earth, covering roughly 80 percent of the ocean bottom with tidal flats occupying over 31 million acres.<sup>43, 44</sup> Environmental characteristics, such as grain size, salinity, DO, depth, and flow conditions affect the condition of the habitat and the organisms using it. The characteristic common to all soft bottom is the mobility of unconsolidated sediment.<sup>45</sup> Soft bottom is in a constant state of flux, as other habitats expand or contract. The loss of more structured habitat, such as SAV, wetlands, and shell bottom, leads to gains in soft bottom habitat. Gains in new soft bottom habitat may not be as beneficial as mature soft bottom habitat. It is estimated that approximately 16 percent of tidal flats were lost between 1984 and 2016 due to coastal development, lack of sediment transport, increased erosion, and sea level rise (SLR).<sup>44</sup>

In NC, soft bottom covers approximately 90 percent of the estuaries and coastal rivers.<sup>46</sup> As expected, the most extensive amounts of soft bottom can be found in CHPP regions 1 and 2, which include the vast open waters of the Albemarle and Pamlico sound systems.<sup>47, 48, 49, 50</sup> The deep soft bottom (>6 ft) is dominant with at least more than twice the amount of shallow soft bottom ( $\leq 6$  ft) in every region. No targeted mapping efforts exist for soft bottom and bathymetry data are out dated. Therefore, it is not possible to quantify how the extent of soft bottom habitat has changed through time.

The condition and quality of soft bottom habitat can affect species abundance and diversity of the benthic community and could be considered a more important factor for soft bottom than extent. Sediments in soft bottom habitat can accumulate both chemical and microbial contaminants, potentially impacting benthic organisms and the community structure. The US Environmental Protection Agency (EPA) National Coastal Condition Assessment (NCCA) is the only regular monitoring source of soft bottom in NC. In 2010, the biological quality of 77 percent of the waters in the Southeast Coastal Region was rated as good based on the benthic index, 65 percent was rated good based on the sediment quality index, and 81 percent was rated as good based on sediment toxicity.<sup>10</sup> The contaminants that most often exceed the lowest observed adverse effect level (LOAEL) thresholds were selenium, mercury, arsenic, and (in rare instances) total Dichlorodiphenyltrichloroethanes (DDTs).

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### 2. IMPLEMENTATION PROGRESS ON PRIORITY HABITAT ISSUES (2016-2020)

#### 2.1 Background

Since the approval of the 2016 Coastal Habitat Protection Plan (CHPP), implementation has focused on four identified priority issues:<sup>1</sup>

1. Restoring oyster reef habitat.
2. Encouraging use of living shorelines.
3. Reducing sedimentation impacts in estuarine creeks.
4. Developing metrics on habitat trends and management effectiveness.

The NC Department of Environmental Quality's (DEQ) Division of Marine Fisheries (DMF), Division of Coastal Management (DCM), Division of Water Resources (DWR), and Division of Energy, Minerals, and Land Resources (DEMLR) are primarily responsible for implementing CHPP recommended actions. Progress on these actions to address priorities are summarized below.

#### 2.2 Oyster Reef Habitat Restoration

The 2016 CHPP included Oyster Reef Habitat Restoration as a priority habitat issue.<sup>1</sup> The participating DEQ divisions and partners made substantial progress towards achieving and implementing the 2016 recommended actions. Progress was strengthened by DMF partnering with others on the NC Oyster Steering Committee (OSC). The OSC consists of a diverse group of state and federal agencies, including DMF, as well as researchers, nongovernmental organizations (NGOs), and shellfish lease growers with the common goal of restoring and protecting oyster habitat through multiple strategies. The NC Coastal Federation (NCCF) serves as the lead organization for the OSC and production of the Oyster Restoration and Protection Plan: A Blueprint for Action, that is updated on five-year cycles. The 2015-2020 Oyster Blueprint summarizes work being done in NC related to oysters, and builds on progress accomplished through the 1995 Blue Ribbon Advisory Council for Oysters and the CHPP. Many of the goals in the Oyster Blueprint closely align to recommendations and implementation actions of the CHPP, including creating additional acreage of oyster sanctuaries, planting cultch for sustainable harvest, protecting and improving water quality in priority shellfish growing areas, and documenting oyster population status and trends.<sup>2</sup> Through collaboration with partners, particularly the OSC, and support from the NC General Assembly, progress on oyster restoration has made been significant advances over the past five years.

The 2016 CHPP recommended actions were presented for three categories: Cultch Planting, Oyster Sanctuaries, and Hatchery and Oyster Seed Production.

##### 2.2.1 Cultch Planting

The 2016 CHPP recommended actions for cultch planting were:<sup>1</sup>

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

Since 2016, several actions have been taken to advance the success of cultch planting. In early 2019,

## Chapter 2. Implementation Progress on Priority Habitat Issues (2016-2020)

DMFs' special delegation for the purchase and transport of oyster shell was increased to account for inflation of transportation costs. New state purchasing procedures were implemented in 2021 providing DMF greater flexibility for purchasing and transporting oyster shell to account for market fluctuations. In 2018, due to lack of appropriated funding, DMF formally terminated the Oyster Shell Recycling Program. However, the NCCF has continued recycling across the state. Recycled shell used for DMF cultch planting is either donated or available for purchase under the shell delegation. No progress has been made toward establishing incentives or funding mechanisms such as oyster use fees (tax on sale of oysters with revenue allocated for cultch planting) to acquire shell for the program. As described in the 2016 CHPP, DMF recently reallocated a position to establish the new Cultch Planting Program biologist which focuses on providing scientific support to the cultch planting decision-making process including: identifying alternative substrates for larval settlement in intertidal and subtidal oyster reefs, establishing a long-term monitoring program and using new siting tools and monitoring protocols to maximize reef success. Of note, the newly redefined Coastal Recreational Fishing License Fund (CRFL) Request for Proposal (RFP) process has afforded the Cultch Planting Program an opportunity to request focused university research to inform decisions. Also, DMF recently repurposed another position to create a dedicated side-scan mapping role. This position is tasked with mapping hard bottom areas, with particular attention paid to cultch planting reefs, oyster sanctuaries, artificial reefs, and natural oyster reefs. Data will provide spatial context for public consumption, reference tools for other division programs (i.e., leases, CHPP).<sup>3</sup>

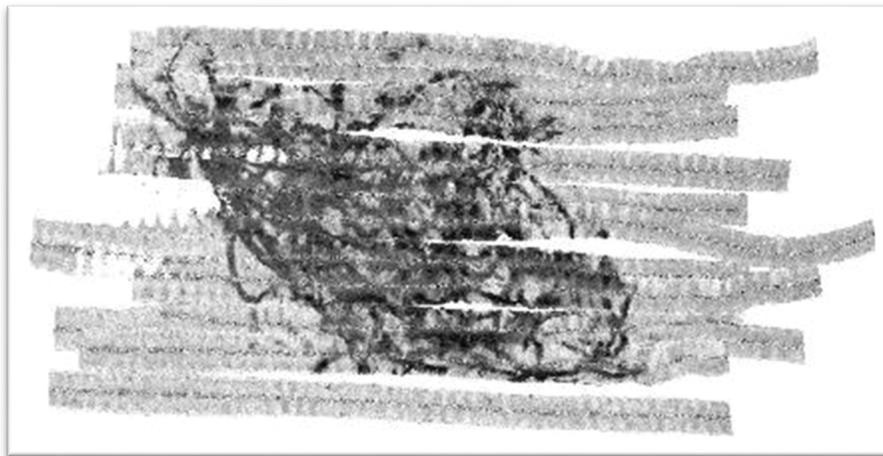


Figure 2.1. Backscatter imagery from a high-resolution survey conducted at a cultch planting site in Bonner Bay on 6/9/2016. The darker colors indicate hard bottom habitat created by the NC Division of Marine Fisheries (DMF) cultch planting vessel, RV Shell Point. The lighter colors indicate softer sand/mud bottom.

While not listed under any recommended actions, it is important to note the substantial accomplishments of DMF in pursuit of the cultch planting objective. Since 2016, staff have built a total of 261 acres of oyster habitat using 1,266,815 bushels of material, without assistance from marine contractors.

### 2.2.2 Oyster Sanctuaries

The 2016 CHPP recommended actions for oyster sanctuaries were:<sup>1</sup>

1. Identify alternative substrates for larval settlement in intertidal and subtidal oyster reefs, including a cost-benefit analysis.

## Chapter 2. Implementation Progress on Priority Habitat Issues (2016-2020)

2. Identify the size and number of oyster sanctuaries needed.
3. Develop oyster reefs that are resistant to poaching.
4. Utilize new siting tools to maximize oyster reef success.
5. Explore actions for in-situ sampling protocol to incorporate alternative construction materials.
6. Expand oyster sanctuary network to include intertidal oyster reefs in euhaline waters.

Since 2016, substantial progress has been made toward achieving and implementing the oyster sanctuary recommended action. Between 2016 and 2019, DMF protected approximately 80.7 acres of bottom, and with partners, developed approximately 51.2 acres of oyster habitat within that area. Two independent oyster sanctuaries were constructed, Little Creek Sanctuary (20.7 acres) and Swan Island Sanctuary (60 acres). The Swan Island project was the most notable accomplishment involving a public-private partnership with the NCCF and funding from both the NC General Assembly and the National Oceanic and Atmospheric Administration (NOAA). The initial project was completed in 2019 using a combined total of 80,600 tons of granite and marine limestone marl. However, additional funding was received that added 4,400 tons in 2020 and 6,600 tons in 2021 for a total of 91,600 tons of material deployed at the Swan Island Sanctuary.

Rigorous sampling of oyster sanctuaries, including Swan Island, resumed in 2019 after a short hiatus. Monitoring will provide size structure and population density information to inform recommendations for identifying alternative substrates for larval settlement in intertidal and subtidal reefs, identifying the size and number of sanctuaries needed, and new siting tools to maximize reef success. Presently, these data are undergoing analysis to compare 2019 results to historic data in published literature.<sup>4</sup> The primary objective of this analysis is to evaluate trends in population and size structure over a long time series and potentially develop predictive tools for future management. Preliminary results and analysis of the 2019 data are presented in Figures 2.2-2.4.

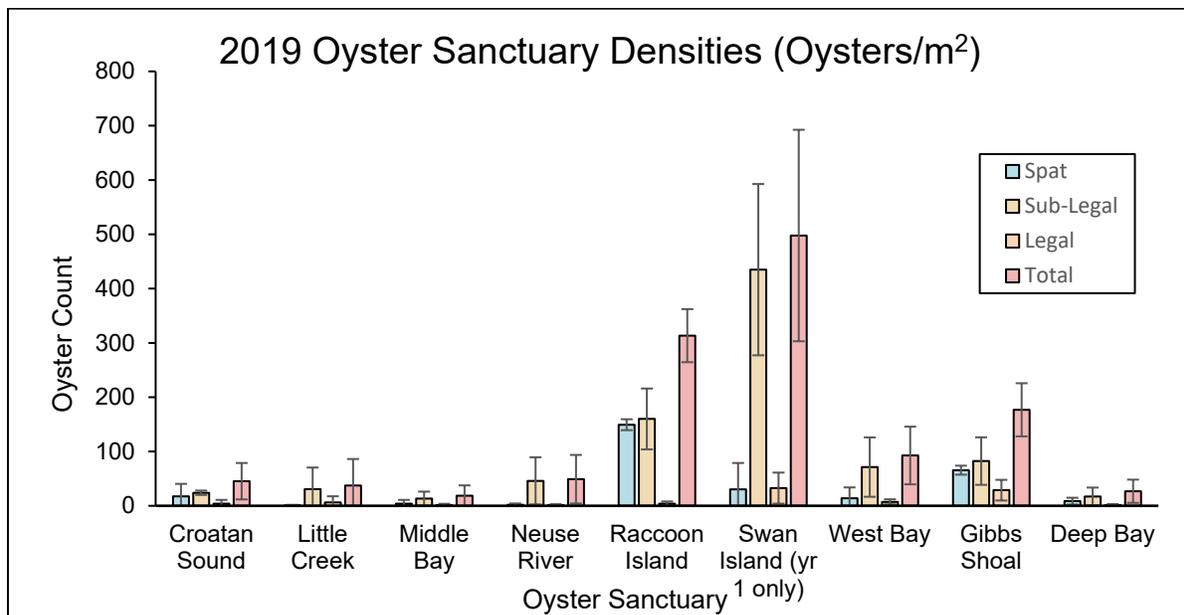


Figure 2.2. Population density data for 13 NC Division of Marine Fisheries (DMF) oyster sanctuary sites in Pamlico Sound. Size class densities (oysters/m<sup>2</sup>) are presented with error bars for each sanctuary, along with the total mean density at each. Only habitat material at Swan Island Oyster Sanctuary with 2 years or more in the water was sampled.

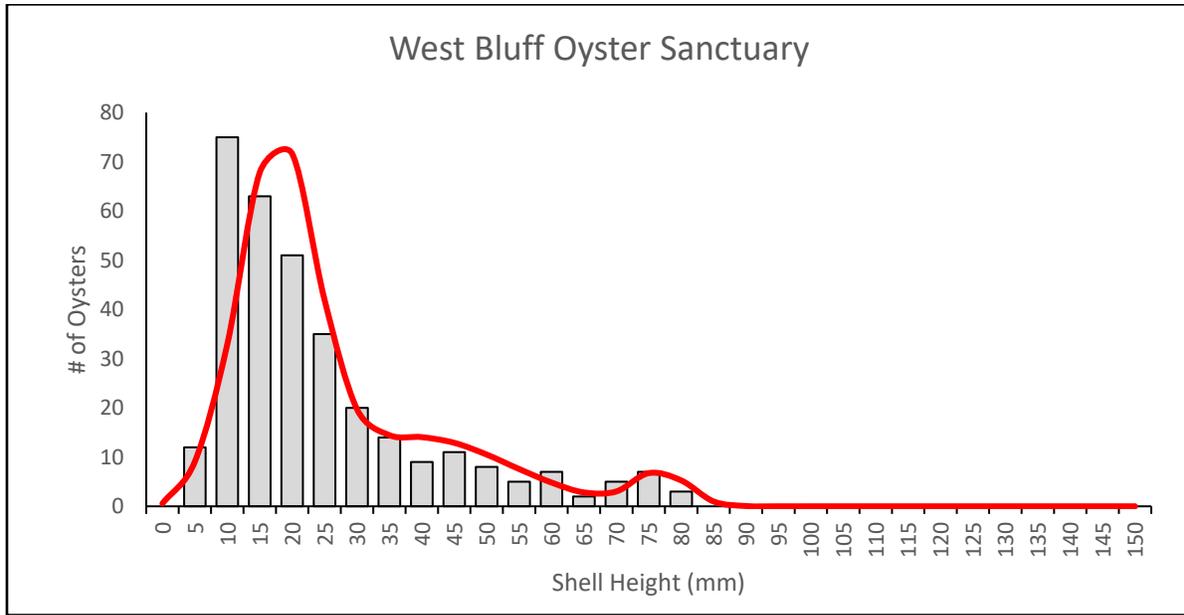


Figure 2.3. Length frequency data collected in 2019 at the NC Division of Marine Fisheries (DMF) West Bluff Oyster Sanctuary in Pamlico Sound. The red line indicates the findings of a cumulative modal analysis to identify individual cohorts.

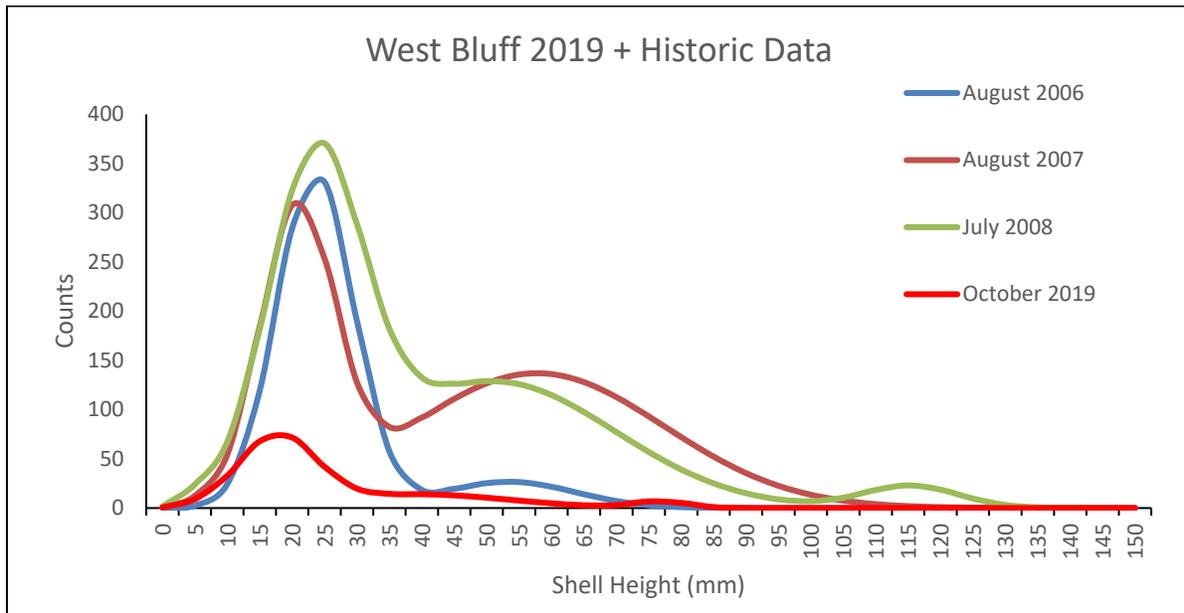


Figure 2.4. Comparison of length frequency data for the NC Division of Marine Fisheries (DMF) West Bluff Oyster Sanctuary site in Pamlico Sound and historic data.<sup>4</sup>

### 2.2.3 Hatchery Oyster Seed Production

The 2016 CHPP recommended actions for hatchery oyster seed production were:<sup>1</sup>

1. Explore options for increasing funds to support University of North Carolina at Wilmington (UNC-W) oyster hatchery.

## Chapter 2. Implementation Progress on Priority Habitat Issues (2016-2020)

2. Identify regional genetic variability within NC.
3. Improve availability of seed oysters genetically suited to respective regions.

Since 2016, UNC-W has been making progress on the recommended actions for hatchery oyster seed production. Based on legislative reports provided by UNC-W, the university has successfully and progressively increased viable spawns and provided broodstock from multiple lines to commercial hatcheries and community colleges statewide. The Shellfish Research Hatchery Breeding Program was substantially compromised during Hurricane Florence, which identified a need for storm resilience through industry/community/academic partnerships. Funding has been budgeted for genetics and additional staff to presumably address recommended actions to identify regional genetic variability within NC and improve availability of seed oysters genetically suited to respective regions.

### 2.3 Encourage Use of Living Shorelines

The 2016 CHPP directs agencies to continue focusing efforts on encouraging living shorelines to protect property, restore shoreline habitat, and improve water quality.<sup>1</sup> Starting in 2018, a Living Shoreline Steering Committee (LSSC) was established through a partnership with Albemarle-Pamlico National Estuary Partnership (APNEP) and the NCCF. Member partners include DEQ staff from DMF, DWR, DCM and its NC Coastal Reserve and National Estuarine Research Reserve (NC Coastal Reserve) as well as research scientists from NOAA, UNC-W, UNC at Chapel Hill (UNC-CH), East Carolina University (ECU), Duke University and NC Sea Grant. Two NGOs, NCCF and The Nature Conservancy (TNC) are also members. The goals and objectives of the LSSC and the CHPP Living Shoreline Priority Issue Paper closely align.

Through the LSSC, there has been a dramatic increase in communication, collaboration and significant progress in advancing the recommended actions in the 2016 CHPP Living Shoreline priority habitat issue paper, including:

1. Continuing to educate the public and waterfront property owners regarding the benefits of living shorelines.
2. Promoting additional research and monitoring of living shorelines.
3. Continuing to simplify the federal and state permitting process for living shorelines.
4. Promoting the appropriate use of oyster shells to facilitate habitat enhancement and incorporation into living shorelines.

Much of the progress described in the following sections is associated with members of the LSSC and CHPP Team.

#### 2.3.1 Permitting

The most notable accomplishment toward CHPP implementation is the simplification of permit requirements, specifically the changes to the General Permit (GP) for marsh sills. In 2017, DCM worked with a stakeholder group that included the US Army Corps of Engineers (USACE), marine science community, DMF, DWR, NCCF, NC Sea Grant, and NOAA to determine how best to move forward with creating a more streamlined permitting process for marsh sills. For there to be an efficient streamlined general permit, all federal and state agency concerns must be addressed with permit conditions. In early 2017, DCM compiled all the comments and recommendations from the stakeholder group and drafted an amended general permit 15A NCAC 7H .2700. In 2018, the USACE used the draft amended GP .2700 as guidance in the development of a Regional General Permit (RGP) for marsh sills that would allow DCM to issue GPs for marsh sills without a case-by-case federal review prior to issuance.

On September 5, 2018, the USACE issued a public notice proposing to authorize a RGP for the

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construction, maintenance, and repair of marsh sills. The RGP for the construction and maintenance of marsh sills included all conditions that were agreed upon at the stakeholder meetings. On March 26, 2019, the USACE issued the RGP (RGP 20181536) that authorizes the construction, maintenance, and repair of marsh sills for shoreline stabilization.

The CRC adopted amendments to 15A NCAC 7H .2700 that were consistent with the USACE RGP and the temporary rule became effective on April 1, 2019 followed by the permanent rule which became effective on July 1, 2019. This GP does not require any coordination with state and federal agencies if the permit conditions are met; therefore, creating a streamlined GP process that is consistent with other Coastal Area Management Act (CAMA) general permits. Since the effective date of this general permit, there has been an increase in 15A NCAC 7H .2700 applications and to date there have been approximately 14 GPs issued for the construction of marsh sills.

Another permit related activity underway is exploring the possibility of living shorelines being constructed for mitigation credits. The NCCF is currently looking into the feasibility of this with environmental consulting companies. Similar crediting is being used in the Chesapeake Bay. Living shorelines are one type of shoreline Best Management Practice (BMP) that can be used for Total Maximum Daily Load or Limit (TMDL) or shoreline management BMP credits to reduce nutrients and sediment. Virginia offers a residential cost-share program (Virginia Conservation Assistance Program), an agricultural cost-share program, and low interest loans as incentives.

### **2.3.2 Education**

Since 2017, the NC Coastal Reserve has conducted nine living shoreline training events throughout NC's coast to promote the use of living shorelines as a preferred erosion control method where appropriate. These training events were conducted in three coastal regions and attendees included real estate professionals, marine contractors, land use planners, landscape architects, property owners, and homeowner associations. Adapted from a Florida training, in 2021 due to COVID-19, the NC Coastal Reserve conducted a pilot virtual training that included a field session. They plan to have future in-person events. DCM regulatory staff and the NCCF presented at most of the NC Coastal Reserve workshops, providing valuable technical expertise. The workshops have been effective in increasing understanding of not only the benefits of living shorelines, but where and how to construct them. A contractor that attended training has independently built several living shorelines, a sign that the workshops are effective.

The NCCF has played a major role in encouraging property owners to consider living shorelines to stabilize their shorelines. They provided shoreline consultations to 55 waterfront property owners coast wide in 2019 alone. The NCCF also engaged with multiple homeowner associations, providing presentations and guidance on living shoreline implementation, as well as to town planners and during town meetings. By utilizing community volunteers to construct living shorelines, the value, applicability, and effectiveness of living shorelines reach large numbers of people from a diversity of backgrounds, including students, to church members, environmental groups, and private businesses.

### **2.3.3 Research**

There are several research projects that are ongoing and include monitoring of salt marsh surface elevation tables (SET) and vegetation in natural marshes and nearby living shorelines in Carteret County. A study that surveyed coastal property owners after Hurricanes Irene (2011) and Arthur (2014) found that most homeowners believed that bulkheads were the most effective way to prevent erosion from hurricanes.<sup>5</sup> However, the study also showed that most hurricane damages were to bulkheads. Cost for repairs of these bulkheads were double the price and four times the cost of annual maintenance of

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natural or living shorelines. However, during the same timeframe, shoreline hardening increased by 3.5 percent from along the Outer Banks. Recent work demonstrated the resilience of living shorelines to hurricanes and that living shorelines had better resistance to erosion than bulkheads and natural marshes.<sup>6</sup> It was also found that no repairs were required during the two-year study period. Post Hurricane Florence monitoring of several living shorelines throughout the state showed minimal signs of damage to both rock and oyster sills. Some marsh shoreline erosion was observed but only an average loss of 14 percent of marsh vegetation, suggesting that marsh was protected and retained after the storm. What structural damage was observed was some displacement of oyster bags from the main sill.<sup>7</sup> There are several other studies that are completed or are close to completion that demonstrate: 1) that bulkheads reduce salt marsh extent, 2) how wave energy is attenuated by natural marshes, reducing erosion of uplands, and 3) how waves are transformed across living shorelines. A new online tool was developed by NOAA and TNC incorporating recent research and the relationship between salt marsh distribution, shoreline wave energy, and suitability for living shorelines.<sup>8</sup>

Several presentations were given at various scientific conferences. Beaufort, NC was also the site of Restore America's Estuaries' Third National Living Shoreline Technology Transfer Workshop in October 2019. The workshop, locally hosted by NCCF, was attended by approximately 250 professionals. Field trips showcased local living shorelines projects at Piver's Island, Carrot Island, Trinity Center, the NC Aquarium at Pine Knoll Shores and Hammocks Beach State Park's Jones Island.

Work on testing alternative construction materials has also been ongoing. A 185 ft. living shoreline was constructed in Bogue Sound at the NC Aquarium at Pine Knoll Shores using Sandbar Oyster Company's Oyster Catcher™ material. Oyster shell and rock gabions developed by the Tensar International Corporation and JLS Contracting Services, LLC, are being tested at Jones Island and at a shoreline along the Intracoastal Waterway in Swansboro. The NCCF is working with Green Recycling Solutions to develop a degradable alternative to the traditional plastic mesh bags. The company is in the process of developing a jute mesh bag that can be used to fill oyster shells. This will be tested for living shoreline construction. The use of their degradable erosion control sock may also be explored.

### **2.3.4 Living Shorelines with Oyster Habitat**

Using oyster shell as substrate to create a living shoreline doubles the habitat benefits by enhancing wetland and oyster habitat. While oyster shell is limited in supply, other hard substrate can be used that oysters can recruit onto. Environmental conditions, primarily salinity, limits oyster habitat on all living shorelines. Therefore, living shorelines incorporating oysters represents a subset of all living shorelines. The 2021-2025 Oyster Blueprint includes a new goal to expand the use of living shorelines in areas that support oyster habitat and make them the most commonly used stabilization method in those areas.<sup>9</sup> Living shorelines located in areas that support oysters will provide benefits to oyster rehabilitation efforts by potentially providing another source for oyster larvae. They provide another opportunity to supplement oyster rehabilitation efforts and improve water quality. Living shorelines are one strategy to protect and restore wetlands, and in some cases oysters.

Being a Nature-based Solution, living shorelines remain a priority in the 2021 CHPP Amendment for the benefits they provide as fish habitat, wetland restoration, oyster restoration, water quality improvement, and enhancing coastal resilience (Figure 2.5). Recognition of the benefits of living shorelines has greatly increased in the past five years. To this point, the NC General Assembly in 2019 (Session Law 2019-251) allocated \$2 million to the NC Department of Transportation (DOT) to construct living shorelines in areas close to vulnerable infrastructure. For additional information, see **Chapter 5. Wetland Protection and Restoration through Nature-Based Solutions.**

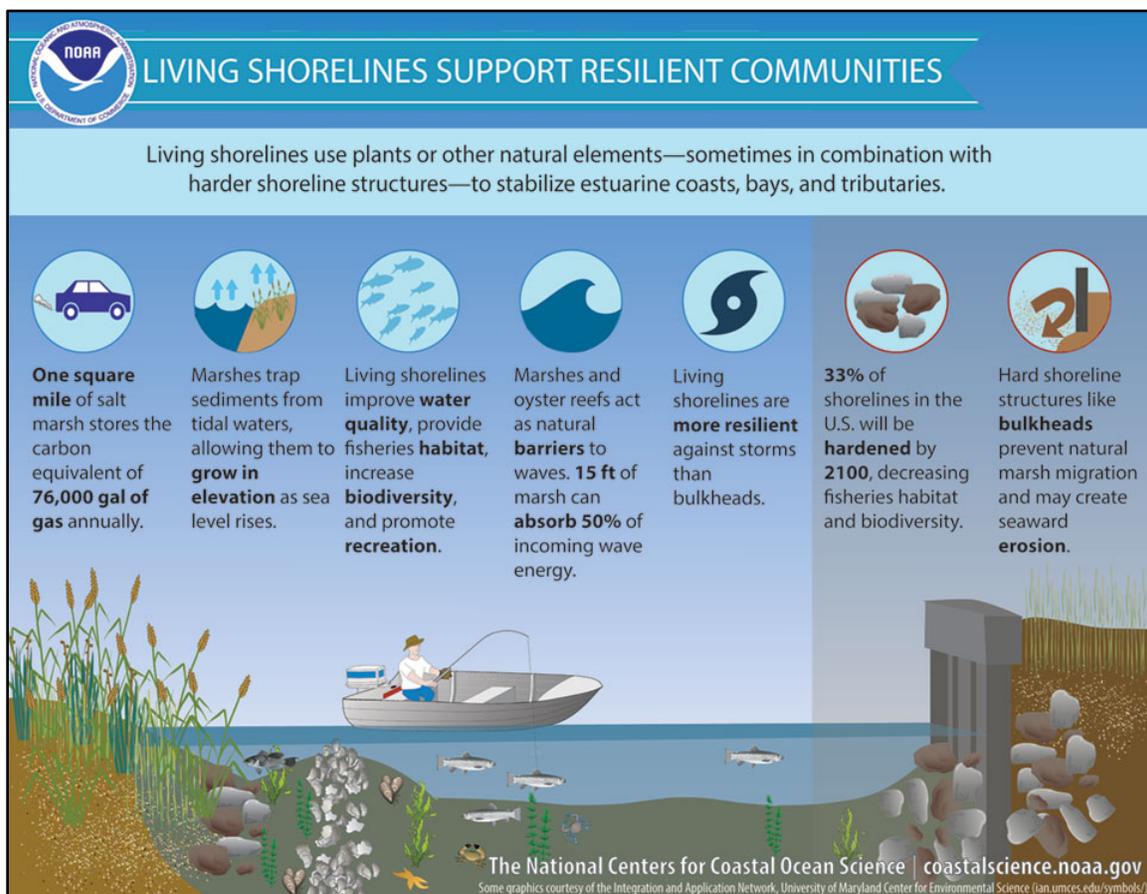


Figure 2.5. The ecosystem benefits of living shorelines for shoreline stabilization.

## 2.4 Sedimentation in Estuarine Creeks

Tidal creeks are the critical connection between the upper and lower estuary, but many have been overloaded by influx of sediment and pollutants.<sup>10</sup> Reducing sedimentation in tidal creeks was a priority issue in the 2016 CHPP due to concerns that sedimentation was causing upper creeks to fill in, reducing habitat availability for juvenile fish, smothering oyster reefs, and degrading water quality, particularly shellfish harvest waters. Review of literature concluded that the negative impacts of sedimentation are fairly well understood and a few studies were done in NC to look at sedimentation rates and sources. However, more assessments of tidal creeks across a continuum of anthropogenic disturbance were needed to determine prevalence of high sedimentation, major land use activities contributing to it, and the effects of sedimentation on nursery area function. The research and management actions included:

1. Determine magnitude and change in sedimentation rates and sources over time at sufficiently representative waterbodies and regions.
2. Determine the effect of sedimentation in the upper estuaries on primary and secondary productivity and juvenile nursery function.
3. Encourage research for innovative and effective sediment control methods in coastal areas.
4. Encourage expanded use of stormwater Best Management Practices (BMPs) and low impact development (LID) to reduce sediment loading into estuarine creeks.
5. Improve effectiveness of sediment and erosion control programs.

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### 2.4.1 Research Actions

Two studies completed since 2015 examined sedimentation rates and sources in NC and both found that sedimentation rates in tidal creeks were exceeding local sea level rise (SLR). One study examined the relationship of land use, shoreline change, and sedimentation rates in three creeks in Onslow and Carteret counties.<sup>11</sup> Sediment composition and profiles indicated sediment in the upper creeks originated from land runoff and an increased flux of organic carbon and nitrogen over time. There was not a clear relationship between sedimentation, shoreline change, and land use. However, timing of the measured change in sediment accumulation rates in Oyster and Broad creeks coincided with periods of development and land use change in the surrounding areas.

Another study examined sedimentation rates and resulting impacts to fishery production in nursery areas.<sup>12</sup> This study, funded by the CRFL, began in 2016 and is in the final stages of completion. The first part of the study assessed the relationship of land use change and tidal creek infilling by calculating sedimentation rates from twelve tidal creeks in Carteret and New Hanover counties. Sedimentation rates were compared to changes in watershed land use from 1959 to 2010. Sedimentation rates experienced notable increases through time as developed land area increased and the sedimentation in all creeks was greater than the relative SLR rates. The results of the study indicated that land-use change, particularly increasing development, leads to higher sedimentation rates with the potential to drive infilling and shallowing of tidal creeks. However, it was noted that hydrological conditions influence whether sediment loads are deposited in the upper creeks or exported downstream to larger estuaries.

The second part of the study conducted extensive spring, summer, and fall nekton sampling in the same 12 creeks, from 2017 to 2019. Preliminary results indicated that for 11 of the tidal creeks, there appeared to be a negative relationship between sedimentation rate (integrated over the last 50 years) and catch rate of nekton (fish and decapod crustaceans).<sup>13</sup> The investigators continue to explore whether the mechanism for this negative relationship include changes in habitat amount (i.e., higher sedimentation = smaller creeks), changes in water quality (i.e., turbidity), and/or changes in benthic habitat quality (i.e. altered sediment characteristics and/or burial of biogenic habitat).

Another research action in the 2016 CHPP Living Shoreline priority habitat issue paper was the need for more research on innovative and effective sediment control measures in coastal areas.<sup>1</sup> Changes to coastal stormwater rules in 2016 made this even more critical than in the past. With less emphasis on built-upon limits and stormwater ponds, research on innovative and effective infiltration systems continued to be a high priority. Significant research has been conducted in the past five years, primarily through collaboration among NC State University (NCSU), DEQ, and DOT. Research projects in coastal counties examined effectiveness of rain gardens, permeable pavement, stormwater wetlands and drainage improvements.

Through Section 319(h) of the Clean Water Act, the United States Environmental Protection Agency (EPA) provides states with funding to reduce nonpoint source pollution. North Carolina typically receives around \$1 million for competitive funding of watershed restoration projects. Section 319 grant projects must be used to help restore waterbodies currently impaired by nonpoint source pollution in areas with approved watershed restoration plans. Since 2015, several projects have occurred in coastal watersheds. These ranged from drafting and implementing watershed restoration plans, to designing and constructing projects that reduce stormwater runoff, and establishing stormwater wetlands to improve water quality. Project descriptions are available on the DWR website.<sup>14</sup>

A major source of impervious surfaces in coastal NC is DOT roadways. Consequently, they have several

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programs to research and implement innovative techniques to reduce stormwater runoff. Although not within DEQ, the magnitude of their potential impact on sedimentation and progress they are making to minimize adverse impacts is worth noting. Through the DOT Research Program, the agency explores new and innovative technologies that may be suitable for use with the linear nature of most DOT activities. DOT actively funds university research to investigate and evaluate suitable methods for treating pollutants associated with DOT activities. Active research programs involving detailed analytical monitoring have been established to investigate and document the impacts of stormwater runoff from highways as well as the effectiveness of BMPs. This has included research on performance of dry swales, wet swales, permeable pavement, and bioswales. Research publications sponsored by the program are listed on their website.<sup>15</sup>

### **2.4.2 Management Actions**

#### DEMLR Coastal Stormwater and Erosion and Sedimentation Control Programs

The Sedimentation Pollution Control Act (SPCA) addresses sedimentation impacts in surface waters. The law requires an erosion and sedimentation control plan for any land-disturbing activity if more than one acre is to be disturbed. The law is primarily implemented by the Sediment Control Commission (SCC) and two programs in DEMLR - Stormwater Program and Erosion and Sedimentation Control Program (E & S). The SCC and DEQ are charged with enforcement of the SPCA and educating the regulated community and general public about erosion and sedimentation control. Agriculture, forestry, mining, and emergency situations are exempted from the law. Coastal counties that are subject to National Pollutant Discharge Elimination System (NPDES) Phase II MS4 post-construction requirements (15A NCAC 02H .1016) such as Brunswick, New Hanover, Onslow, Pitt, and Wayne counties, must have their own stormwater programs. Additionally, some local municipalities have elected to implement their own stormwater and E & S programs.

The Coastal Stormwater Program has undergone several rule changes from its inception in the late 1980's. The rules of 1995 were updated in 2008 and again in 2017 due to legislation. In 2008, coastal stormwater rules were modified, reducing the percent impervious cover limits for low density development from 24 percent to 12 percent adjacent to Outstanding Resource Waters (ORW), SA waters, and areas with 0.5 mi and draining to SA waters. This change was based on research that showed fecal coliform bacteria increased directly with increasing runoff from impervious surface and shellfish harvest closures were continually increasing.<sup>16</sup> In 2016, legislation required the coastal stormwater rules to be modified. While impervious surface limits in SA-HQW and SA-ORW, and ORW remained at 12 percent, impervious surface limits in other coastal county waters returned to 24 percent.<sup>17</sup> A DEQ report on the existing coastal stormwater program stated that "any direct discharge of stormwater to a coastal water can compromise its quality" and that the solution for controlling fecal coliform contamination is incorporation of Stormwater Control Measures (SCMs) in developments to infiltrate stormwater onsite. Recommended SCMs includes but are not limited to infiltration systems (basins and aggregate-filled trenches designed to soak stormwater into the ground), permeable pavement, and disconnected impervious surface (i.e., direct rainwater from roofs and pavement to vegetated areas with gutters). Where high water tables make infiltration systems ineffective, wet ponds and stormwater wetlands are considered a more effective technique. Due to the revised rules, greater use of stormwater BMPs and low impact development are encouraged (Action #4).<sup>18</sup>

The latest stormwater rules have created new flexibility in the stormwater approach that reduces costs, while still protecting water quality. The flexibility and reduction in cost comes from reduction in size of some of the SCM's (i.e., wet pond's vegetative shelf reduced from 10 feet to 6 feet). More flexibility was given in the design of infiltration systems, disconnecting built-upon area, use of smaller SCMs, as well as

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use of other innovative systems. The new set of rules favors use of infiltration systems over the traditional “store and release” approach. It is important to mention that despite agency efforts to step away from the wet pond approach in stormwater treatment, a large percentage of developers and consultants continue proposing these systems. The stormwater permitting process is being streamlined by implementation of the new “Fast Track” permitting option by scanning of all stormwater files and switching to electronic permitting.

The financial support for the local and state programs to better manage sediment control measures from all land disturbing activities has stayed at about the same level. Several coastal municipalities and counties have their own Stormwater or E & S programs, or both, and are inspected annually. Examples include Goldsboro, Greenville, Pitt County, Nags Head, and Kill Devil Hills. Although Greenville was non-compliant in 2014-2015 and minor non-compliances were noted during annual inspections, the overall efficiency of local programs is high because non-compliances in the field can be monitored regularly (daily/weekly) until corrected. In contrast, the state programs have much higher number of projects per staff and cannot monitor as frequently.

While agricultural activities are exempt from the SPCA, farmers must address erosion and sedimentation control through other means such as reduced tillage, vegetative filter strips/buffers, cover crops and other conservation practices. Farmer education and BMP implementation is addressed by the NC Department of Agriculture and Consumer Services (DA&CS) Division of Soil and Water Conservation (DSWC), and local Soil and Water Conservation Districts.

### DOT Post Construction Stormwater and Best Management Practice (BMP) Retrofit Programs

DOT is required by its NPDES permit to implement a Post-Construction Stormwater Program (PCSP). The primary objective of the PCSP is to manage stormwater runoff from DOT projects by requiring structural and non-structural BMPs to protect water quality. The requirements described in the PCSP apply to DOT projects which increase built-upon area. DOT implements structural BMPs described in the BMP Toolbox and/or non-structural pollution minimization measures described both in the PCSP and the BMP Toolbox.<sup>19</sup>

The NPDES Retrofit Program designs and constructs BMPs retrofitted into existing DOT roadways and facilities. While effective SCMs for new construction minimizes water quality impacts, retrofitting is a means of potentially improving water quality. The program is required by the NPDES permit to implement a minimum of 70 retrofits over the course of the five-year NPDES permit term. In most cases, the stormwater discharge cannot be eliminated due to space constrictions, therefore the goal is to reduce the volume and increase the quality of the stormwater. Criteria for selecting retrofit projects include water quality improvement and the need for stormwater conveyance maintenance. Collaboration with another organization, such as when a watershed restoration plan has already been developed, will increase project priority. Another role of the Retrofit Program is to test new BMPs or design criteria prior to inclusion in the BMP Toolbox. DOT maintains a geospatial inventory of its roadway system and stormwater outfall assets within priority watersheds. The outfall inventory is used to support the BMP Retrofit Program. There are over 20 different types of BMPs used for stormwater outfall retrofits (Figure 2.6).

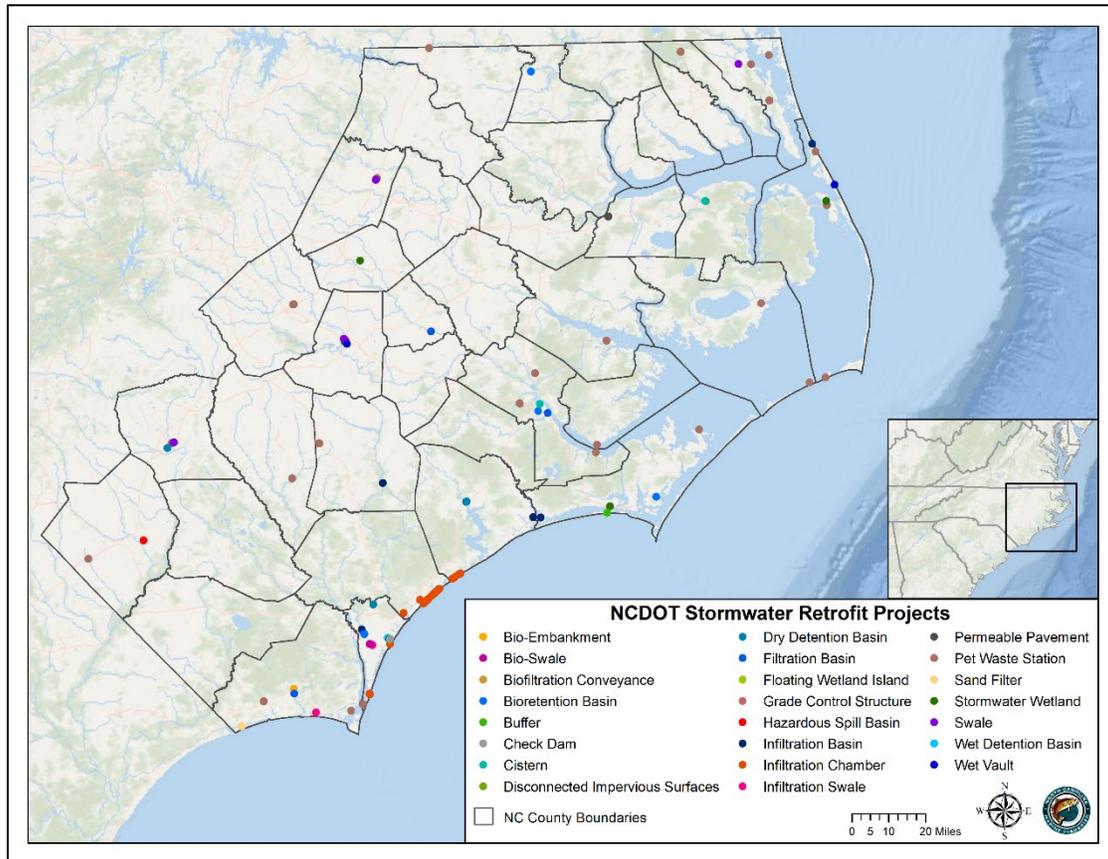


Figure 2.6. The NC Department of Transportation (DOT) stormwater retrofit projects completed from 2018 to 2019.<sup>20</sup>

### 2.4.3 Outreach

Outreach on sedimentation control occurs in several ways within DEMLR, starting at the Regional Office during daily interactions, inspections, and meetings with interested parties, as well as the DEQ website. A 319(h) grant provides funding for one Sediment Education Specialist, for the education and training program mandated by the Sedimentation Pollution Control Act. Outreach is used as a tool to encourage use and proper construction of SCMs in both the Stormwater and E & S programs.

Technical assistance is offered through the Sedimentation and Erosion Control Planning and Design Manual, the companion Field Manual and the Inspectors Guide, and annual workshops for design professionals and local government programs.<sup>21</sup> Another objective of the program is to provide education on erosion and sedimentation control to the general public. Technical expertise has been and will continue to be provided to education professionals to help implement sedimentation pollution awareness in public schools and colleges.

In 2019, two Erosion and Sedimentation Control Design Workshops were conducted for design professionals, with a total of 255 participants. A wide range of experts presented on common erosion and sedimentation issues and solutions based on innovative design and solid research. Additionally, an annual training workshop was conducted for local government staff with delegated local erosion and sediment control programs. Representatives from 45 of the 54 local governments participated in the workshop with a total of 102 participants. State representatives provided updates on the latest

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regulatory changes, various experts presented on related erosion and sedimentation control topics including planting native, beneficial fill, forestry inspections and research updates from NCSU's Erosion Field Lab. The workshop also provides an opportunity for local programs to connect, learn from each other, and share challenges, strategies, and successes of managing erosion and sediment throughout the state.

In 2019 the Sediment Education Specialist exhibited at and distributed educational materials at the NC Association of Soil and Water Conservation Districts annual meeting, two conferences, and made numerous school visits. One tool often brought to these education outreach events is the Enviroscope, a watershed model that is used to demonstrate point and non-point source pollution.

In 2020, approximately seven trainings were provided on stormwater inspection and maintenance certification; stormwater design and erosion and sediment control plans; stormwater installation; Minimum Design Criteria; rain garden and permeable pavement installation and maintenance.

### Stormwater and Erosion Control Programs Limitations

While progress has been made by DEMLR in controlling sedimentation, more resources are needed to run these programs effectively. The current compliance programs are insufficient to address the large percentage of noncompliant sites and complaints, reducing program efficiency (see Compliance Issue Paper for more information). There is interest in the programs becoming more "user-friendly" for the developing community, yet the impact of sedimentation on the state's estuarine resources continues. In 2020, DEMLR is going through a program evaluation of the E & S, Post-Construction Program with the Stormwater Program to address legislative complaints. Resulting program changes that are implemented will likely affect both programs in a negative way since a goal is to reduce costs of running these programs. To the contrary, more resources are needed to improve compliance and monitoring capabilities of both local and state sediment control programs. Purchasing of new equipment to enhance the monitoring and appropriate training of program staff can be only achieved by increased funding.

## **2.5 Generating Metrics on Management Success and Habitat Trends**

The 2016 CHPP included Generating Metrics on Management Success and Habitat Trends as a priority habitat issue.<sup>1</sup> The participating DEQ divisions have made substantial progress towards achieving and implementing the identified proposed management options. See **Chapter 8: Coastal Habitat Mapping and Monitoring to Assess Status and Trends** for more details on progress made. The 2016 options included:

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

### **2.5.1 Submerged Aquatic Vegetation**

Substantial progress has been made to establish SAV monitoring protocol and collect data. The APNEP published a revised coastwide map from the 2006-2008 SAV mapping cycle and a new map of the high-salinity zone of the Albemarle Pamlico estuary for the 2012-2014 mapping cycle.<sup>22, 23</sup> The DMF revised

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and finalized 2015 SAV mapping data for coastal waters south of Bogue Inlet.<sup>24</sup> The APNEP and DMF conducted a coastwide aerial survey in 2019, and re-surveyed in 2020 to improve image quality for interpretation. Funding for the 2019/2020 efforts was supplied by APNEP and DEQ. However, long-term funding to sustain this monitoring is still being sought. Using past SAV delineations and field sampling data collected by a partnership of agencies, APNEP produced a high-salinity SAV extent report and funded a study on the economic value of SAV.<sup>25, 26</sup> The APNEP also completed a monitoring plan for high and low salinity SAV, with input from APNEP's SAV Monitoring Team.<sup>27</sup> In 2021, using methodology set forth by this plan, tier one (aerial survey) and tier 2 (monitoring) data were collected in high salinity regions from Back sound to Bogue Inlet by APNEP and partners, and from Bogue Inlet to Mason Inlet by DMF and UNC-W.

The APNEP established low salinity SAV sentinel sites for monitoring in Neuse (10) and Pamlico rivers (6), and Albemarle Sound (10), and work is being done to establish a site in Currituck Sound. The protocol used to monitor these sites was developed through CRFL grant funding and employs sonar methodology. These sites have been established and monitored over the last five years, although lack of funding prevented monitoring in 2021. Methods for sentinel site monitoring of the high-salinity zone SAV are being developed through a pilot project. The results will be used to establish a long-term high-salinity SAV monitoring protocol. For additional information, see **Chapters 4. Submerged Aquatic Vegetation Protection and Restoration through Water Quality Improvements** and **Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends**.

### **2.5.2 Shell Bottom**

Several CRFL funded research projects are examining the use of remote sensing technology, such as sonar and drones, to develop repeatable protocols for mapping and monitoring multiple coastal habitats including intertidal and subtidal oysters, SAV, and wetlands.

In 2019, DMF began a pilot study to explore the use of remote sensing technology, such as drones and sonar, as alternative means of mapping shell bottom. The Estuarine Bottom Habitat Mapping Program is using drones to map intertidal oysters and modifying parameters to establish sentinel sites for more frequent and rapid mapping and monitoring. These changes will greatly increase the efficacy of the Estuarine Bottom Habitat Mapping Program and allow more timely trend assessments of the intertidal oyster population. To enhance subtidal oyster habitat mapping, a vacant position in the Habitat and Enhancement section was repurposed to focus on using side scan sonar to map priority subtidal areas for the Oyster Sanctuary and Clutch Planting Programs with primary focus in Pamlico Sound. For additional information, see **Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends**.

### **2.5.3 Wetlands**

Most of the progress in wetlands mapping and monitoring within DEQ has been undertaken by DWR. In 2016, DWR participated in the EPA's National Wetland Condition Assessment (NWCA). As part of this national wetland assessment, 21 wetland sites were surveyed (and two sites twice). The DWR is participating in the 2021 NWCA. In 2021, DWR will also begin sampling for an EPA grant called "The Assessment of Change in North Carolina Coastal Plain Wetlands". This assessment will be looking at new wetland sites as well as known sites surveyed five, 10, and 30 years ago. In addition, NCSU continued the long-term monitoring of a few sites previously monitored by DWR from 2014 through 2018/2019. The DWR is currently awaiting funds from the EPA to initiate a statewide wetland mapping project and a more accurate, publicly available wetland mapping tool for NC.

In addition to the wetlands mapping and monitoring conducted by DWR, other agencies and academics

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have also contributed to improving wetland status. The DOT developed a LiDAR-based GIS wetland prediction model to update wetland mapping as part of a pilot project. DOT has been working with researchers at University of North Carolina at Charlotte (UNC-C) to automate the modeling process which has resulted in GIS tools that can rapidly predict wetland locations. Ultimately, DOT will use these tools to update wetland mapping across the state which will be accessible in the DOT ATLAS web-based applications. In Back and Bogue sounds, and parts of the Newport and New rivers, some site-specific monitoring has been conducted. Using remotely sensed imagery, rates of saltmarsh shoreline erosion and upland transgression with and without the presence of bulkheads were quantified over a 30-year period.<sup>28</sup> The 2021 CHPP priority habitat issue paper, *Wetland Protection and Enhancement through Nature-Based Solutions*, provides more detail on shoreline erosion, wetlands loss, and potential mitigating techniques. Other studies have used multiple metrics (i.e., elevation, accretion, sediment supply, SLR) to assess the vulnerability of salt marshes to SLR at National Estuarine Research Reserves (NERRs) across the country. In NC, Masonboro Island Reserve near Wilmington was assessed and found to have very low resilience to SLR.<sup>29</sup> For additional information, see **Chapter 3. Climate Change and Coastal Habitat Resiliency** and **Chapter 5. Wetland Protection and Restoration through Nature-Based Solutions**.

### 2.5.4 Strategic Habitat Areas

Since the 2016 CHPP, the nomination of Strategic Habitats Areas (SHAs) was completed for all four CHPP regions, with Region 4 (The Cape Fear River Basin) nominations being approved by the Marine Fisheries Commission at the May 2018 business meeting.<sup>30, 31, 32, 33</sup> The same year, a CRFL grant provided funding to begin the validation of the fish use and habitat condition of the nominated SHAs. The first two years of the study focused on CHPP Region 3 (The White Oak River Basin). Multiple sampling gears are used to collect various fish and habitat metrics to compare fish abundance and diversity and habitat condition between SHA nominations and areas not nominated as SHAs. Sampling in CHPP Region 3 was completed in the fall of 2019 with a total of 252 sampling events (126 SHAs and 126 Non-SHAs). In the spring of 2020, the study expanded into CHPP Region 4 and analysis of the CHPP Region 3 data is underway. The expansion of the study into the larger waters of CHPP Region 1 (Albemarle Sound) and Region 2 (Pamlico Sound) is also being examined. The results of this study will be used to validate or modify the existing SHA nominations and provides a foundation for the ecological evaluation of management areas such as designated nursery and spawning areas.

The progress made towards establishing baseline habitat conditions through sentinel sites and long-term monitoring of coastal habitats, and the validation and verification of SHAs in all CHPP regions is the foundation for establishing management thresholds for coastal habitats. The quality, quantity, and extent of the coastal habitats in NC must be identified before management thresholds can be applied. This was recognized by the CSC during the selection of priority habitat issues for this update. For additional information, see **Chapter 4. Submerged Aquatic Vegetation Protection and Restoration through Water Quality Improvements**, **Chapter 5. Wetland Protection and Restoration through Nature-Based Solutions**, and **Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends**.

## 2.6 Implementation Progress on Other Coastal Habitat Protection Plan Recommendations

In addition to the priority habitat issues, progress has occurred with other recommendations from the 2016 CHPP. One implementation action to aid in compliance with existing rules and permits (Recommendation 1.1) was to “cross train Marine Patrol officers to take note of and report violations of CRC and EMC rules and permits in coastal waters to appropriate agencies”.<sup>1</sup> The DCM staff conducted training in 2019 to DMF’s Marine Patrol staff in the Northern and Central districts and over 60 officers

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attended. Background on CAMA jurisdictional areas and rules was provided. They were shown how to look for unusual activity such as heavy equipment on the shoreline, projects that stand out like excessively longer pier than surrounding areas, fresh dirt piled on vegetation without a silt fence, new looking boatlifts or docks in very shallow primary nursery areas (PNAs), and bulkheads unusually far from the shoreline. The officers were receptive to assisting when out in the field and provided flights to assess potential violations periodically.

Considerable work continues to be done by DEQ regarding expanding outreach on fish habitat value, threats, and explanations of management measures (Recommendation 1.3). One implementation action was to provide educational information to school children (K-12) regarding biodiversity and value of estuaries. Towards this, APNEP has an ongoing Shad in the Classroom program. An education specialist position with DWR was filled in 2017. Through that, staff conduct live workshops and online modules. The primary programs are Project WET (reached 500-3780 students/ year 2017-2020); It's Our Water Online Module (reached 80-680 students per year from 2017 to 2020), and NC Stream Watch. Other smaller programs and school visits are also done. Project WET, NC Sea Grant, NC Water Resources Research Institute (WRRRI), and NC Watershed Stewardship Network partnered to create a new PBS online program called Watershed Wisdom that includes interactive lessons/videos. The Soil and Water Conservation Districts continue with Envirothon training and competition, Resource Conservation workshops, school field days, and Poster and essay contests.

One implementation action to restore fish passage for migratory fishes through elimination or modification of stream obstructions (Recommendation 3.5b) was "the DEQ, through the DWR and Division of Mitigation Services (DMS) will pursue dam removal projects where appropriate".<sup>1</sup> Staff from DWR participate in the NC Aquatic Connectivity Team, a group of experts that manage dam removal projects within the state. American Rivers and Southeast Aquatic Resources Partnership (SARP) provide technical support on barrier identification, inventory, and prioritizations. Several projects were completed 2018-2020 in the coastal draining river basins by DWR and DMS (Table 2.1). Additionally, Milburnie Dam on the Neuse River was removed by a restoration company for mitigation bank credits. The DEQ actively engaged with the USACE to encourage transfer of the Lock and Dams on the Cape Fear River to the Department. The outcome of that effort has not yet been determined.

Table 2.1. Barrier removals or modifications completed by NC Divisions of Water Resources (DWR) and Mitigation Services (DMS) and partners in coastal river basins, 2018-2020.<sup>34</sup>

River Basin	Dam removal	Culvert, ditch, or pond modifications
Chowan	-	3
Neuse	4	5
Cape Fear	-	4
Lumber	-	2

Managing stormwater will not only reduce sediment loading as discussed earlier in the chapter, but also nutrient and bacteria loading. The revised stormwater rules, stormwater design manual, and minimum design criteria support Recommendations 4.5, "to improve strategies to reduce nonpoint pollution and minimize cumulative losses of fish habitat through voluntary actions, assistance, and incentives, including a) improved methods to reduce pollution from construction, agriculture, and forestry; and b) increased on-site infiltration of stormwater; and c) encouraging and providing incentives for implementation of Low Impact Development practices."<sup>1</sup> Additionally, the recently readopted Neuse and Tar-Pamlico nutrient stormwater rules require implementation of the Division's Stormwater

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Nitrogen and Phosphorus (SNAP) calculator for new development activity subject to those rules. The rules also require annual electronic reporting from local governments, which will include exported SNAP data from developments within their jurisdictions. Taken together, the rules provide the division data to maintain effective regulatory strategies for water quality (Recommendation 4.6).<sup>1</sup> The DWR, through the Nutrient Criteria Development Plan (NCDP), is evaluating existing nutrient-related criteria and will consider changes needed to support aquatic life in the Albemarle Sound region. For additional information, see **Chapter 4. Submerged Aquatic Vegetation Protection and Restoration through Water Quality Improvements.**

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Photo Credit: Joe Facendola

### 3. CLIMATE CHANGE AND RESILIENCY

#### 3.1 Introduction

Impacts from climate change including sea level rise (SLR) will affect all coastal habitats and species throughout NC. On October 29, 2018 in the wake of Hurricane Florence, NC's Governor Roy Cooper signed Executive Order 80 – NC's Commitment to Address Climate Change and Transition to a Clean Energy Economy (EO80) directing all cabinet agencies to integrate climate adaptation and resiliency planning into their policies, programs, and operations.<sup>1</sup> As part of this executive order, the Climate Change Interagency Council (Council) was created including members from all of the cabinet agencies. The Department of Environmental Quality (DEQ) was tasked to serve as the lead agency with the Secretary of DEQ serving as Council chair.

Staff from all DEQ divisions were active on the Council and associated working groups. These working groups, along with staff from the National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), NC State University's (NCSU) Institute for Climate Studies (NCICS), Duke University's Nicholas School of the Environment, and numerous other academics and stakeholders, developed a state-specific NC Climate Science Report (NCCSR), assessed hazards and risks associated with climate change, and compiled a Natural Working Lands (NWL) Report.<sup>2,3</sup> These efforts were incorporated into the 2020 NC Risk Assessment and Resilience Plan (2020 Resilience Plan)<sup>4</sup> with strategies and recommendations to increase carbon sequestration and resiliency of coastal habitats and communities. The 2016 CHPP provided valuable information during this process and many of the goals and recommendations from the 2016 CHPP were aligned in the 2020 Resilience Plan and NWL Action Plan.<sup>5</sup> Likewise, aspects of the NCCSR, 2020 Resilience Plan, and the NWL Action Plan will be integrated into this CHPP update wherever possible.

#### 3.2 Background

The foundation for addressing climate change related issues is the NCCSR, which is a scientific assessment of historical climate trends and potential future climate change specific to NC under increased greenhouse gas (GHG) concentrations.<sup>2</sup> For the NCCSR, statements about future changes refer to projections through the end of this century, and the following definitions apply:

**Virtually Certain** = 99-100% probability of outcome  
**Very Likely** = 90-100% probability of outcome  
**Likely** = 66-100% probability of outcome

The scientific understanding of the climate system strongly supports the conclusion that large changes in NC's climate, much larger than at any time in the state's history, are very likely by the end of this century under both the lower and higher GHG concentration scenarios.

North Carolina's annual average temperature has increased by about 1.0°F since 1895, somewhat less than the global average.<sup>2</sup> However, the most recent 10 years (2009-2018) represent the warmest 10-year period on record in NC, averaging about 0.6°F warmer than the warmest decade in the 20th century (1930-1939). Recently released data for 2019 indicate that it was the warmest year on record for NC. Although regional changes in temperature can vary from global changes, it is very likely that NC

## Chapter 3. Climate Change and Resiliency

temperatures will also increase substantially in all seasons. It is also very likely that the number of warm and very warm nights will increase, and summer heat index values will increase due to increases in absolute humidity. Just as the number of hot and very hot days is likely to increase, the number of cold days will likely decrease. Along the northeastern coast of NC, SLR is occurring about twice as fast as along the southeastern coast, averaging 1.8 inches per decade since 1978 at Duck, NC, and 0.9 inches per decade since 1935 at Wilmington, NC (Figure 3.1). It is virtually certain that SLR along the NC coast will continue to increase due to expansion of ocean water from warming and melting of ice on land, such as the Greenland and Antarctic ice sheets.

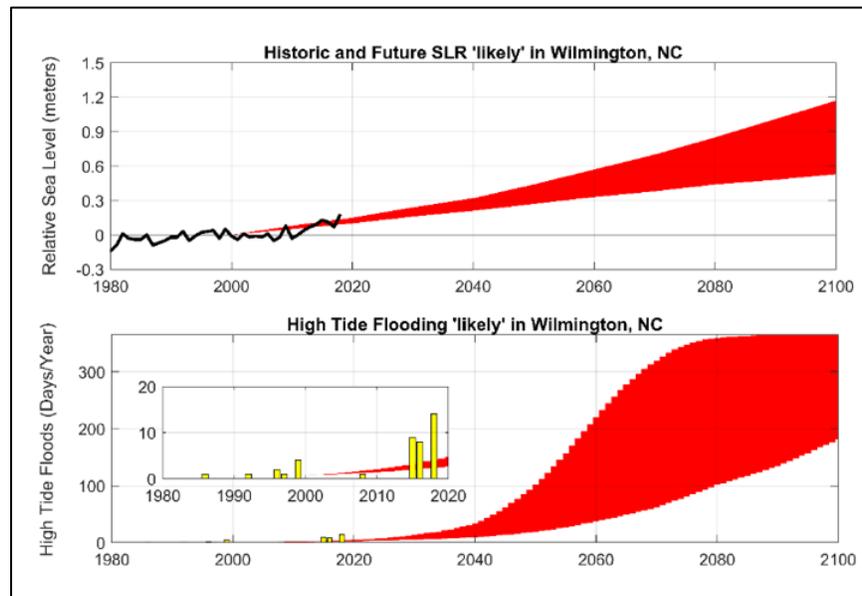


Figure 3.1. Historic and future relative sea level rise (SLR) and high tide flood events in Wilmington, NC.<sup>2</sup>

In NC, hurricanes have some of the most important impacts on the state, often catastrophic (storm surge, wind, and flooding damage), but sometimes environmentally beneficial (rainfall recharging soil moisture and groundwater aquifers). The intensity of the strongest hurricanes is likely to increase with warming temperature that could result in stronger hurricanes impacting NC.<sup>2</sup> Heavy precipitation accompanying hurricanes that pass near or over NC is very likely to increase, which would in turn increase the potential for freshwater flooding. These events could have major ramifications on the hydrology, carbon and nutrient loads, and habitat and water quality in the state. However, there is low confidence concerning future changes in the number of hurricanes making landfall in NC. Additionally, it is likely that the frequency of severe thunderstorms and the annual total precipitation in NC will increase. It is very likely that extreme precipitation frequency and intensity in NC will increase due to increases in atmospheric water vapor content. So, it is virtually certain that SLR and increasing intensity of coastal storms, especially hurricanes, will lead to increases in storm surge flooding in coastal NC. Additionally, changes to salinity, water temperatures, depth, and wave exposure are expected to affect habitat and fish distribution.

The repeated impacts and compounding losses from the effects of climate change, such as stronger hurricanes, more severe storms, SLR, and associated flooding events can be catastrophic not only to the coastal communities, but to the coastal habitats and the ecosystem services they support. While the risk and hazards associated with climate change and natural disasters cannot be eliminated, their affects can

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be lessened by increasing coastal resiliency. Coastal resiliency can be broken down into two parts that are intertwined: 1) community resiliency – the ability of a community to withstand, respond to, and recover from a disruption, and 2) ecosystem resiliency – the ability of the natural environment to withstand, respond to, and recover from a disruption, such as hurricanes, tropical storms, and flooding.<sup>4</sup> A resilient ecosystem is able to bounce back from disturbances over time while resistant ecosystems may withstand a disturbance or two but over time the ecosystem function is lost and unable to recover (Figure 3.2).

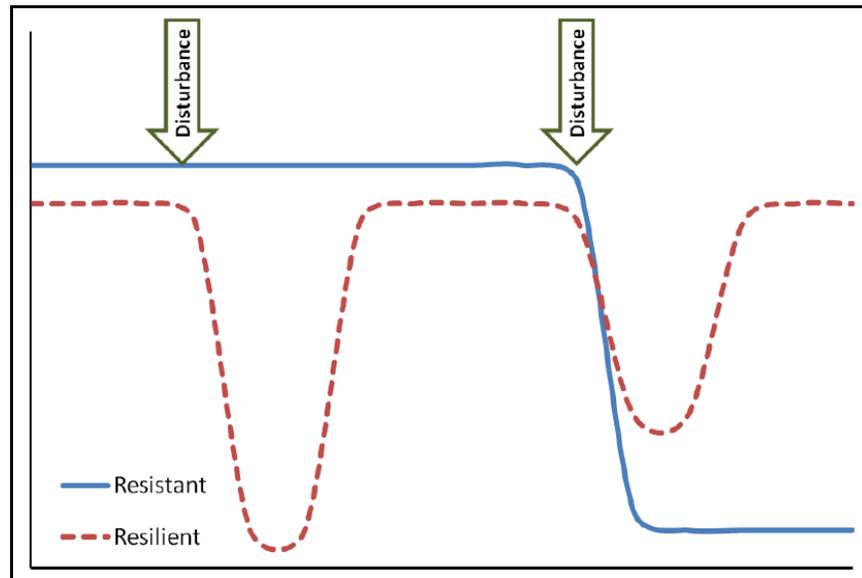


Figure 3.2. Illustration of the response of ecosystem function of resistant and resilient ecosystems after multiple disturbances.

### 3.3 Discussion

Coastal habitats contribute to the resilience and resistance of coastal communities and ecosystems by reducing coastal erosion and flooding by stabilizing sediment and attenuating waves (Figure 3.3a).<sup>6, 7, 8</sup> In NC, dunes are especially important for protecting the communities and habitats on the barrier islands, which are frequently exposed to waves and ocean overwash (Figure 3.3b). Other habitats like salt marsh and coastal forests also provide significant protection (Figure 3.3c).

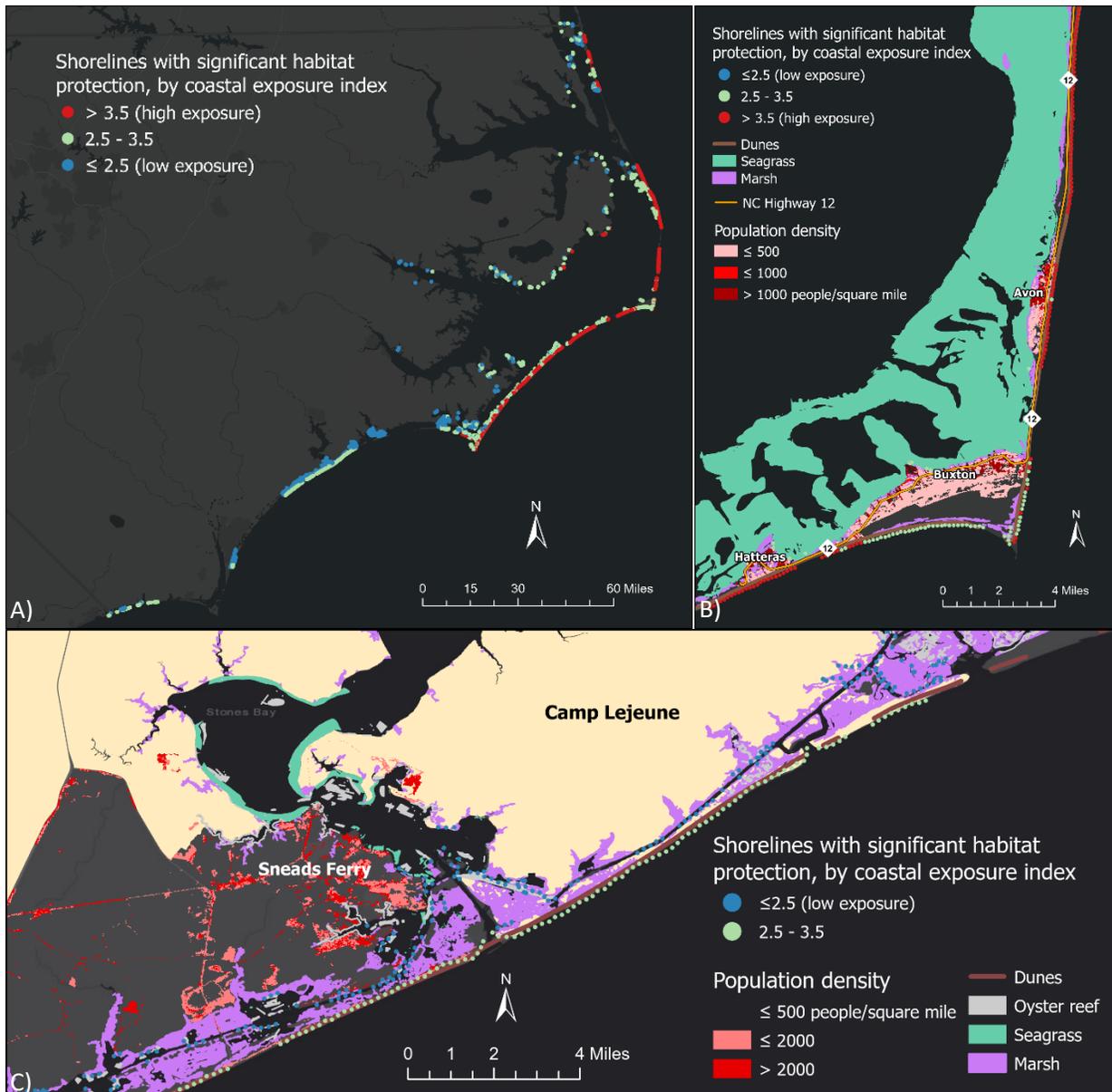


Figure 3.3. Shoreline protection by coastal habitats in NC. (a) Sections of the NC shoreline that benefit from significant protection by coastal habitats. Colors indicate how exposed the shoreline is to coastal hazards such as flooding and erosion. (b) Dunes protect the Outer Banks communities of Hatteras and Avon, in addition to NC Highway 12, the only access route for residents and tourists. (c) Salt marsh and dunes protect Camp Lejeune and the town of Sneads Ferry. Maps adapted from an updated analysis originally conducted for the 2020 NC Risk and Resilience Plan.<sup>4,9</sup>

Impacts from climate change including SLR will affect all coastal habitats and species throughout NC. Therefore, actions should be taken to make them more resilient to these disturbances and ensure coastal habitats and their valuable ecosystem services continue to persist. Changes to environmental variables, such as increased water temperatures due to warmer air temperatures and salinity due to increased freshwater runoff or breached inlets from hurricanes, will impact the distribution, range, and

## Chapter 3. Climate Change and Resiliency

abundance of coastal habitats and the species that use them for nursery, forage, spawning, and refuge. Impacts can be minimized and coastal resilience can be increased by conserving, protecting, and restoring coastal habitats that provide valuable ecosystem services and using natural and nature based infrastructure wherever possible.

Wetland loss due to SLR will likely outpace the rate of wetland migration inland in many areas, especially under higher rates of SLR (Figure 3.4). Currently, NC has about 220,000 acres of salt marsh. Much of this marsh is projected to be lost through drowning or erosion by the end of the century. Sea level rise will allow some marshes to migrate inland, partially offsetting the loss. In the lowest SLR scenario, there may be more marsh in 2100 than currently exists. However, the potential for marsh migration decreases at higher SLR elevations, resulting in greater net marsh loss.

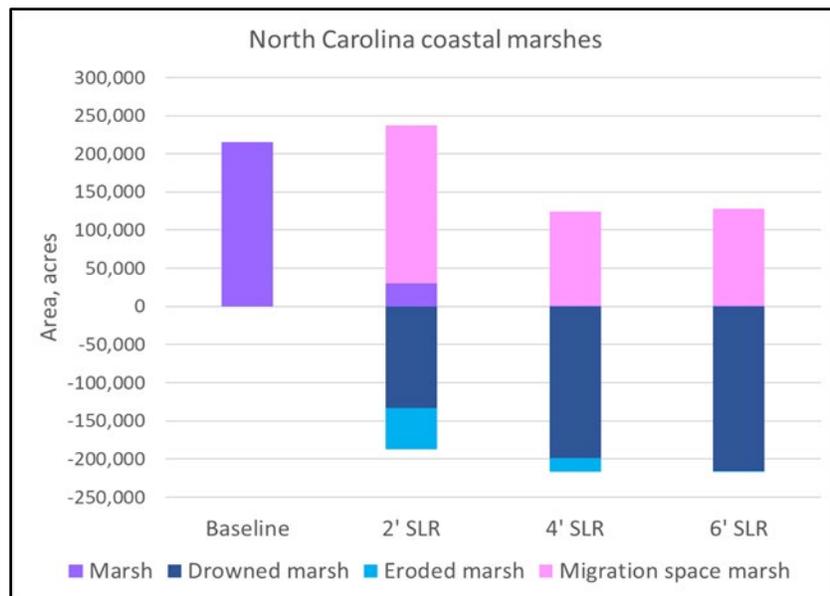


Figure 3.4. Projected coastal marsh area under three sea level rise (SLR) scenarios representing 2-6 feet of SLR by 2100, in comparison to current marsh extent. As SLR elevation increases, so does the area of marsh that is projected to drown due to SLR. North Carolina's low-lying coastal plain provides space for marsh migration under the lowest SLR scenario, but less space is available for migration under the higher scenarios. Data from an updated analysis originally conducted for the NC 2020 Risk and Resilience Plan.<sup>4,9</sup>

Assessing when certain areas of coastal marshes are likely to be lost due to SLR can help prioritize conservation and restoration (Figure 3.5). For example, marshes that are very vulnerable to SLR (projected to drown by 2050) are likely to need extensive intervention, such as thin-layer sediment deposition, to survive and may be too risky for investing limited resources for restoration. Marshes projected to persist to the end of the century could be good candidates for conservation and management to ensure they remain as healthy as possible.

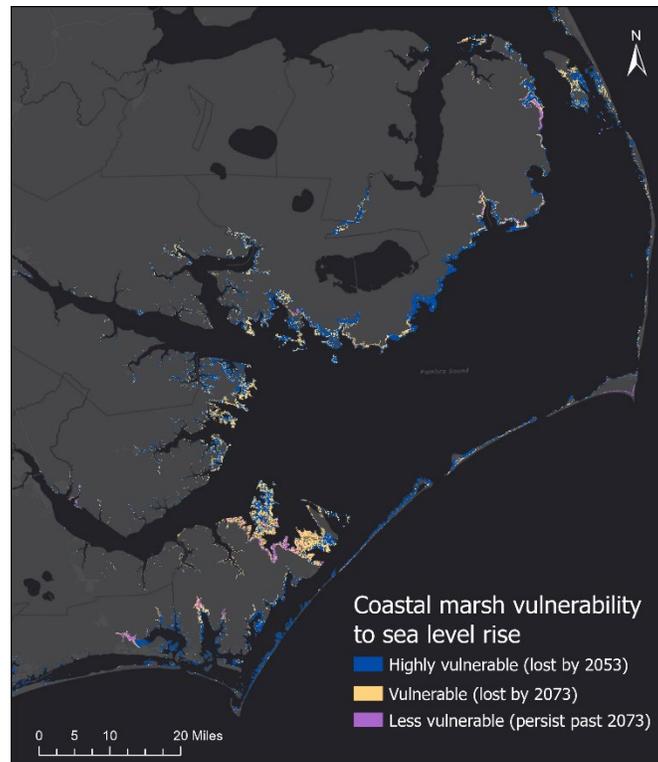


Figure 3.5. North Carolina coastal marshes' vulnerability to sea level rise (SLR). 134,000 acres (62%) of NC's marshes are projected to drown by 2053 and 194,000 acres (90%) by 2073 under the scenario projecting four feet of SLR by 2100.

Loss of wetlands will result in habitat losses that will impact the species that use them and degrade water quality due to the reduction in buffering capacity of nutrient rich stormwater runoff. For additional information, see **Chapter 5. Wetland Protection and Restoration through Nature-Based Solutions**. Extreme precipitation events result in flooding which leads to high loads of organic matter and organic nitrogen and phosphorus, fueling phytoplankton production and resulting in algal blooms and associated hypoxia. Runoff from agricultural fields and urban development also add to the contamination of floodwaters into the watershed. These impacts to water quality could have major detrimental effects on coastal habitats in NC.

Coastal marshes not only provide essential habitat and protect shorelines, but also store large amounts of carbon in their sediments. North Carolina's coastal marshes are currently estimated to store about 64 million metric tons CO<sub>2</sub>-e, equivalent to the state's gross GHG emission for five months.<sup>10</sup> These marshes are continuing to lock away approximately 200,000 metric tons CO<sub>2</sub>-e each year. When marshes drown or erode, not only do we lose their ongoing carbon sequestration function, but a significant proportion of this carbon is also released to the atmosphere, contributing to GHG emissions. Marsh loss due to SLR may turn NC's coastal habitats from a carbon sink into a carbon source (Figure 3.6).

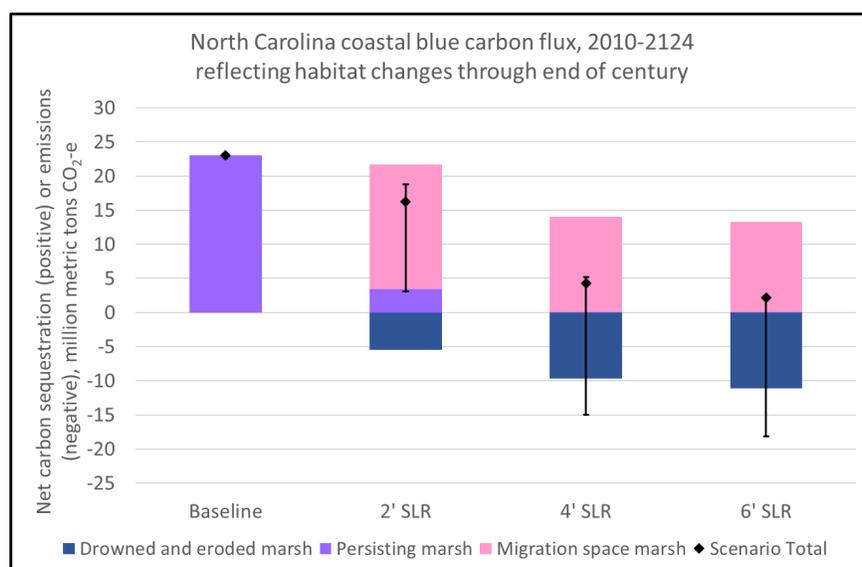


Figure 3.6. Projected net carbon flux from NC marshes through 2124, reflecting marsh loss due to sea level rise (SLR) compared to a baseline scenario (no SLR). Positive values indicate carbon sequestration by marshes; negative values indicate carbon released from drowned or eroded marshes. The black diamond shows the net carbon flux (sequestration minus emissions) for the scenario. There is high uncertainty about how much stored carbon is released when marshes drown or erode. These results assume 25 percent loss; the error bars show the range in net carbon flux when that assumption is varied. Data from an updated analysis originally conducted for the 2020 Resilience Plan.<sup>4,9</sup>

Submerged aquatic vegetation (SAV), also known as seagrass or underwater grass, is a critical coastal habitat for many important aquatic species, and is also highly responsive to degraded water quality including changes in salinity, water temperature, and water clarity, making SAV an ideal indicator species for water quality and climate change impacts. The expected changes to water conditions due to climate change are likely to result in varying distribution and reduced abundance of SAV. The impairment of water quality is one of the most widespread threats to SAV ecosystems, with global losses estimated at over 29 percent during the last century.<sup>11</sup> Along the Atlantic seaboard, SAV has already experienced significant declines directly or indirectly attributed to the stressors associated with degraded water quality. What distinguishes NC from other coastal seagrass systems on the Atlantic seaboard is the overlapping distribution of temperate and tropical seagrasses in the higher salinity waters: eel grass, *Zostera marina*, a temperate grass at the southernmost extent of its range, and shoal grass, *Halodule wrightii*, a tropical grass at the northern most extent of its range. It has been suggested that under the current emissions scenario, it is likely that eelgrass will be extirpated in NC and the Chesapeake Bay with the new southern range as far north as Long Island Sound by 2100.<sup>12</sup>

The effects of the climate-change-driven shift in distribution of SAV species will affect the aquatic organisms of the coast of NC that use the SAV as nursery areas, refuge from predation, and foraging for food. It has also been indicated that there is a potential for increased Harmful Algal Bloom (HAB) occurrence due to increased nutrient loading in the water and increasing water temperature attributed to changing climate.<sup>13</sup> In addition to causing detrimental impacts to water quality, fish, and habitats, particularly submerged aquatic vegetation (SAV) and shell bottom, HABs are unsightly, malodorous, and potentially hazardous to humans and pets if exposed to contaminated waters or consumed shellfish that have taken up the algae toxins. For additional information, see **Chapter 4. Submerged Aquatic Vegetation Protection and Restoration through Water Quality Improvements.**

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Shell bottom, composed of living or dead shellfish serves as both an important commercial and recreational fishery resource and an essential coastal habitat. Shellfish species found in NC include the Eastern oyster (*Crassostrea virginica*), Northern quahog or clam (*Mercenaria mercenaria*), and bay scallop (*Argopecten irradians*). Increased precipitation from hurricanes and storm events coupled with wetlands loss will increase the amount of nutrient rich and polluted stormwater runoff entering the estuaries. This can lead to hypoxic (low oxygen) conditions, resulting in mass mortality of shellfish and finfish. Smaller storm events can result in the closure of shellfish growing areas and recreational swimming advisories, all of which have economic impacts to the resource and the use of the public trust waters of NC. As sea level continues to rise, intertidal oysters will become inundated and must adapt to the subtidal environment. Additionally, increased water temperatures could result in more occurrences of illness from naturally occurring *Vibrio* species from shellfish consumption, which is a significant public health issue and can also disrupt shellfish markets.<sup>14</sup> The acidification of ocean waters, a consequence of excess carbon dioxide in the atmosphere, will also cause oysters and other shellfish to be unable to grow their shells. The loss of shell bottom habitat will not only affect these important fisheries, but the marine organisms that rely on them for habitat. As shell bottom and other coastal habitats are lost or shift in distribution and abundance due to climate change and anthropogenic impacts, they will need to be mapped and monitored to assess these changes and habitat conditions to ensure they persist. For additional information, see **Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends.**

The predicted impacts of climate change will have direct impacts on the finfish and invertebrate populations off NC's coast. In recent years, it has been predicted that hundreds of finfish and invertebrate species will be forced to move northward by climate change.<sup>15</sup> The range of valuable fisheries species in NC, including black sea bass (*Centropristis striata*) and summer flounder (*Paralichthys dentatus*), have already been seen shifting northward while other species such as white shrimp (*Litopenaeus setiferus*) are having greater biomass following warm winters.<sup>16</sup> Other species, such as spot (*Leiostomus xanthurus*) are shifting their migration route to occur further offshore or deeper in the water column, affecting catchability.<sup>17</sup> Environmental changes are affecting how species use certain estuaries and habitat types, such as bull sharks (*Carcharhinus leucas*) using NC's estuary as a nursery area when it has historically only been used as foraging grounds for adults.<sup>18</sup> Some species like Cobia (*Rachycentron canadum*) may be able to withstand the environmental fluctuations due to climate change that occur in coastal habitats and the broad environmental conditions their prey items can tolerate.<sup>19</sup> Under some future climate change scenarios, spotted seatrout (*Cynoscion nebulosus*) have been shown to increase range due to increased habitat suitability. However, under the same scenarios, their prey species show significant decreases which could result in a food-limited population.<sup>20</sup>

In addition to shifts in coastal habitat availability and species distribution, economic impacts and regulatory issues due to impacts from climate change will need to be addressed. North Carolina already exhibits one of the greatest northward shifts in commercial fishing effort, with average vessel landings occurring 24km further north each year.<sup>21</sup> As finfish move north, the commercial fishermen follow, resulting in NC fishermen landing more finfish in NC ports that were caught outside of state waters. This can cause confounding regulatory issues when trying to determine the new or expanded ranges and distributions of the finfish species. The management of commercially and recreationally important finfish and shellfish species and the coastal habitat they call home is vital to ensuring the sustainability of these species.

Since its inception, the CHPP has focused on identifying threats and recommending management actions to protect and restore habitats critical to NC's coastal fishery resources. The 2016 CHPP included priority

## Chapter 3. Climate Change and Resiliency

habitat issues focused on oyster restoration, living shorelines, sedimentation, and developing metrics to assess habitat trends along with implementation actions such as improving water quality by reducing stormwater runoff. These issues and actions are not only beneficial to the fishery habitats, but also increase coastal community and ecosystem resilience to climate change stressors. The CHPP has and will continue to highlight the importance of conserving, protecting, and restoring coastal habitats and the ecosystem services they provide, and will integrate climate adaptation and resiliency planning wherever possible. Recommendations and implementation actions from CHPP will continue to support and align with the 2020 Resilience Plan and NWL Action Plan.<sup>2,4</sup> With more interest and urgency sparked by the storm events of the last several years and Governor Cooper's EO80, the CHPP will play an even more important role in ensuring the future of coastal fishery habitats for the benefit and resiliency of all North Carolinians.<sup>1</sup>

All residents of the coast deserve to live, work, and play in healthy and safe communities, and all members of these coastal communities should have a voice in management decisions that affect their future. In Eastern NC, there are environmental justice issues where many communities struggle to safeguard the health of their residents from pollution and obtain help recovering from natural disasters. For the CHPP to ultimately succeed, the climate resilience of these communities must be directly addressed. The people living in these communities will have to be directly involved with local government and state agencies in finding the needed solutions.

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### 4. SUBMERGED AQUATIC VEGETATION PROTECTION AND RESTORATION THROUGH WATER QUALITY IMPROVEMENTS

#### 4.1 Issue

Protection and restoration of submerged aquatic vegetation (SAV) is critical for healthy fisheries in NC while providing additional valuable ecosystem functions and benefits that enhance coastal resiliency of aquatic life and coastal communities. Nationally, water quality, in particular water clarity, is recognized as one of the most significant factors limiting SAV distribution, abundance, survival, and expansion. Regionally, on the Atlantic seaboard of the US, large declines of SAV have been attributed to impaired water quality in neighboring estuaries both north (Chesapeake Bay) and south (Indian River Lagoon, FL) of NC. Environmental monitoring data indicate that water quality is also having an adverse impact on SAV in NC estuarine waters, especially in the lower salinity regions more directly impacted by numerous watersheds and coastal land use. Water quality impairment coupled with the expectation of sea level rise (SLR) and increasing water temperatures associated with climate change, will expose all NC SAV to multiple stressors that can limit their growth, reproduction, and distribution.

#### 4.2 Background

Currently, NC is steward to one of the most productive and biodiverse SAV resources on the Atlantic seaboard, including the largest polyhaline and mesohaline seagrass meadows in the temperate western Atlantic.<sup>1, 2, 3, 4, 5, 6</sup> SAV habitat is the foundation for ecological services that directly benefit the coastal ecosystems of NC and neighboring states.<sup>7, 8</sup> These services include primary and secondary fisheries production, habitat for fish, wildlife and waterfowl, sediment and shoreline stabilization, wave energy attenuation, water purification, and carbon sequestration. Recently, it has been shown that SAV may reduce bacterial pathogens that can cause disease in humans and marine organisms.<sup>9</sup> All these services are important to ecosystem health and provide increased community and ecosystem resilience.<sup>10</sup> Resource valuation studies indicate that the monetary value of the ecosystem services provided makes SAV habitat protection and restoration a priority conservation and management issue. SAV contributes to coastal resilience and economic and cultural values from local coastal communities and residents statewide, to the millions of annual visitors to NC.<sup>6, 11, 12, 13, 14, 15</sup>

Through work funded by Albemarle-Pamlico National Estuary Partnership (APNEP), it has been reported that estimates of economic loss increase proportionately with declines in SAV in the Albemarle-Pamlico estuary.<sup>16</sup> Based on economic losses to commercial and recreational fisheries, residential property values, and carbon sequestration, they conservatively estimated an aggregate loss of \$1,290 per acre over the next decade. It was found that a five percent decadal decline in SAV acreage would generate total economic loss of \$8.6 million in 2019 dollars. If SAV acreage loss were to accelerate to 50 percent, the estimated total economic loss would be \$88.7 million over a decade. In both cases, most of the loss comes from declines in carbon sequestration.

Submerged aquatic vegetation is important to many aquatic organisms at some point in their life cycle, with fish and invertebrates depending on SAV for refuge, spawning, nursery, foraging, and corridor needs.<sup>1</sup> Because of the seasonal abundance patterns of SAV, refuge and foraging habitat are provided almost year round for estuarine-dependent species.<sup>17</sup> Fish and invertebrate use of SAV differs spatially and temporally due to distribution ranges, time of recruitment, and life histories.<sup>18, 19, 20</sup> Table 4.1 provides a list of species that use SAV in NC.

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Table 4.1. List of fish and invertebrates documented to use Submerged Aquatic Vegetation (SAV) in NC. Names in bold are species with relative abundances reported in literature as higher in SAV than other habitats. Note: lack of bolding does not imply non-selective use of the habitat, but lack of information.<sup>1, 6, 21, 22, 23, 24, 25</sup>

Species	Refuge	Submerged Aquatic Vegetation (SAV) Functions			
		Spawning	Nursery	Foraging	Corridor
River herring*	X		X	X	X
Striped bass				X	
<b>Yellow perch</b>		<b>X</b>			
American eel	X		X	X	X
<b>Bay scallop</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	
<b>Blue crab</b>	<b>X</b>		<b>X</b>	<b>X</b>	<b>X</b>
<b>Grass shrimp</b>	<b>X</b>		<b>X</b>	<b>X</b>	
<b>Hard clam</b>	<b>X</b>		<b>X</b>	<b>X</b>	
<b>Red drum</b>	<b>X</b>		<b>X</b>	<b>X</b>	<b>X</b>
<b>Spotted seatrout</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
Weakfish	X		X	X	X
Atlantic croaker	X		X	X	X
Atlantic menhaden	X		X	X	X
<b>Brown shrimp</b>	<b>X</b>		<b>X</b>	<b>X</b>	<b>X</b>
Southern flounder			X	X	
Spot	X		X	X	X
Striped mullet	X		X	X	X
White shrimp	X		X	X	X
Black sea bass	X		X	X	X
Bluefish			X	X	
Gag	X		X	X	X
Kingfish spp.	X		X	X	X
<b>Pinfish</b>	<b>X</b>		<b>X</b>	<b>X</b>	<b>X</b>
<b>Pink shrimp</b>	<b>X</b>		<b>X</b>	<b>X</b>	<b>X</b>
<b>Smooth dogfish</b>				<b>X</b>	
Spanish mackerel			X	X	
Summer flounder			X	X	

\*Includes blueback herring and alewife

The Fisheries Reform Act of 1997 requires the DMF to prepare fishery management plans (FMP) for adoption by the NC Marine Fisheries Commission (MFC) for all commercially and recreationally significant species or fisheries that comprise state marine and estuarine resources. The goal of the plans is to ensure long-term viability of these fisheries. Fisheries habitat and water quality considerations are one of several requirements of these plans and are to be consistent with the CHPP. Several state FMPs list SAV and water quality management actions because of the importance of SAV and water quality to the different fisheries that are managed and prosecuted within the state. The Blue Crab Fishery Management Plan Amendment 3 is the latest plan with management actions that focus on water quality.<sup>26</sup> One action specifically tasks the CHPP Steering Committee to prioritize blue crab water quality impacts (Table 4.2). The Blue Crab FMP is one of several FMPs that have both SAV and water quality management actions that overlap with the CHPP issue of protection and restoration of SAV through water quality improvements (Table 4.2).

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Table 4.2. The NC State Fishery Management Plans (FMPs) with submerged aquatic vegetation (SAV) and water quality management actions.

NC Fishery Management Plan	Habitat and Water Quality Management Actions
Bay Scallop Amendment 2 (2015) <sup>27</sup>	<ul style="list-style-type: none"> <li>• Remap and monitor SAV coverage in NC to assess distribution and change over time</li> <li>• Restore coastal wetlands to compensate for previous losses and enhance water quality conditions for the bay scallop</li> <li>• Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry</li> <li>• Reduce impervious surfaces and increase on-site infiltration of stormwater through voluntary or regulatory measures</li> <li>• Aggressively reduce point and non-point nutrient and sediment loading in estuarine waters, to levels that will sustain SAV habitat, using regulatory and non-regulatory actions</li> </ul>
Blue Crab Amendment 3 (2020) <sup>26</sup>	<ul style="list-style-type: none"> <li>• Create a joint interagency work group</li> <li>• Task the CHPP steering committee to prioritize blue crab water quality impacts</li> <li>• Send letters to other state agencies sharing concerns about water quality and Best Management Practices</li> <li>• Invite other agencies to future Marine Fisheries Commission (MFC) meetings to present their efforts to address water quality</li> </ul>
Estuarine Striped Bass Amendment 1 (2013) <sup>28</sup>	<ul style="list-style-type: none"> <li>• Work with NC Wildlife Resources Commission (WRC), Division of Water Resources (DWR), and others to implement management measures that will enhance water quality in Strategic Habitat Areas (SHAs) used by striped bass</li> <li>• Division of Marine Fisheries (DMF) and WRC should work with DWR and other agencies to initiate efforts to determine and establish more stringent water quality standards in waters designated as Anadromous Fish Spawning Areas (AFSAs)</li> </ul>
Kingfishes (2007) <sup>29</sup>	<ul style="list-style-type: none"> <li>• Reduce nutrient and sediment loading in the Albemarle-Pamlico system, particularly the Neuse and Tar-Pamlico rivers, to levels that will support SAV, using regulatory and non-regulatory actions</li> <li>• Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry</li> <li>• Increase on-site infiltration of stormwater through voluntary or regulatory measures</li> <li>• Modify stormwater rules to more effectively reduce the volume and pollutant loading of stormwater runoff entering coastal waters</li> </ul>
River Herring Amendment 2 (2015) <sup>30</sup>	<ul style="list-style-type: none"> <li>• Work with other agencies to identify potential incentives for landowners for protection of riparian buffers in the management area</li> <li>• Develop, identify and clarify what critical habitat actions are needed to protect, enhance and restore habitats and water quality affecting river herring.</li> </ul>
Southern Flounder Amendment 1 (2013) <sup>31</sup>	<ul style="list-style-type: none"> <li>• Coordinate SAV mapping efforts such that statewide monitoring and trend analysis can be conducted most efficiently</li> <li>• Reduce point and non-point nutrient and sediment loading in estuarine waters, to levels that will sustain SAV, using relevant standards and regulatory/non-regulatory actions</li> <li>• Acquire updated and coast-wide data on bathymetry, sediment type, and pollutant concentrations</li> <li>• Increase coverage of waters assessed for aquatic life and increase coverage of continuous monitoring stations</li> <li>• Restore hydrology on lands used for silviculture, agriculture, and urban development using Best Management Practices (BMPs)</li> </ul>
Spotted Seatrout Revision (2014) <sup>32</sup>	<ul style="list-style-type: none"> <li>• Continue mapping of SAV in NC to assess distribution and change over time</li> <li>• Aggressively reduce point and non-point nutrient and sediment loading in estuarine waters, to levels that will sustain SAV, using regulatory and non-regulatory actions</li> <li>• Work with National Oceanic and Atmospheric Administration (NOAA) and DWR to determine appropriate levels of total suspended solids (TSS), turbidity, chlorophyll <i>a</i>, and other water clarity parameters to achieve adequate water quality conditions for SAV growth, and model potential SAV habitat</li> </ul>

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NC Fishery Management Plan		Habitat and Water Quality Management Actions
		<ul style="list-style-type: none"> <li>Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry</li> <li>Increase on-site infiltration of stormwater through voluntary or regulatory measures</li> <li>Work with DWR and the NC Environmental Management Commission (EMC) to modify stormwater rules to more effectively reduce runoff volume and pollutant loading to coastal waters to levels that protect and enhance fish habitats vital to spotted seatrout</li> <li>Reduce impervious surfaces associated with new development as much as possible and reduce the maximum amount of impervious surfaces allowed in the absence of engineered stormwater controls</li> </ul>
Striped Mullet Amendment 1 (2015) <sup>33</sup>		<ul style="list-style-type: none"> <li>Develop and maintain accurate maps and documentation of wetlands, soft bottom, SAVs, and water column</li> <li>Support research on the causes of hypoxia and anoxia and impacts on striped mullet populations in NC's estuarine waters</li> </ul>

There are two distinct groups of SAV habitats in NC distributed according to estuarine salinity. One group thrives in fresh and low salinity riverine waters ( $\leq 10$  ppt), referred to as low salinity SAV. The second group occurs in moderate to high ( $> 10$  ppt) salinity estuarine waters of the bays, sounds, and tidal creeks, referred to as high salinity SAV or seagrasses. Collectively they are referred to as SAV. These groups are distinguished by different species composition and environmental requirements, and have characteristics similar to SAV communities found in many other estuaries in the US (Table 4.3).<sup>34, 35</sup>

Table 4.3. Average environmental requirements at locations where submerged aquatic vegetation (SAV) occurred in coastal NC, 1988-1991.<sup>1</sup>

SAV species	Environmental parameter					
	Salinity (ppt)		Secchi depth m (ft)		Water depth m (ft)	
	Range	Average	Range	Average	Range	Average
<b>HIGH SALINITY (&lt;10-30 ppt)</b>						
Eel grass ( <i>Zostera marina</i> )	10 $\geq$ 36	26	0.3 - 2.0 (1.0 - 6.6)	1.0 (3.3)	0.4 - 1.7 (1.3 - 5.6)	1.2 (3.9)
Shoal grass ( <i>Halodule wrightii</i> )	8 $\geq$ 36	25	0.4 - 2.0 (1.3 - 6.6)	1.0 (3.3)	0.1 - 2.1 (0.3 - 6.9)	0.8 (2.6)
Widgeon grass ( <i>Ruppia maritima</i> )	0 - 36	15	0.2 - 1.8 (0.7 - 5.9)	0.7 (2.3)	0.1 - 2.5 (0.3 - 8.2)	0.8 (2.6)
<b>FRESHWATER-LOW SALINITY (0-<math>\geq</math>10 ppt)</b>						
Redhead grass ( <i>Potamogeton perfoliatus</i> )	0 - 20	1	0.4 - 1.4 (1.3 - 4.6)	0.9 (3.0)	0.4 - 2.4 (1.3 - 7.9)	0.9 (3.0)
Wild celery ( <i>Vallisneria Americana</i> )	0 - 10	2	0.2 - 2.0 (0.7 - 6.6)	0.6 (2.0)	0.2 - 2.3 (0.7 - 7.6)	1.0 (3.3)
Eurasian watermilfoil ( <i>Myriophyllum spicatum</i> )	0 - 10	2	0.2 - 1.4 (0.7 - 4.6)	0.6 (2.0)	0.5 - 2.4 (1.6 - 7.9)	1.1 (3.6)
Bushy pondweed ( <i>Najas guadalupensis</i> )	0 - 10	1	0.2 - 2.0 (0.7 - 6.6)	0.7 (2.3)	0.5 - 1.7 (1.6 - 5.6)	1.0 (3.3)
Sago pondweed ( <i>Stuckenia pectinate</i> )	0 - 9	2	0.2 - 0.4 (0.7 - 1.3)	0.3 (1.0)	0.6 - 0.9 (2.0 - 3.0)	0.8 (2.6)

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North Carolina is unique among other coastal SAV ecosystems on the Atlantic seaboard because of overlapping distributions of temperate and tropical seagrasses in relatively higher salinity waters.<sup>1, 36</sup> Eel grass (*Zostera marina*) is a temperate species at the southern limit of its western Atlantic range in NC. In contrast, shoal grass (*Halodule wrightii*) is a tropical species that reaches its northernmost extent in NC. Widgeon grass (*Ruppia maritima*) has a wide salinity tolerance, but grows best in moderate salinity areas. The co-occurrence of these three SAV species in NC, results in high coverage of shallow bottom areas in NC's estuaries, both spatially and temporally.<sup>4</sup> In NC, perennial and annual meadows of eelgrass are common in shallow, protected estuarine waters in the winter and spring when temperatures are cooler. However, in the summer when water temperatures are above 20-25°C (68-77°F), shoal grass is more abundant while eelgrass survives where water temperatures are relatively cooler in deeper sub-tidal areas, especially locations with continuous water flow.<sup>24</sup>

SAV occurs in subtidal and intertidal areas of sheltered estuarine and riverine waters where there is unconsolidated sediment, adequate light reaching the bottom, and moderate to negligible current velocities or wave turbulence.<sup>1, 4</sup> The primary factors controlling SAV distribution are water depth, sediment composition, wave energy, and the penetration of light through the water column.<sup>37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49</sup>

Because SAVs are rooted in anaerobic sediments, they need to produce a large amount of oxygen to aerate the roots, and therefore have the highest light requirements of all aquatic plants.<sup>6, 34</sup> SAV can become stressed by eutrophication and other environmental conditions which impair water transparency and/or diminish the oxygen content of water and sediments. The plant's response to these factors makes them a sensitive bio-indicator of environmental health.<sup>48, 49</sup> Required light conditions can vary by species; low salinity grass species have slightly lower light requirements of >9 percent of surface incident light required at the leaf and >13 percent of surface incident light required through the surface compared to >15 percent and >22 percent, respectively, for species found in moderate to high salinity areas.<sup>45, 50, 51</sup>

High salinity SAV in coastal NC occurs on shallow back-barrier bars behind the Outer Banks (Pamlico, Core, Back, and Bogue sounds), and along the mainland shores.<sup>6, 52</sup> Estuarine high salinity SAV occurs at a smaller scale in protected coastal embayments, marsh channels and along the Intracoastal Waterway, south of Bogue Inlet to around Mason's Inlet in northern New Hanover County. It has been documented in the New River, Chadwick Bay, Topsail Sound, and along the edges of creeks and the Intracoastal Waterway as far south as northern New Hanover County. In the fresh and brackish water portions of NC estuaries, low salinity SAV is abundant in larger black water systems, but rare in small black water streams, due to tannic water, irregular flows, and shading from forested wetlands. SAV can be extensive in low-salinity back bays and lagoons, such as Albemarle and Currituck sounds, tributaries of the Pamlico and Neuse rivers, and in coastal lakes like Lake Mattamuskeet (not included in SAV coverage estimates).<sup>53</sup>

There have been various mapping projects over the last 40+ years by several universities, and state and federal agencies. The data sources, mapping years, methodology, and extent of each individual mapping event are described in Table 4.4. These individual mapping events compiled together make up the historically known presence and suitable habitat of SAV along NC's coast, and suggests a historic extent of approximately 191,155 acres of SAV in public trust waters (Table 4.5; Figures 4.1-4.9). Additional mapping and monitoring of fresh and brackish SAV have occurred with hydroacoustic surveys, and the establishment of sentinel sites in recent years in the Neuse and Pamlico rivers and Albemarle Sound.<sup>54, 55, 56, 57</sup> Coastwide aerial photography mapping of high salinity SAV occurred in 2019 and 2020 with

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funding from NC Department of Environmental Quality (DEQ) and APNEP. This imagery is currently being processed and will be incorporated into this SAV mosaic along with future efforts to better inform the known historic and current extent of SAV in NC.

Table 4.4. Data sources, mapping years, methodology, and extent of each individual submerged aquatic vegetation (SAV) mapping event along the NC coast, 1981 to 2015.

Data Source	Mapping Year(s)	Methodology	Mapping Extent
Carraway & Priddy (1983) <sup>2</sup>	1981	Maps of SAV were created from aerial natural color photography accompanied by ground truth data for verification including location and density.	May 1981: Bogue and Core sounds
Ferguson & Wood (1994) <sup>4</sup>	1983, 1985, 1988, 1990, 1992	SAV was delineated and mapped from natural color aerial photography with a minimum mapping unit of 20m. Accompanying field inventories were conducted within study regions to verify SAV signatures and species distribution and composition.	1990: Currituck, Albemarle and Roanoke/Croatan Sounds 1991: Pamlico River Estuary, Neuse River Estuary, western Pamlico Sound and Albemarle Sound 1992: Pamlico River, Core and Bogue sounds and parts of eastern Pamlico Sound, western Pamlico Sound, Perquimans River
Division Water Quality (DWQ) 1998 (Now DWR)	1998	Maps from aerial photography	Neuse River and tributaries
Eastern Carolina University (ECU)	2002-2003, 2006	Maps from aerial photography	Albemarle and Currituck sounds
North Carolina State University (NCSU) <sup>58</sup>	2005	Aerial photography from July 2005 accompanied by ground truth data	Southern shore of Albemarle Sound including Bull Bay to northern Croatan Sound
Division Water Quality Rapid Response Team (Now DWR) <sup>59, 60</sup>	2005-2008	Maps from interpolated transect data. SAV was observed and collected using a garden rake from boat, traveling along the shoreline.	2005 & 2006 (June-September): major tributaries of Neuse and Pamlico Rivers 2007 (May-August): Neuse and Pamlico Rivers and tributaries
Marine Corps Air Station Cherry Point <sup>61</sup>	2007	Field survey's consisting of visual observations and underwater cameras and aerial survey analysis of hyperspectral imagery.	Mouth of the Neuse River near Point of Marsh.
Albemarle Pamlico National Estuarine Partnership (SAV Partners) <sup>62, 63</sup>	2006-2008	SAV was mapped along the coast of NC and northward into Back Bay, Virginia by manually digitizing visible SAV from remotely-sensed imagery.	This extent encompasses the coastal zone that lies within the APNEP regional boundary (Bogue Inlet north to Back Bay), as well as that which is outside of that boundary (Bogue Inlet south to Masonboro Inlet).
	2012-2013	SAV was mapped along the coast of NC by manually digitizing visible SAV from remotely-sensed imagery.	This extent encompasses the high-salinity coastal zone that lies within the APNEP regional boundary (Hwy. 64 Bridge of Roanoke Sound south to Bogue Inlet).
DEQ, DOT, & NOAA <sup>64</sup>	2015	SAV was mapped along the Southern coast of NC by manually digitizing visible SAV from remotely-sensed imagery.	This extent encompasses the high-salinity coastal zone of Onslow Bay that lies south of the APNEP regional boundary.

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Table 4.5. The known historical extent of mapped submerged aquatic vegetation (SAV) in NC, 1981-2015.

Salinity Zone	SAV Region #	SAV Region Name	Historic Extent* (ac)	Percent of Historical Extent* (%)
Low	1	Currituck and Back Bay	21,613	11.3
Low	2	Albemarle Sound	12,872	6.7
Low	3	Tar-Pamlico & Neuse rivers	4,581	2.4
High	4	Pamlico Sound	712	0.4
High	5	Roanoke Sound to Ocracoke Inlet	101,739	53.2
High	6	Core Sound	36,862	19.3
High	7	Bogue Sound	10,826	5.7
High	8	Bear Inlet to Snow's Cut	1,950	1.0
High/Low	9	Cape Fear River to SC line	0	0.0
<b>Total</b>			<b>191,155</b>	<b>100.0</b>

\*SAV Mosaic 1981 to 2015 (as of 6/3/2020)



Photo Credit: unknown

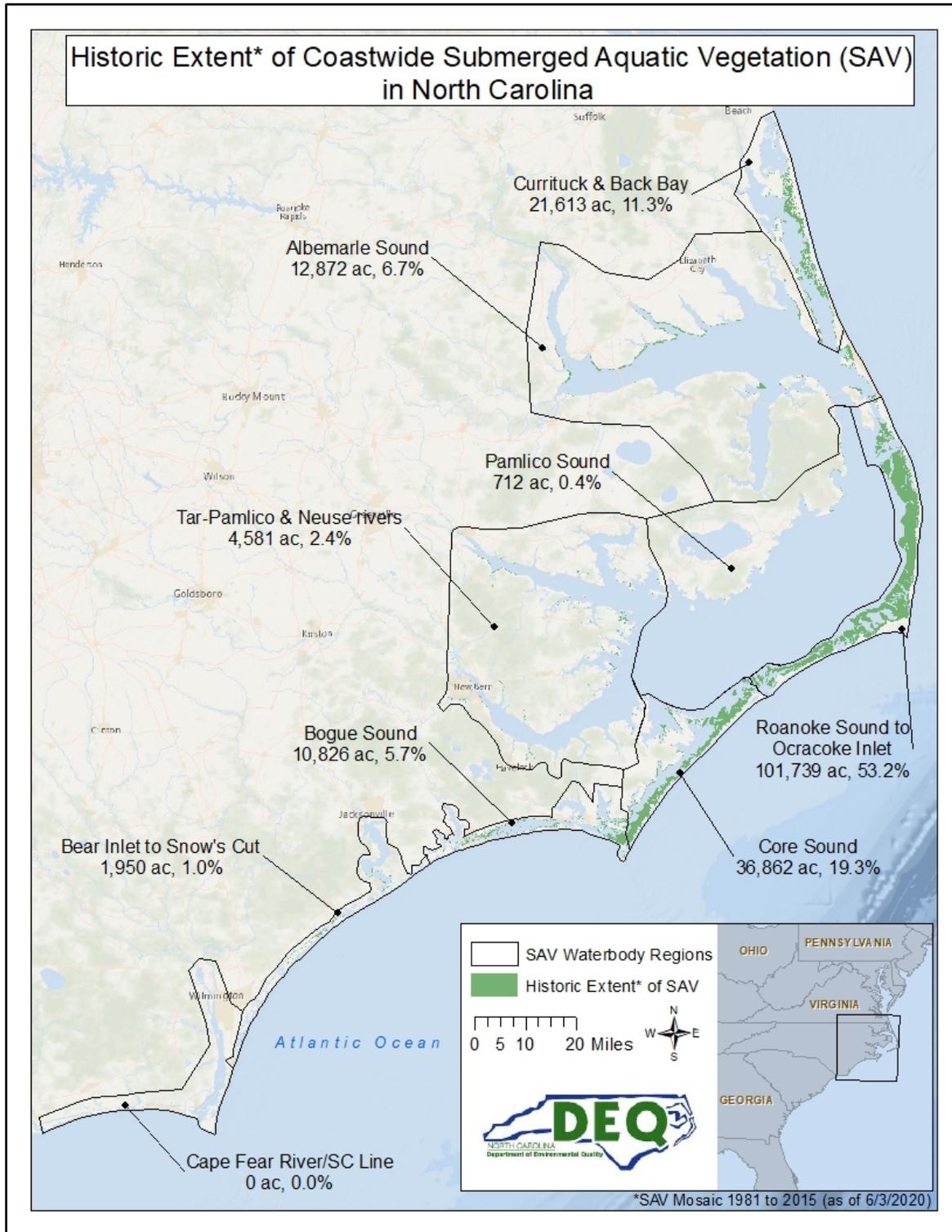


Figure 4.1. Known historic extent of submerged aquatic vegetation (SAV) mapped in NC, 1981 to 2015. Absence of SAV does not suggest actual absence, as surveys have not been conducted in all areas. Presence of SAV does not reflect current state, as data dates to 1981.

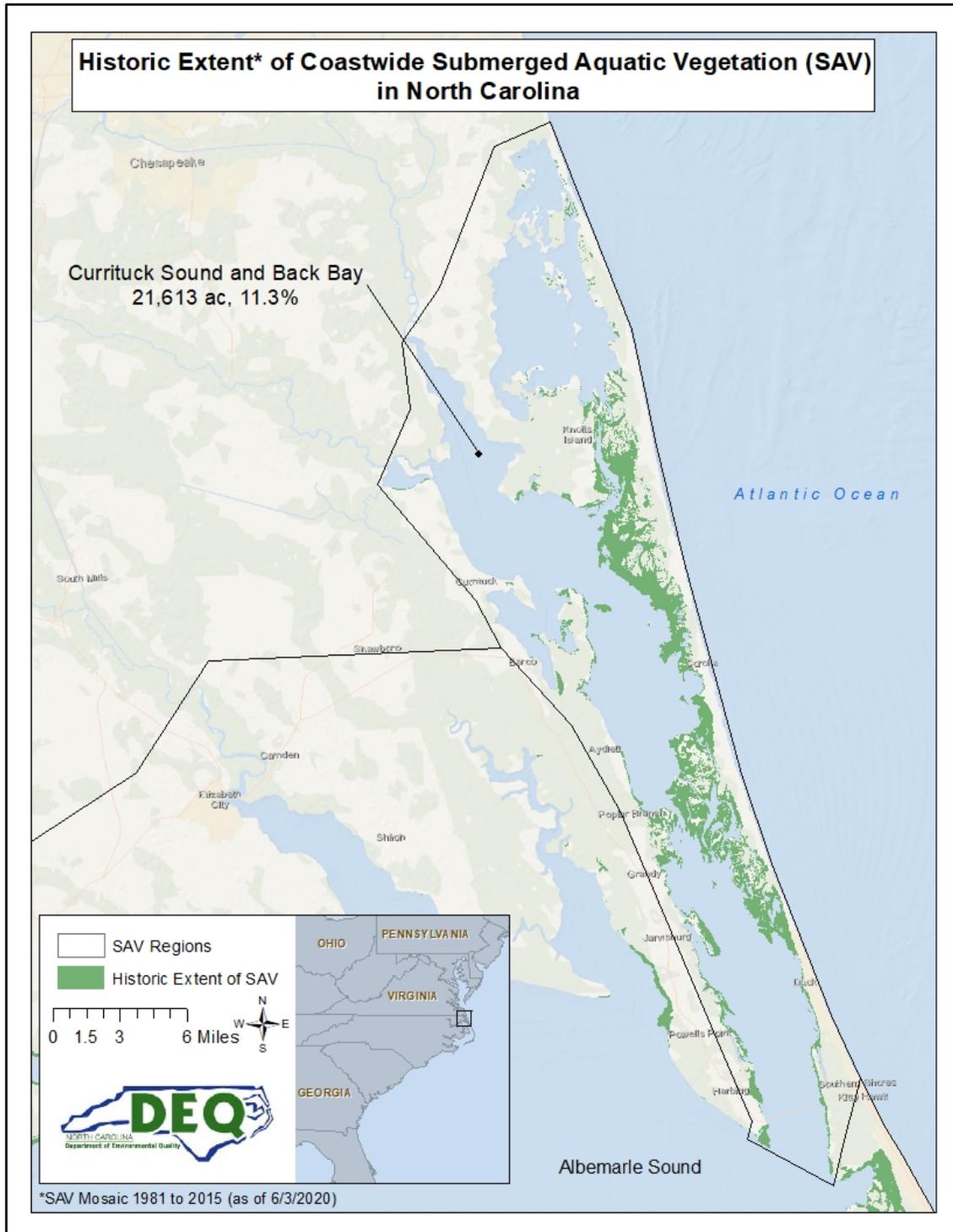


Figure 4.2. Known historic extent of submerged aquatic vegetation (SAV) in mapped in Currituck and Back Bay, NC, 1981 to 2015. Absence of SAV does not suggest actual absence, as surveys have not been conducted in all areas. Presence of SAV does not reflect current state, as data dates to 1981.

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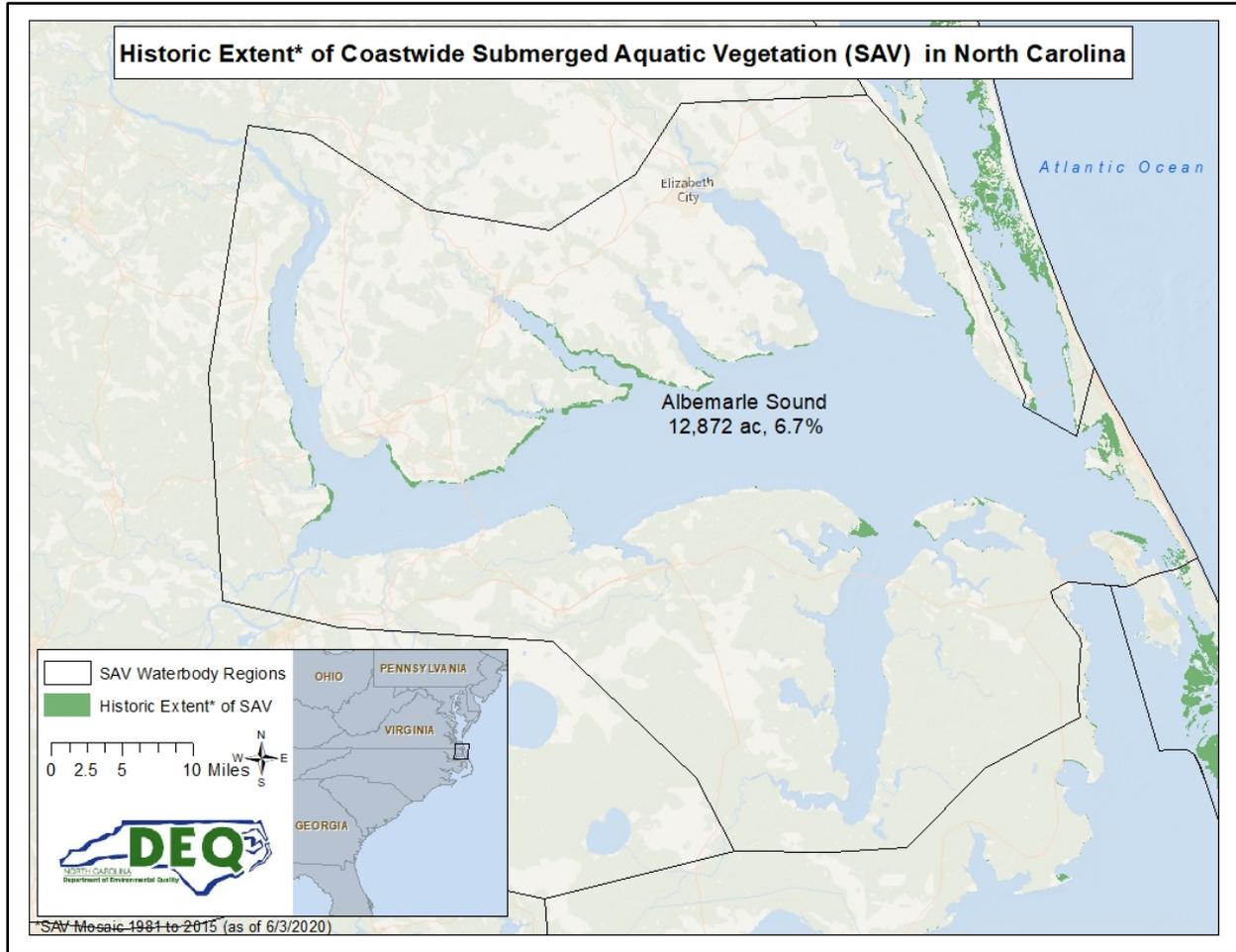


Figure 4.3. Known historic extent of submerged aquatic vegetation (SAV) mapped in Albemarle Sound, NC, 1981 to 2015 in. Absence of SAV does not suggest actual absence, as surveys have not been conducted in all areas. Presence of SAV does not reflect current state, as data dates to 1981.

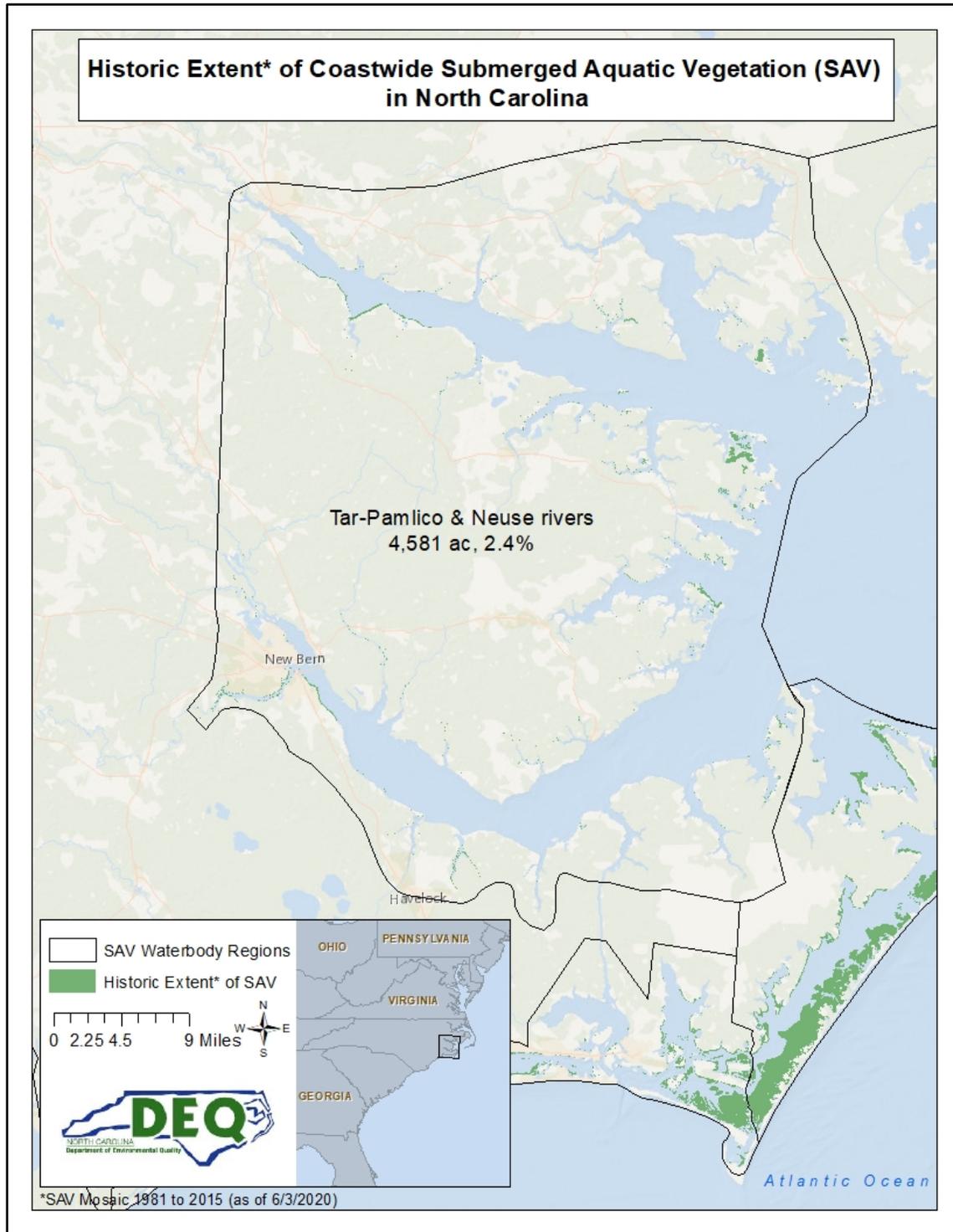


Figure 4.4. Known historic extent of submerged aquatic vegetation (SAV) mapped in in Tar-Pamlico and Neuse rivers, NC, 1981 to 2015. Absence of SAV does not suggest actual absence, as surveys have not been conducted in all areas. Presence of SAV does not reflect current state, as data dates to 1981.

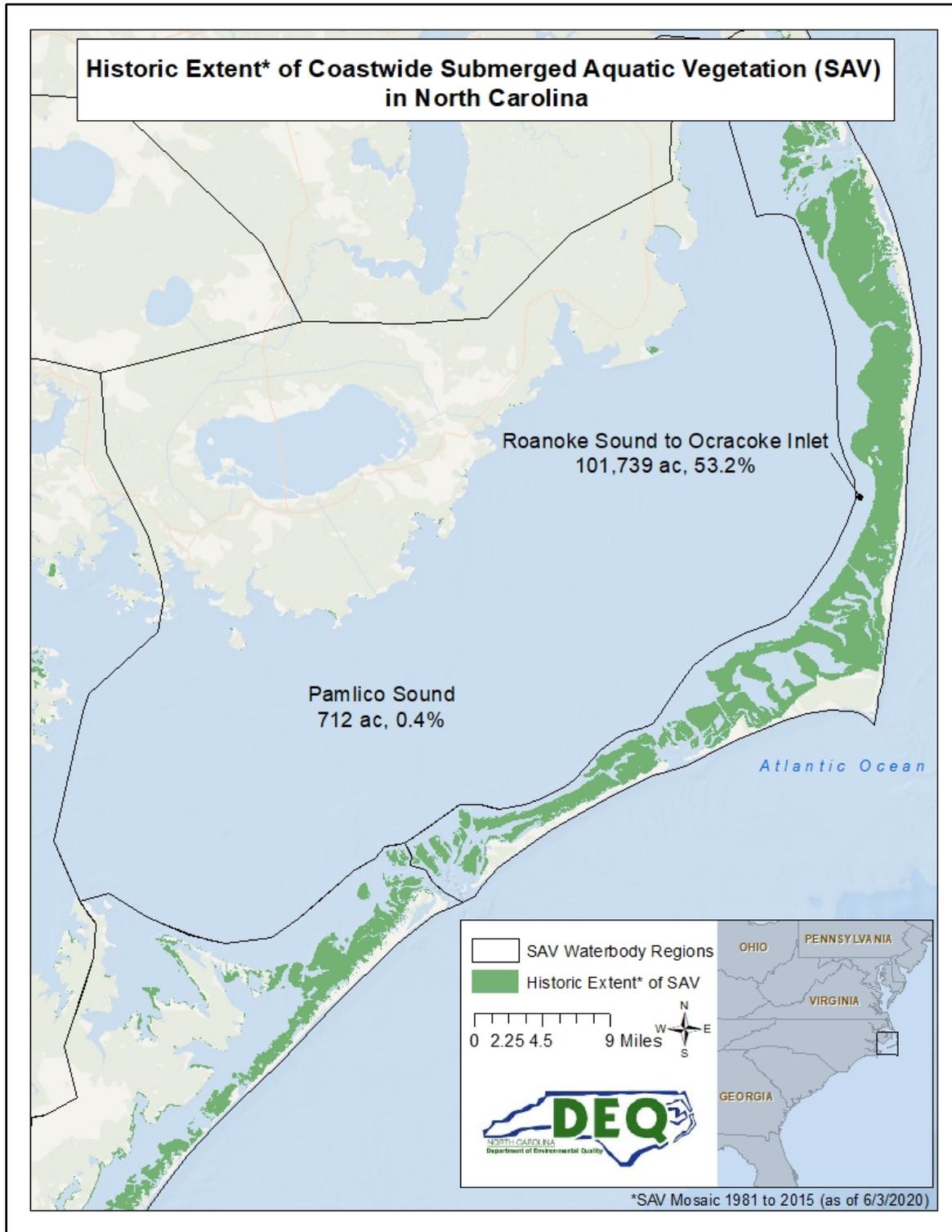


Figure 4.5. Known historic extent of submerged aquatic vegetation (SAV) mapped in Pamlico Sound, NC, 1981 to 2015. Absence of SAV does not suggest actual absence, as surveys have not been conducted in all areas. Presence of SAV does not reflect current state, as data dates to 1981.

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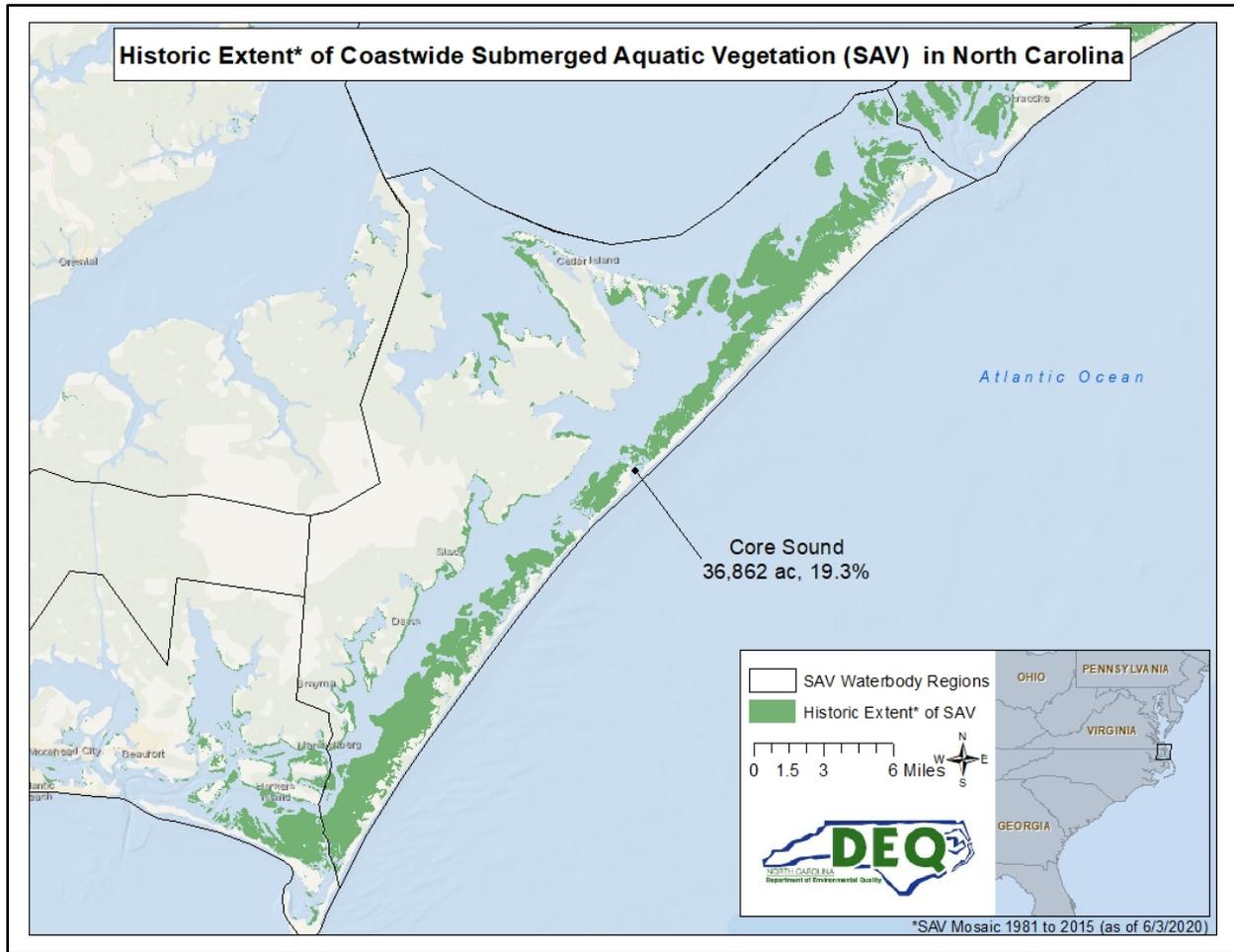


Figure 4.6. Known historic extent of submerged aquatic vegetation (SAV) mapped in Core Sound, NC, 1981 to 2015. Absence of SAV does not suggest actual absence, as surveys have not been conducted in all areas. Presence of SAV does not reflect current state, as data dates to 1981.



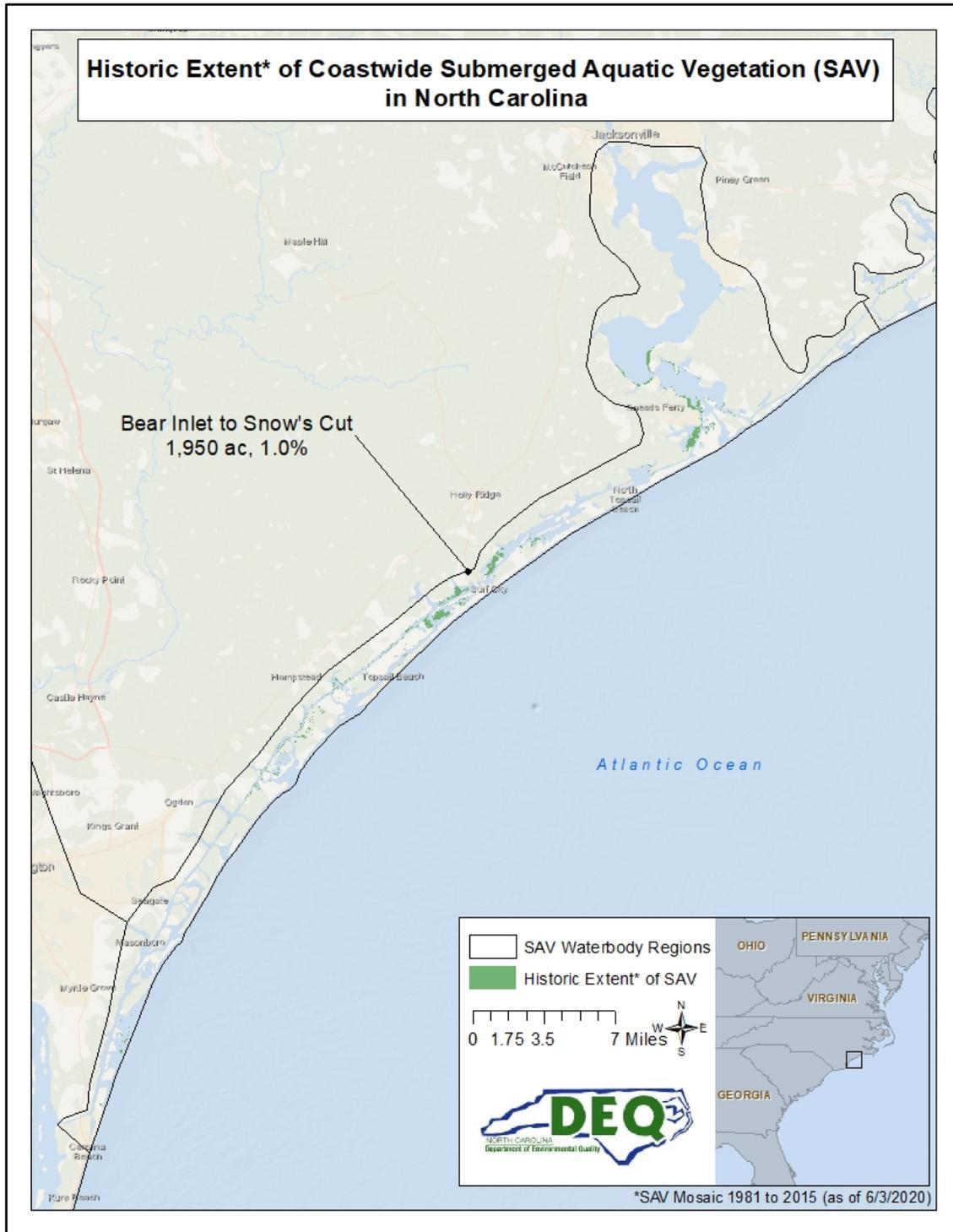


Figure 4.8. Known historic extent of submerged aquatic vegetation (SAV) mapped from Bear Inlet to Snows Cut, NC, 1981 to 2015 in Bear Inlet to Snows Cut. Absence of SAV does not suggest actual absence, as surveys have not been conducted in all areas. Presence of SAV does not reflect current state, as data dates to 1981.

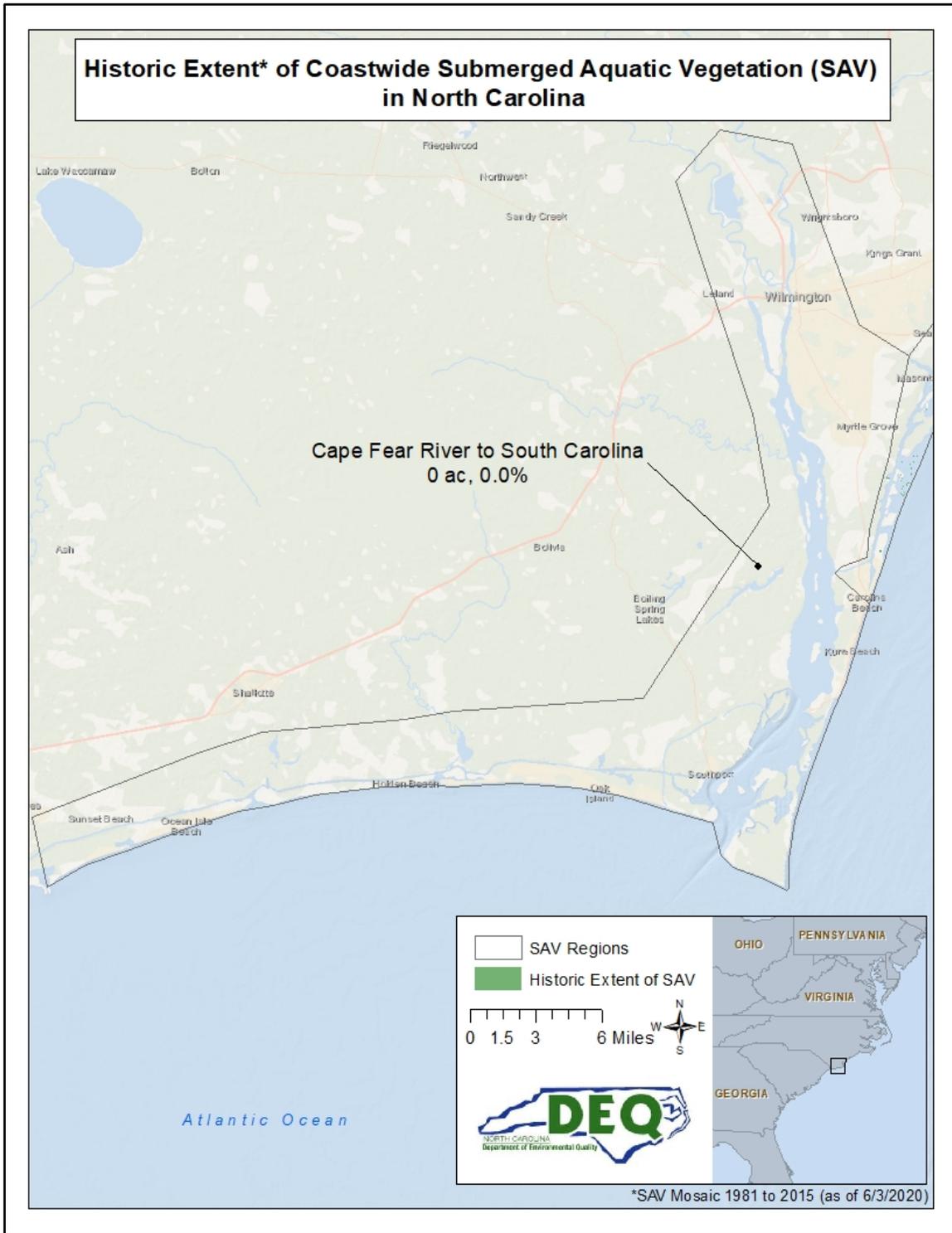


Figure 4.9. Known historic extent of submerged aquatic vegetation (SAV) mapping from the Cape Fear River, NC to the SC line, 1981 to 2015. Absence of SAV does not suggest actual absence, as surveys have not been conducted in all areas. Presence of SAV does not reflect current state, as data dates to 1981.

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Mapping and monitoring low salinity SAV is more difficult due to low water clarity compared to high salinity SAV areas of the estuary. Despite low water clarity and the limited availability of historical baseline data of low salinity SAV habitat, fluctuations in SAV abundance have been observed through hydroacoustic surveys and other sentinel site observations.<sup>57, 65</sup> Based on the most recent hydroacoustic surveys of linear SAV extent along the 1-meter isobath in the Neuse, Pamlico and Albemarle river sub-estuaries, there has been an estimated 33 percent decline from the historical extent of low salinity SAVs (Table 4.6). Although there is less known about low salinity SAV extent, there are recurring themes. These include large fluctuations in abundance, changes in species composition, occurrence of non-native species in some waterbodies, high turbidity, extreme weather events, large amounts of precipitation, and fluctuations in salinity.<sup>65</sup>

Table 4.6. Net change from known historical extent of submerged aquatic vegetation (SAV) to 2014-2017 linear extent (LE) along 1-meter isobaths line for low salinity SAV based on recent hydroacoustic surveys in NC.<sup>57, 65</sup>

Estuary	Historical* SAV LE (m)	2014-2017 SAV LE (m)	No change in SAV from historical (m)	Change in SAV LE (gain)	Change in SAV LE (loss)	Percent change in SAV LE (loss)
Albemarle Sound	117,778	90,565	56,457	+34,108	-61,321	-23.10
Tar - Pamlico River	29,223	6,036	756	+5,280	-28,467	-79.33
Neuse River	10,512	9,519	2,821	+6,692	-7,685	-9.42
Total	157,513	106,120	60,034	+46,080	-97,473	-32.62

\*From 1981-2015 SAV Mosaic

The high salinity seagrasses appear to be in better condition than the low salinity SAVs. There is a good baseline of data on distribution and abundance for most of the high salinity SAV resource, along with a good understanding of species composition, persistence, and resilience. However, little water quality data are collected and represents a crucial data gap.

The APNEP metric report: *Extent of Submerged Aquatic Vegetation, High-Salinity Estuarine Waters*, provides an analysis of SAV change based on spatial coverage detected from aircraft during two survey periods: 2006-2007 (Survey 1) and 2013 (Survey 2) (Table 4.7).<sup>66</sup> Survey 1 represents late spring aerial surveys of Bogue and Back Sounds and fall aerial surveys between Roanoke Island and Barden's Inlet. Survey 2 represents late spring aerial surveys between Roanoke Island and Bogue Inlet. For analysis purposes, these coastal areas are broken down into three geographic regions. The northern region is from the US Hwy 64 Bridge (Roanoke Island) to Hatteras Inlet; the central region is from Hatteras Inlet to Ophelia Inlet; and the southern region is from Barden's Inlet to Bogue Inlet.

All three regions showed declines in SAV acreage (Table 4.7).<sup>66</sup> However, the southern region, where there is more development and higher population densities, declined by over 10 percent (Table 4.8). The northern and central regions are less developed, receive less direct riverine input, and therefore had a lower estimated SAV acreage loss. No regions gained SAV based on this assessment despite the ability for SAV to grow at depths generally  $\leq 2.0$  meters, yet much of that available benthic habitat within this depth range was not occupied by SAV. An additional concern is the amount of continuous beds that were converted to patchy beds. The biggest component of the overall change in the northern region was the conversion of 15,327 acres (6,202.8 ha) of continuous seagrass in Survey 1 to patchy seagrass in Survey 2.

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Table 4.7. Net change in high salinity submerged aquatic vegetation (SAV) extent in NC from Survey 1 (2006/2007) to Survey 2 (2013) in three regional zones 1) the “North Zone” from the US Highway 64 Bridge at Roanoke Island to Hatteras Inlet, 2) the “Central Zone” from Hatteras Inlet to Ophelia Inlet and, 3) the “South Zone” from Barden’s Inlet at Cape Lookout to Bogue Inlet and overall (acres, hectares in parentheses).<sup>66</sup>

Regional Zones	Survey 1	Survey 2	Change	% Change
North	70,861 (28,676)	66,445 (26,889)	-4,416 (-1,787)	-6.2
Central	24,132 (9,766)	23,477 (9,501)	-655 (-265)	-2.7
South	5,850 (2,367)	5,235 (2,119)	-615 (-249)	-10.5
Overall	100,843 (40,810)	95,157 (38,509)	-5,686 (-2,301)	-5.6

Table 4.8. From-to calculations for the net change in high salinity submerged aquatic vegetation (SAV) extent in the three NC zones 1) the “North Zone” from the US Highway 64 Bridge at Roanoke Island to Hatteras Inlet, 2) the “Central Zone” from Hatteras Inlet to Ophelia Inlet and, 3) the “South Zone” from Barden’s Inlet at Cape Lookout to Bogue Inlet and overall (acres, hectares in parentheses).<sup>66</sup>

Conversion		Zone		
From	To	North	Central	South
No SAV	Patchy SAV	4,462 (1,810)	4,386 (1,775)	638 (258)
No SAV	Continuous SAV	203 (82)	150 (601)	60 (24)
Gain		4,665 (1,888)	4,537 (1,836)	698 (283)
Continuous	None	1,895 (766)	401 (162)	88.4 (36)
Patchy	None	7,009 (2,837)	4,782 (1,935)	1,218 (493)
Loss		8,904 (3,603)	5,184 (2,098)	1,306 (528)
Net Loss (Loss – Gain)		4,239 (1,715)	647 (262)	607 (246)
Total		70,861 (28,676)	24,132 (9,766)	5,850 (2,367)
% Change		-6.2	-2.7	-10.5
% Change yr-1		-1.1	-0.5	-1.7

A global assessment of 215 studies found that seagrasses around the world have been disappearing at a rate of 110 km<sup>2</sup> per year since 1980 with an overall global average rate of decline of 1.5 percent per year.<sup>67</sup> Although rates of decline within the northern and central regions of NC are lower than this global average, the higher rate of decline in Back and Bogue sounds (1.7 percent per year) is comparable.<sup>66</sup> Bogue and Back Sounds may be especially vulnerable to the impairment of water quality associated with shoreline development and other anthropogenic impacts (boat wakes, dredging, fishing gears, etc.).

### 4.2.1 Management of Submerged Aquatic Vegetation in North Carolina

There are several DEQ commissions that manage activities that can directly and indirectly affect SAV. The MFC has authority over regulations of fishing practices in coastal waters through the DMF. The NC Environmental Management Commission (EMC) has authority over activities that affect water quality and are implemented by the NC Division of Water Resources (DWR) and NC Division of Energy, Minerals, and Land Resources (DEMLR). The NC Coastal Resources Commission (CRC) has authority over development activities within and adjacent to the public trust and estuarine waters and coastal marshes which are implemented by the NC Division of Coastal Management (DCM). Although the NC Wildlife Resources Commission (WRC) is not a formal participant in the development of the CHPP, they oversee

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regulation of boating in coastal and inland waters and fishing in inland waters and are involved with the three commissions as it concerns SAV and other fisheries habitats. Additionally, the NC Department of Agriculture and Consumer Services (DA&CS) and NC Department of Transportation (DOT) oversee activities that effect water quality via runoff.

### 4.2.2 Policies and Plans

There are several state, federal, and interstate policies and plans that directly or indirectly influence SAV management, restoration, and protection in NC. Table 4.9 provides information on the four policies detailed below, with specific guidance as it pertains to monitoring, water quality, physical disturbance, land use and development, restoration, research, and education in NC. The MFC SAV Policy recognizes the importance of SAV to NC and calls for management guidelines to monitor and protect SAV.<sup>68</sup> The NC Department of Environmental and Natural Resources (DENR; now DEQ) Technical Guidance Document for the Protection of Submerged Aquatic Vegetation Habitat is a document created to ensure regulatory review bodies consider SAV during the permit review process.<sup>69</sup> The South Atlantic Fishery Management Council (SAFMC) Policy for Protection and Enhancement of Estuarine and Marine Submerged Aquatic Vegetation (SAV) Habitat encourages the South Atlantic states to assess the status and trends in SAV and consider establishing plans that integrate monitoring and research, planning, management, education, and enforcement to protect and revitalize SAV resources.<sup>70</sup> The Atlantic States Marine Fisheries Commission (ASMFC) Policy was developed to communicate the necessity of conservation of coastal SAV resources because of the importance of SAV habitat to managed fish species.<sup>71</sup>



Photo Credit: Jay Fleming Photography

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Table 4.9. Existing submerged aquatic vegetation (SAV) management policies from regulatory agencies affecting NC.

	NC Marine Fisheries Commission <sup>68</sup>	NC Department of Environmental Quality <sup>69</sup>	South Atlantic Fishery Management Council <sup>70</sup>	Atlantic State Marine Fisheries Commission <sup>71</sup>
Assessment & Mapping	In order to delineate and assess the distribution and health of SAV habitat, SAV beds need to be mapped and monitored.	Definition of SAV habitat is expanded for mapping and monitoring purposes.	Develop and standardize imagery acquisition and resource mapping protocols, with regional modification as necessary to achieve effective results. <sup>72</sup> Develop and maintain a GIS database for essential habitat including SAV and use that information for assessment of trends in SAV extent (e.g., SIMM or OBIS-SEAMAP).	At a minimum, each member state should ensure the implementation of an SAV resource assessment and monitoring program which will provide a continuing quantitative evaluation of SAV distribution and abundance and the supporting environmental parameters.
Water Quality	Minimize nutrient and sediment loading to coastal waters that support existing SAV to protect adequate water quality as defined by water-column clarity in standard measurement units.	Minimize nutrient and sediment loading to coastal waters that support existing SAV to protect adequate water quality as defined by water-column clarity in standard measurement units.	Evaluate water quality criteria needed to support SAV survival and growth and support policy making to manage quality and quantity of surface runoff. Review state water quality standards and rules to determine if changes are needed to protect and enhance SAV.	Support and promote the development of water quality standards by the EPA and member states that can be implemented to protect SAV habitat (i.e., light attenuation, total suspended solids, chlorophyll <i>a</i> , dissolved inorganic nitrogen, dissolved inorganic phosphorus, critical life period).
Fishing Gear Disturbance	All SAV needs to be protected from all bottom-disturbing fishing and recreational gear. Sufficient buffer zones surrounding SAV beds should also be protected from disturbance to prevent impacts of sediments on growing SAV.	Dredging directly alters the bottom to conditions unfavorable for SAV growth or recolonization and should be avoided in existing and suitable bottom that has supported SAV in the past.	Review and modification of state and federal rules to ensure protection of SAV from impacts such as dredging, propeller scarring, marina and pier construction, and bottom-disturbing fishing activity.	In partnership with NOAA Fisheries and USFWS, develop technical guidelines and standards to objectively evaluate fishing gear, propeller scarring, dredging, coastal construction, and bottom fishing impacting, and develop standard mitigation strategies.
Docks & Piers		Piers and docking facilities can potentially impact SAV through construction impacts, shading, and indirect impacts from boat wakes and prop dredging. Floating docks block more sunlight due to the solid surface and lower position over the bottom and in shallow water may rest on top of the vegetation. The design, size, and location of the docking facility will determine the level of impact to SAV habitat.	Encourage states to minimize impacts to SAV by developing design criteria for docks and piers which establish minimum height, maximum width and materials.	Encourage citizen involvement in impact reporting.

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	NC Marine Fisheries Commission <sup>68</sup>	NC Department of Environmental Quality <sup>69</sup>	South Atlantic Fishery Management Council <sup>70</sup>	Atlantic State Marine Fisheries Commission <sup>71</sup>
Protection from Development	Provide adequate safeguards to prevent direct (or indirect) impacts from development projects adjacent to or connected to SAV. Assess cumulative impacts of land use and development changes in the watershed affecting SAV to identify the potential impact. Require identification of cumulative impacts as a condition of development of permit applications.	Field reps and permit reviewers should consider the potential impacts of proposed activities to SAV habitat on a case-by-case basis. Reviewers should consider the level of impact of the specific proposed activity on SAV habitat and the level of scientific documentation supporting the habitat determination (currently exists, suitable SAV habitat conditions and documented to support SAV within the past ten years).	Development of economic analyses on the economic benefits of protecting and enhancing SAV habitat.	
Habitat Restoration	Require compensatory mitigation where impacts are unavoidable. Initiate restoration programs to recoup and/or enhance lost SAV habitat.	Shoreline stabilization practices that result in increased wave energy regimes, turbidity, or sedimentation can potentially impact SAV habitat. Shoreline stabilization methods should utilize the method that would cause the least expected impact to SAV habitat if possible.	Investigate effective restoration techniques, including ecological function and cost/benefit. Development of SAV restoration guidelines for both high and low salinity SAV to accelerate successful, cost-effective SAV restoration.	Protection is preferred over restoration. Restoration programs should include establishment of habitat quality necessary for SAV prior to restoration. Restoration methods should incorporate scientifically based protocols. Restoration goals should consider potential and historical SAV spatial footprint.
Education & Outreach	Educate landowners adjacent to SAV, boaters, and other potential interested parties about the value of SAV as a habitat for many coastal fishes and invertebrates.		Design of education programs to heighten the public's awareness of the importance of SAV. An informed public will provide a firm foundation of support for protection and restoration efforts.	ASMFC and member states should promote and support public education and stewardship programs that will increase the public's knowledge of SAV, its importance as fish habitat, and commitment to SAV conservation.
Scientific Research			Research and document causes and effects of SAV losses, including cumulative impacts, watershed runoff, shoreline development, shading associated with pier and dock, development, invasive species, and extreme weather conditions (drought, tropical storms, algal blooms, etc.). Research potential effect of climate change on SAV habitat.	ASMFC and member states should promote and support those research projects which will improve our knowledge of SAV and its benefits as fish habitat.
Regulations & Enforcement Improvements		Specific guidance for permits.	The regulatory definition of SAV habitat is: shallow water habitat with appropriate sediment, depth, light penetration and wave energy, including areas without existing SAV. Review of existing regulations and	ASMFC members should propose improvements necessary in state regulation and management including conditions pertaining to harvesting shellfish or finfish in SAV beds by use of mechanical means and the placement and operations of

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	NC Marine Fisheries Commission <sup>68</sup>	NC Department of Environmental Quality <sup>69</sup>	South Atlantic Fishery Management Council <sup>70</sup>	Atlantic State Marine Fisheries Commission <sup>71</sup>
			enforcement to determine their effectiveness. Coordination with state resource and regulatory agencies to ensure that existing regulations are being enforced.	aquaculture activities to protect existing SAV beds. Encourage state agencies or departments with jurisdiction over construction activities to propose improvements necessary in state regulation and management of SAV habitats based on the standards developed in the above actions.

In addition to the policies described above, there are also various NC plans that address the importance of monitoring, protecting, and restoring the state’s SAV resources. They are summarized below:

### NC Wildlife Resources Commission Wildlife Action Plan (WAP)

The Wildlife Action Plan (WAP) is a comprehensive planning tool used by the WRC to help conserve the state’s fish and wildlife species and their habitats. This includes numerous recommendations for monitoring the state’s SAV. The WRC received approval from the US Fish & Wildlife Service (USFWS) for the comprehensive revision of the WAP on March 30, 2016.<sup>73</sup>

### Albemarle-Pamlico National Estuary Partnership (APNEP) Comprehensive Conservation and Management Plan (CCMP)

The APNEP CCMP was developed using the principles of ecosystem-based management (EBM) which includes consideration of human and natural systems, an adaptive management framework, and meaningful engagement with the region’s citizens to find environmental management and policy solutions. Protection and restoration efforts to improve water quality and SAV are addressed with an emphasis on assessment and monitoring to facilitate adaptive management as more knowledge is gained in the system.<sup>13</sup>

### APNEP Submerged Aquatic Vegetation Partners Plan

This document provides a framework to guide actions and efforts in protecting and restoring SAV habitat through coordinated research, monitoring, assessment and outreach activities. It also serves as a more detailed “step-down” document that can be used to implement conservation measures specific to SAV in support of the CHPP, the WAP, and the CCMP. The goals, objectives, and actions of this plan must utilize an ecosystem approach to maximize effectiveness and efficiency.<sup>74</sup>

### North Carolina Aquatic Nuisance Species (NCANS) Management Plan

The purpose of the NCANS Management Plan is to improve the state’s ability to address aquatic invasive and aquatic nuisance species with the goal of preventing and controlling their introduction, spread, and negative impacts. Within this plan, invasive aquatic plant species, which can have an impact on native brackish water and high salinity SAVs, are addressed.<sup>75</sup>

### **4.2.3 Impacts of Water Quality Impairment to Submerged Aquatic Vegetation**

As noted earlier, SAV is especially sensitive to water quality impairment from nutrient and sediment pollution and has been considered a “coastal canary”, serving as a valuable bio-indicator of the overall

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health of our coastal ecosystems.<sup>48</sup> Global losses of SAV are estimated to be at over 29 percent during the last century.<sup>67</sup> The impairment of water quality is one of the most widespread threats to SAV habitats. In the US, SAV along the Atlantic seaboard has experienced significant declines directly or indirectly attributed to the stressors associated with degraded water quality.<sup>8, 76</sup>

The majority of SAV loss can be attributed to large-scale eutrophication (nutrient enrichment) and suspended sediments, which reduces light penetration to the plants.<sup>7, 34, 37, 38, 48, 77, 78, 79</sup> Eutrophication and/or increased sediment loads impact light available for SAV by:

- Reducing water clarity with sediment or phytoplankton associated with algal blooms<sup>8, 79</sup>
- Increasing epiphyte and/or drift algae coverage<sup>8, 80</sup>

Eutrophication of shallow estuaries can lead to proliferation of ephemeral macroalgae and filamentous green and brown algae and epiphytes that compete directly with SAV for nutrients and light.<sup>81, 82, 83</sup>

Studies have found that macroalgal biomass is directly related to increased nutrient levels and that SAV loss is greater with increased macroalgae.<sup>84, 85</sup> Once macroalgal blooms die, they decompose rapidly, increasing nutrient levels in the water column, stimulating phytoplankton production, further reducing light, and decreasing dissolved oxygen (DO) in the water and sediments. These have all been important factors in the decline of SAV on the Atlantic seaboard.

Chlorophyll *a* is an indicator of phytoplankton production, where high concentrations in the estuary can indicate algal blooms that in turn decrease light penetration, thus impacting SAV growth. In Albemarle Sound there has been a substantial increase in chlorophyll *a* over time, which is associated with increasing reports of cyanobacteria blooms over the same time period. Concentrations have fluctuated over the last twenty years across the Albemarle-Pamlico estuarine systems. Additionally, remote sensing information corroborates a rapid increase in cyanobacteria biomass throughout the Albemarle Sound region.

Colored dissolved organic matter (CDOM) is primarily leached from decaying detritus and organic matter and gives water a brownish color. Light penetration is greatly reduced in waters with high CDOM concentrations. In general, CDOM concentrations are higher in fresh and oligohaline waters compared to polyhaline waters. In the Neuse River estuary, CDOM is increasing and may be linked to the salinity regime. As such, declines in water quality for this region could be harder to manage because they are not just directly related to nutrient enrichment.<sup>65</sup>

### **4.2.4 Case Studies of Water Quality Improvements that Benefit Submerged Aquatic Vegetation**

Water quality impairment is a serious but manageable threat to SAV in NC. Water clarity for light penetration is necessary for SAV growth, and SAV survival is impacted by suspended sediments and nutrients. Coastal development expansion combined with increases in the intensity and severity of storm events, and rising sea levels, are resulting in runoff and associated increases in suspended sediments nutrient loading and more turbid waters. However, in Chesapeake Bay and Tampa Bay, improvements in water quality and resulting improved water clarity have in turn improved environmental conditions for SAV survival, growth, and propagation, allowing each system to reach targeted SAV acreage goals.

#### Chesapeake Bay

Loss of SAV in the shallow waters of the Chesapeake Bay from the early 1960s through the mid-1980s has been documented over time, resulting from nutrient over-enrichment and increased suspended sediment and the associated reduction of light availability to the plants.<sup>51</sup> Since the 1950s, the

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population grew around the bay, more than doubling from 8 million to over 18 million by 2020. Consequently, land development doubled and correspondingly impervious surfaces, fertilizer use (domestic and agricultural), and livestock production increased. These factors impacted water quality in the bay from nutrient enrichment and sediment loading. This, in turn, increased light attenuation (reduction) by suspended sediments, higher phytoplankton populations, and epiphytic fouling on SAV blades resulting in significant SAV population decreases.<sup>8, 86, 87</sup>

Early efforts were made to reduce point source nutrient loads, especially from wastewater treatment plants (WWTP). Examples include the Upper Patuxent River and Potomac River where WWTP upgrades to improve nitrogen and phosphorus removals were implemented in the late 1980s and early 1990s.<sup>78</sup> Both areas were devoid of SAV until these WWTPs were upgraded. SAV has since reappeared downstream of these plants and the reappearance has been linked to the reductions in wastewater nutrient discharges that reduced nutrient concentrations, algal biomass and light attenuation.<sup>8, 78, 87</sup>

Since establishment of the Chesapeake Bay Program Partnership in 1983 with the signing of the first of four Chesapeake Bay watershed agreements, significant progress has been made in reducing nitrogen loads by over 60 percent and phosphorus loads by over 75 percent from hundreds of significant municipal and industrial wastewater dischargers across the six-state watershed. Atmospheric deposition of nitrogen to the bay's watershed and tidal waters has been reduced dramatically as a result of implementation of the Clean Air Act and regional efforts connecting clean air to a healthy Chesapeake Bay. Implementation of hundreds of Partnership approved conservation practices across millions of acres of agricultural cropland, hay land, pasture and livestock operations is making measurable improvements in the thousands of miles of streams and rivers flowing into Chesapeake Bay. Widespread implementation of stormwater management practices and systems are starting to show signs of holding the line against increased flows and pollutant loads within areas of increased land development and construction. Chesapeake Bay's SAV habitats have been responding in kind to these pollutant load reductions. From a low of 38,000 acres in 1984, annual baywide coordinated aerial and ground surveys mapped a high of 105,000 acres of SAV in 2017.

In response to the Chesapeake 2000 Agreement, the six watershed states (Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia) and the District of Columbia worked with the United States Environmental Protection Agency (EPA) and hundreds of partners and stakeholders to develop a set of Chesapeake Bay specific water quality criteria, designated uses and criteria attainment assessment methodologies.<sup>51, 88</sup> Agreement was reached on establishing the Program's overall strategy, including the following five designated uses for Chesapeake Bay's tidal waters:

- Migratory fish spawning and nursery habitat
- Open-water fish and shellfish habitat
- Deep-water seasonal fish and shellfish habitat
- Deep-channel seasonal refuge habitat
- Shallow-water bay grass habitat

Shallow-water grass habitat was defined as areas that supported underwater bay grasses in 0.5 m to 2.0 m depth. The designated use "protects underwater bay grasses and the many fish and crab species that depend on the vegetated shallow-water habitat provided by underwater grass beds".<sup>88</sup>

The *Chesapeake 2000 Agreement* also committed the signatories—state governors, DC mayor, EPA administrator, and chair of the Chesapeake Bay Commission—to adopting these criteria, designated uses and criteria attainment assessment methodologies into Delaware, Maryland, Virginia and the

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District of Columbia's state water quality standards regulations. These unprecedented adoptions of consistent state water quality standards across the shared multi-state body of water occurred simultaneously from 2004-2006.<sup>89</sup> For the protection of the shallow-water bay grass designated use, the three states and the District of Columbia adopted numerical water clarity criteria as well as numerical SAV restoration acreages into their respective states' water quality standards regulations.

Based on historical SAV acreage and abundance from the 1950s through 2000, the Chesapeake Bay Program partners established an SAV restoration goal of 185,000 acres.<sup>88, 90</sup> An interim target to achieve 50 percent of the 185,000-acre restoration goal (92,500 acres) by 2017 was set and met in 2015. By 2017, there was over 100,000 acres in the bay, meeting the 50 percent interim goal. The baywide SAV restoration goal was broken down into acreages for each of the 106 Chesapeake Bay segments. It was these Bay segment-specific SAV restoration acreages which were promulgated into the respective states' water quality standards regulations.

In order to achieve these SAV restoration goals, water clarity criteria were developed by the Chesapeake Bay Program partners and published by the EPA on behalf of the partnership based on:

- Light requirements for underwater grasses
- Factors that contribute to light attenuation
- Epiphyte contribution to light attenuation on leaf surface
- Minimal requirements for light penetration through the water column and leaf surface.

Based on research, literature review and modeling, the minimal amount of light necessary for SAV is  $\geq 22$  percent light availability through the water column (PLW) for polyhaline and mesohaline species. For tidal fresh and oligohaline species,  $\geq 13$  percent light availability is necessary.<sup>45, 49, 51, 90, 91</sup>

In the Chesapeake Bay, linking biological responses of SAV to improved water quality management over time was possible through the availability of annual digital SAV maps based on aerial overflights with ground-based surveys for species distribution delineations conducted annually since 1984. These maps, along with extensive land cover and land use mapping, water quality data collected through a coordinated monitoring network within the Chesapeake Bay and across its watershed enabled monitoring of SAV abundances, which served as a response indicator of nutrient and sediment inputs into the bay. The positive feedback of increased light availability leading to increased SAV abundance led to lower suspended chlorophyll, particulates and turbidity, resulting in further increased water clarity.<sup>87</sup>

### Tampa Bay

As with the Chesapeake Bay, Tampa Bay has also experienced environmental degradation by similar stressors as a result of urbanization and development.<sup>79, 92, 93</sup> Discharges of poorly treated wastewater into the bay, an abundance of small package plants and aging septic systems, stormwater runoff and industrial discharges all led to algal blooms that peaked in the 1970s in the upper reaches and expanded throughout the Bay. This resulted in approximately 44 percent loss of SAV between 1950 and 1990 in the bay due to increased light attenuation caused by algal blooms.

Because of these issues, citizens demanded that the government take action to restore Tampa Bay. In the early 1970s, an ambient water quality monitoring program was established and is still in place today. Municipal WWTPs were required to provide advanced water treatment in Tampa Bay, which reduced this source of nitrogen loading by 90 percent.<sup>79, 92, 93</sup> Stormwater regulations were also put in place by the State of Florida that reduced nitrogen loading from non-point sources.

During the 1990s, numerous agencies around the Tampa Bay area worked to adopt water quality

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management strategies that linked nitrogen loading management to SAV restoration and protection. With the formation of the Tampa Bay Estuary Program, nitrogen management became the focus in order to benefit SAV restoration through the Tampa Bay Nitrogen Management Consortium.<sup>94, 95</sup> Over fifty stakeholders, consisting of local, state, and federal partners began working with diverse private entities such as electric utilities, phosphate mining companies, and the shipping industry to reduce nitrogen loading in the bay. Through this Consortium, hundreds of projects were implemented by voluntary actions to collectively reduce or prevent nitrogen from entering the bay.

To improve and maintain water quality conditions in the face of growing populations around the bay, numeric targets were established for chlorophyll *a* concentration and light penetration levels based on light requirements of SAV.<sup>45, 94, 95</sup> Models were used to relate nitrogen loads to chlorophyll *a* concentrations within four bay segments. These models were then used to develop nitrogen loading targets necessary to restore SAV in each of the four bay segments. Over time, periodic evaluations of these targets have occurred using an adaptive management strategy through assessment of both seagrass coverage and water quality improvements. Based on the assessment, if targets are met, the Consortium continue to implement projects as planned and continue monitoring. If standards are not met, and based on the level of water quality conditions, some form of management action is required.<sup>79, 92, 93</sup>

As a result of the efforts made by the numerous partners within the Consortium and the Tampa Bay Estuary Program, Tampa Bay has experienced a decrease in nitrogen loading to approximately one third of estimated levels from the 1970s, even as populations around the Bay have increased.<sup>95</sup> This has resulted in decreases of chlorophyll *a* and increases in water clarity to the extent that seagrass coverage now exceeds the 1950s target estimates, reaching the SAV recovery goal of 38,000 acres by 2016. It should be recognized that the collaboration of numerous regulatory, non-regulatory, industry and municipalities are responsible for the overall water quality in the bay.<sup>93, 96</sup>

### **4.2.5 Nutrient Control in the Albemarle Sound/Chowan River**

The Albemarle Sound and the Chowan River have experienced an increase in the number of algal blooms over the past several years. Based on sampling in Chowan River, a tributary of the Sound, organic nitrogen has increased over time. In Potecasi Creek, a tributary of the Chowan River, nutrient patterns shifted around 2002, with nitrate concentrations declining and total nitrogen increasing. The cause for this is unknown. In the Nottaway River, total nitrogen has increased similar to Potacasi Creek, but to a lesser extent. In the Blackwater River, there has been a decline in nitrogen over time, in contrast to what is occurring in Chowan River. There were initial thoughts that the increases were from Virginia, but data suggest this is a NC issue.<sup>97</sup> Other potential causes being examined are runoff from land use activities, particularly agriculture, and subsurface flow of nutrient enriched groundwater into the estuary. This could occur since all WWTPs in the Chowan River watershed utilize land application.

There were several algal blooms in the Chowan, Perquimans, and Pasquotank Rivers in 2019, with different toxins encountered, including microcystin. Concentrations were highly elevated in some blooms (Arrowhead Beach, Indian Creek, Leary Landing), requiring health advisories. In October of 2019, there were six reports of blooms near Elizabeth City. These blooms are starting to begin earlier in the year and are lasting longer.<sup>97</sup> The DWR is actively working to develop appropriate nutrient criteria for the waters of the state. The DWR's goal is to develop scientifically defensible criteria based primarily on the linkage between nutrient concentrations and protection of designated uses. The criteria for each waterbody will be coordinated with other waterbodies to ensure consistency across the state and

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protect downstream uses.

North Carolina's nutrient management strategies have historically been driven by concerns over algal blooms and fish kills, not SAV decline. Early nutrient reduction efforts included the implementation of a statewide chlorophyll *a* standard in 1978, a nutrient sensitive waters (NSW) classification in 1979, and a phosphorus detergent ban in 1988.<sup>65</sup> The NC Nutrient Criteria Development Plan (NCDP) outlines several steps to establish nutrient criteria within the state in two phases.<sup>98, 99</sup> This includes the creation of a Scientific Advisory Council (SAC) and the identification of three geographic areas within the state for development of nutrient criteria. The plan also establishes a process through which DWR will evaluate nutrients throughout NC. One of the three areas identified is the estuarine region of the Albemarle Sound.

Phase I nutrient criteria development for the Albemarle Sound was completed in 2016 where a nutrient workgroup was convened and met over a period of two years to develop nutrient criteria recommendations and research needs. Although no consensus was reached on nutrient criteria recommendations, research needs were identified and a report generated.<sup>99</sup> North Carolina is now in Phase II of the process and has convened a SAC to review research and nutrient criteria proposed in Phase I, assess the quality and relevance of nutrient data, identify data gaps and help develop a management approach for Albemarle Sound.<sup>98</sup> Management actions will be focused on wastewater, agriculture, riparian buffer protection, stormwater runoff from new and existing development, and nutrient trading. Criteria will be regulatory goals for the waterbodies and are aimed at protecting designated uses such as aquatic life, using SAV habitat as a biological endpoint.

### **4.2.6 Other Contributing Factors**

While the focus of this issue paper is improving water quality to protect and restore SAV, there are other contributing factors that can add to the decline of SAV and should be acknowledged. The following section describes the potential impacts of these factors. Factors such as climate change and disease are challenging to control, but it is important to understand their current and potential impacts to the SAV resource. Additional factors, such as physical disturbance and the control of aquatic nuisance species, have been and will continue to be addressed by existing management policies from regulatory agencies affecting NC (Table 4.9).

#### Climate Change

As climate change continues, forecast scenarios predict that NC coastal waters will experience warming temperatures, rising sea levels, and increasing risk for storminess and coastal flooding.<sup>10, 100, 101, 102</sup>

Coastal NC has had 36 tropical cyclones over the past two decades that, based on their duration, wind speed, precipitation, and geographic track, have had impacts on hydrodynamic flows and nutrient and carbon loading to the Pamlico Sound system. A review of these storms by Paerl et al. on the impacts to the Neuse River and to the Pamlico Sound demonstrates that major storms can double annual nitrogen and triple phosphorus loading and can be a significant source of CO<sub>2</sub> releases into the atmosphere from extreme winds.<sup>100</sup> Historic flooding also provides large inputs of carbon from the watershed disrupting the carbon balance and leading to sustained CO<sub>2</sub> releases into the atmosphere for months.

Phytoplankton patterns were also influenced by the loading and flushing of nutrients based on the quantities of freshwater discharged. High freshwater discharges will flush maximum nutrient loads, but these flushing rates can also exceed phytoplankton growth rates and cause temporary reductions in phytoplankton biomass. However, as flushing rates tend to be moderate in the days to weeks following a storm, phytoplankton can take advantage of elevated nutrients delivered during the storm and form

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blooms.

The warming ocean waters contribute to storm intensity, increased precipitation, slowed storm movement, and therefore provide more opportunity for heavy precipitation over a particular area for a longer period of time.<sup>100, 102</sup> It has also been observed that tropical cyclone paths are shifting northward, making NC more susceptible to these events. Extreme precipitation events result in flooding and high loading of organic matter, including organic nitrogen and phosphorus. This in turn fuels phytoplankton production, resulting in algal blooms and associated hypoxia. Runoff from agricultural fields and urban development also add to the contamination of floodwaters. This leads to the consideration that there may be a regime shift in heavy precipitation and tropical cyclone flooding and associated ecosystem impacts.<sup>101</sup> North Carolina has experienced very high precipitation since the late 1990s with increasingly high precipitation events, including those associated with tropical cyclones that could have major ramifications for hydrology, carbon, nutrients, habitat and water quality in NC. Regime shifts in salinity and sediment budgets can also be expected if storms create new inlets alter the hydrology of the barrier islands.

As the climate changes and the waters warm, this could also alter the growth, abundance and distribution of eelgrass with the potential for the southern range to shift north. Based on models of the impacts of sea surface temperatures, sea surface salinity, and melting sea ice on eelgrass distribution under different carbon emission scenarios, it is projected that climate change could possibly result in extirpation of eelgrass in NC by the end of the 21<sup>st</sup> century.<sup>103</sup> If there are no changes to carbon emissions, this study suggests that eelgrass will be extirpated in NC and Chesapeake Bay with the new southern range as far north as Long Island Sound by 2100. However, it is important to note that this study used very few eelgrass occurrence records from NC to inform their species distribution model making it unclear how this may have impacted their findings and the potential relevance to NC's SAV community. A comprehensive, routine, coastwide assessment and monitoring program would also be beneficial in determining the relationships between SAV species extent, distribution, and composition and the effect of climate change. This could be instrumental in determining ways to make the NC coastal community and ecosystem more resilient.

### SAV Pathogens

The endophytic slime mold protist, *Labryinthula zosterae*, has been identified as the causative agent of wasting disease in eel grass; however, the triggers of these pathogenic outbreaks remain unclear. Bockelmann et al. have found that traces of *L. zosterae* endophytes are omnipresent in contemporary grass beds.<sup>104</sup> *L. zosterae* are detectable as black lesions on grass blades, a result of necrosis, but may also be present on apparently green healthy tissue. Historic population losses of large vertebrate grazers may have, among other consequences, increased SAV vulnerability to infection by pathogens.<sup>105</sup> It was suspected, but never proven, that *Labryinthula* was the cause of the wasting disease event that devastated eelgrass populations throughout the North Atlantic between 1930 and 1933, dramatically disrupting estuarine systems.<sup>17</sup> Higher water temperatures apparently stressed the SAV, making them more susceptible to *Labryinthula*. Vergeer et al. later confirmed a decline in the microbial defenses of SAV with increasing temperature.<sup>106</sup> The primary factor enhancing microbial defenses was increasing light intensity, which is related to both water quality and self-shading.

Potential impacts in NC include reductions in fisheries resources, and large reductions in migratory waterfowl populations and loss of ecosystem services. Future research should focus on obtaining quantitative data on the prevalence and abundance of the wasting disease pathogen *L. zosterae* in

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eelgrass populations. Submerged aquatic vegetation needs to be monitored on a periodic basis to assess the status of wasting disease, and its association with human-induced stresses, and to assess the health and condition of SAV. Because the highest abundance of seagrass wasting disease occurs in the summer months, the possibility of global climate change, sea level rise, and increasing rates of marine diseases, baseline data on the distribution and abundance of wasting disease are needed in order to detect trends spatially and temporally.<sup>104, 106</sup> Although outbreaks of diseases and microbial stressors are largely out of the control of coastal managers, these events need to be monitored for trends, which further supports the need for a comprehensive SAV monitoring and assessment program.

### Physical Disturbances

Physical disturbances can impact SAV and the shallow bottom habitat that they occupy by damaging or removing the plant and by changing the depth contour so that light is unable to penetrate for photosynthesis. Physical disturbance can come from fishing gear, mariculture practices, navigational dredging and impacts from marina and dock siting.

Mobile bottom-disturbing fishing gear is towed or run by power, and includes bottom trawls, oyster and crab dredges, hydraulic clam dredges, clam trawls, and haul seines. Most commonly used in NC is the shrimp trawl, followed by oyster and clam dredges. A legislative report to the Moratorium Steering Committee compiled a list of gears used in NC and probable habitat impacts and listed trawls and dredges having the greatest potential for impacts.<sup>107</sup> Shearing or cutting of SAV leaves, flowers, or seeds, and uprooting of the plant are most often caused by dragging or snagging by these mobile fishing gears.<sup>108</sup> Excessive suspended sediments from bottom disturbing fishing gear and propeller wash can bury SAV and reduce water clarity, resulting in decreased SAV growth, productivity, and survival.

Bottom disturbing gears can potentially affect primary productivity through the connection of bottom and water column processes. If large amounts of organic matter are resuspended, the increase in plankton can reduce water oxygen levels, causing hypoxia and anoxia.<sup>109, 110</sup> By resuspending sediments, trawling can make inorganic and organic pollutants available in the water column.<sup>111, 112</sup> Such toxins can affect productivity and accumulate in organisms through food chain interactions.

Through the authority of the MFC, DMF implements and enforces the use of fishing gears in coastal waters. Rules describe and define habitat areas such as SAV that are protected from bottom disturbing gears. For example, the SAV along the Outer Banks are closed to trawling, mechanical clam harvest and mechanical oyster harvest. Areas known as Primary Nursery Areas (PNAs), located in the upper most tributaries of our estuarine sounds and rivers, are also closed to trawling, long haul, swipe nets, and mechanical gear for clams and oysters. Secondary Nursery Areas (SNAs) are typically located adjacent and downstream of primary nursery areas and are closed to trawls.

Through the state FMP process, SAV habitat has been protected from bottom disturbing gear by establishing buffers and altering boundaries. Changes in trawling boundaries have occurred in Pamlico Sound, western Bogue Sound, Core Sound, Back Sound, and New River to further protect SAV. The mechanical clam harvest lines in Core Sound, North River, and New River have also been altered along with the elimination of the mechanical clam area in Bogue Sound giving added protection to SAV. Fishing gears, practices, and areas should be evaluated regularly to ensure there are no additional impacts to SAV.

Currently, DMF is working on the development of Amendment 2 to the NC Shrimp FMP. The goal of Amendment 2 is to manage the shrimp fishery to provide adequate resource protection, optimize long-term harvest, and minimize ecosystem impacts. Two of the objectives to meet this goal reference the

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CHPP including: 1) Promote the restoration, enhancement, and protection of habitat and environmental quality in a manner consistent with the CHPP and 2) Develop a strategy through the CHPP to review current nursery areas and to identify and evaluate potential areas suitable for designation. The CHPP staff will work with staff across DMF's sections, including Fisheries Management, and researchers, to determine different strategies to achieve these objectives once the final draft is approved.

Shellfish mariculture is a growing industry in NC with 278 shellfish leases in 2018 and oyster aquaculture landings eclipsing wild harvest landings for the first time in 2017.<sup>113</sup> With this growth comes the concerns of how shellfish mariculture may impact SAV through use of bottom disturbing gears and by mariculture practices. Mariculture practices that may have an adverse impact on SAV include the type of farming method used (bottom or off-bottom), extent of shading, density of SAV within and adjacent to the shellfish lease area, density of product and equipment within the lease, water depth and harvest/retrieval methods.<sup>114</sup>

However, shellfish mariculture of bivalves such as oysters may have positive impacts to SAV by providing filtration of nitrogen and phosphorus into its shells and tissue and consuming phytoplankton and organic matter, thus improving water quality and clarity. Oysters represent a bottom-up approach to improve water quality while providing fisheries habitat and an economic benefit. Several studies are underway in NC to assess the effects of mariculture on SAV and ecosystem services. As more information becomes available, the full impacts of oyster mariculture can be determined.<sup>115</sup>

Prior to 2015, DMF, in accordance with federal regulation, did not permit shellfish leases where SAV was present. This presented numerous challenges for state managers during the application review process in determining if the location of a proposed lease complies with federal regulation of causing no or acceptably low impact to SAV. To resolve this challenge, a working group of federal and state resource agency staff was created to develop guidance for acceptable amounts of SAV during the survey by water depth. Additionally, no bottom disturbing methods can be used to harvest shellfish from leases meeting the SAV criteria. These interim conditions were later adopted as Regional Conditions of the 2017 US Army Corps of Engineers Nationwide Permit (NWP 48) for Commercial Shellfish Aquaculture Activities in NC. The NWP 48 is re-evaluated and renewed in five year cycles.

Continued improvements in spatial planning and siting shellfish leases, such as the UNC-W NC Shellfish Siting Tool<sup>116</sup> and the DMF Shellfish Aquaculture Tool<sup>117</sup> can help provide a balance between habitat as well as social and economic considerations. Striking that balance can help facilitate sustainable development of shellfish mariculture and protection of SAV and other structural habitats, such as natural oyster rock. It can help reduce user conflicts, and provide information for scientifically based management. A recent report to the NC General Assembly provided recommendations for research needed to better understand the ecological and environmental effects of shellfish mariculture and develop standards to guide regulations and inform best management practices.<sup>113</sup>

Other physical disturbances that can impact SAV include navigational dredging, dock and marina siting, boat wakes and prop scarring by boats and personal watercraft, and shoreline stabilization. Channel dredging impact is the physical loss of SAV within the dredge footprint. Impacts extend beyond the dredge footprint from sloughing into the channel and coverage from sediment on nearby SAV. Impacts from marina construction to SAV come from pile jetting/driving, shoreline stabilization, excavation, installation of docks, wave attenuation, and construction of associated high ground facilities, etc. Lesser recognized impacts are indirect and come from associated boating activities. The impacts from individual docks are less than those from marinas, yet the number of such dock permits far exceeds

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those of marinas. If properly designed, individual piers may not pose significant threats to beds of SAV. Other impacts come from associated boating activities. Direct physical impacts from propeller scarring, vessel wakes, and mooring scars have been identified nationally as a major and growing source of SAV loss.<sup>21, 118, 119</sup>

Propeller scarring of SAV occurs when outboard vessels travel through water that is shallower than the draft of the boat. The propeller blade cuts leaves, roots, and stems, as well as creating a narrow trench, or scar, through the sediment.<sup>118</sup> Large holes may also be blown where boaters rapidly power off shallow bottom.<sup>120</sup> Mechanical disturbance to the sediment damages plant rhizomes, which reduces abundance and cover for extensive periods of time. Recovery of SAV can take from two to 10 years, depending on species and local conditions. In some cases, though, the habitat may never recover.<sup>121, 122</sup> Once started, SAV damage can increase beyond the initial footprint of the scar, due to scour, storms, or biological disturbance such as crab and ray burrowing.<sup>123, 124</sup> Where prop scarring is extensive and SAV beds destabilized, the ecological value of the habitat is reduced.<sup>119, 125</sup>

Shoreline stabilization can threaten SAV and SAV habitat. Vertical hard structures alter the bathymetry and hydrodynamics of the adjacent bottom, with potentially adverse effects on shallow SAV. Such structures can increase reflective wave energy, causing scouring at the toe of bulkheads, eroding adjacent shorelines, and deepening adjacent water, thus reducing or eliminating wetland vegetation and shallow subtidal habitat such as SAV.<sup>126, 127, 128</sup> Shoreline hardening may also prevent wetlands and shallow subtidal habitats from migrating as sea level rises, resulting in loss or conversion of habitat. Other types of shoreline stabilization, such as living shorelines, can result in covering SAV due to its larger footprint, though permitting requirements do not allow living shorelines in SAV in NC.

SAV is offered some protections from physical disturbance under several state, federal, and interstate rules, policies and plans. Further protections and increased mitigation requirements for impacts to SAV and SAV habitat, such as restoration efforts, could be beneficial to the SAV ecosystem and add to its resiliency and the resiliency of the coastal community.

### Chemical Control of Aquatic Nuisance Species

Aquatic nuisance species are non-native and invasive species that can cause detriment to the ecosystem. Many invasive SAV can be transported from one system to another on boats, trailers and other equipment. Aquatic nuisance SAV species form dense beds, making swimming, fishing, and boating difficult; clogging water intake systems for municipalities and industries; and impeding water flow in drainage canals. Dense beds of Eurasian watermilfoil (*Myriophyllum spicatum*) can cause the water column to become anoxic at night, stressing fish or causing them to leave the area.<sup>129</sup> Although watermilfoil and other nuisance SAVs provide some benefits to fish and crabs, such as refuge and sediment stabilization, and can be an important component in the low salinity/freshwater SAV community of northeastern NC, they can also negatively impact natural habitat by shading or out-competing native SAV species, which may have greater value to fish.<sup>130</sup>

Chemical herbicides are used to suppress aggressive nuisance vegetation and should be applied using an integrated management approach. Effects of herbicides are influenced by their toxic mode of action, their method of application and either target a specific species or provide a broad spectrum of control. Registered chemicals are used to control nuisance aquatic vegetation and are highly effective when following labelling. Application rates vary based on the system and environment, and efficacy of herbicides varies based on the herbicide and formulation and the specific species being treated. Rotation of herbicides is recommended because of a growing number of cases where aquatic plants are

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developing resistance.<sup>131</sup>

The DWR implements the Aquatic Weed Control Program (AWCP), which focuses primarily on non-native invasive species in freshwater lakes, ponds, and rivers. The AWCP responds to requests for assistance from local governments, public utilities, and other agencies, providing technical and financial assistance (50:50 cost share). There are growing concerns that the control of noxious aquatic weeds by herbicides may also impact native SAVs. Overall, broader coordination is needed to address and balance the impacts and patchwork treatments of noxious aquatic weeds such as hydrilla (*Hydrilla verticillata*), alligatorweed (*Alternanthera philoxeroides*), and Eurasian watermilfoil and the protection of native SAVs. Some DMF sampling has indicated that these noxious weeds, particularly Eurasian watermilfoil, provide nursery habitat for various fish species such as blue crab and river herring. There are other concerns of the public wanting native SAVs removed because of disruptions in boating traffic, recreation, and aesthetics. Outreach on the value of native SAV is needed to address this negative public perception.

A critical evaluation of ecosystem services that are provided by Eurasian watermilfoil and other invasive species may need to be considered in future management. The evaluation of organismal functional traits may provide one way to quantify the contributions of different species. These traits reflect species' tolerances to disturbance and ability to tolerate more nutrient rich waters than native SAVs, as well as their effects on primary productivity and other ecosystem functions. Invasive plants are often introduced by activities like "hitchhiking" on boats, trailers, or other equipment being moved from one location to another, being regenerated from a fragment, and being released intentionally.<sup>132</sup> Increasing public awareness of aquatic weeds, and aquatic invasive species in general, is paramount to a more proactive and preventative management approach. The DWR, in cooperation with WRC, has posted signs at over one hundred public boating access areas, intending to educate boaters and encourage them to clean and dry their equipment prior to going to other locations.

An objective of the Aquatic Nuisance Species (ANS) Plan is to increase coordination between agencies on control of aquatic nuisance species and impacts to native SAV as well as impacts to fish habitat. There is coordination between staff of DWR's aquatic weed control program and biologists in DMF's habitat enhancement section on projects that may impact native SAV resources. However, developing a more formal collaboration among the experts will only increase communication and participation with governmental agencies.

Other concerns are the use of herbicides by private waterfront landowners who are interested in the removal of SAVs, whether invasive or native, because of the impacts to aesthetics and recreational use of the adjacent waters. Outreach is needed to inform landowners of the importance of native SAVs, and best management practices to address invasive SAVs including processes that are currently in place to remove invasive SAVs.

### 4.3 Discussion

To have cleaner waters and resilient coastal habitats that support fisheries, it has become more important than ever to make the effort to attain a healthy condition that supports SAV recovery. As we experience increased coastal development and extreme rainfall and flooding associated with climate change, SAV can then be more resilient to natural perturbations that also drive the natural fluctuations of SAV populations and extent.

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### 4.3.1 Reducing Nutrient Loads

Submerged aquatic vegetation sensitivity to nutrient concentrations occurring in NC's estuarine system makes it a valuable bio-indicator of eutrophication of our estuarine waters. Both the Tampa Bay experience and the Chesapeake Bay experience are examples of how the direct effects of nutrient and sediment enrichment of estuarine and coastal systems cause losses of SAV. In both cases, reductions in land-based sources of nutrients and sediment pollutant loads documented by scientists and managers directly lead to significant increases in SAV acreage, bed density and species diversity in both estuaries. The adoption of numerical SAV restoration goals by policy makers responsible for management of both of these systems led to actions which significantly reduced nutrient and sediment pollutant loads from land-based sources resulting in clearer and cleaner waters and restoration of SAV. While SAV distribution fluctuates naturally due to storms, temperature, salinity, and other factors, the long-term increase in SAV abundance and density in Chesapeake and Tampa bays was attributed to the improvement of water quality conditions from management changes.<sup>133</sup> Additionally, the improvements in water quality helped make the SAV habitat more resilient to the more frequent and intensive storms and weather patterns. Clean water is a necessity for estuarine health as well as human health. As we begin experiencing the impacts of climate change, it is even more important to establish cleaner and clearer water so that when weather conditions are less favorable for SAV and declines occur, recovery is faster. This will help ensure NC's estuarine ecosystem remains vital for healthy fisheries, coastal resilience, and overall value of these NC resources.

#### Clean Waters and SAV: Making the Connection Workshop

In March 2020, a technical workshop, *Clean Waters and SAV: Making the Connection*, was held and included over seventy federal, state, and local governments, academic institutions, and nonprofit organizations to discuss the scientific links between SAV health and water quality.<sup>65</sup> Strategies to improve water quality for the protection and restoration of SAV in NC coastal waters were discussed. Besides providing an opportunity for different participants to learn about the connection of water quality to SAV, it also provided information to inform this issue paper. Facilitated group discussions focused on identifying additional information needed to develop long-term SAV conservation and management strategies in NC. Through facilitated group discussions, informational needs for both high and low salinity SAV were listed and then prioritized by the workshop participants. Those needs were used to guide potential recommended actions for this issue paper.

### 4.3.2 Proposed Strategies

Following the successful examples of Chesapeake Bay and Tampa Bay and in support of the efforts of the NCDP, NC can consider the development of a five element strategy to improve water quality and restore and protect SAV. These elements include:

- 1) supporting efforts to improve water quality
- 2) protecting and restoring SAV
- 3) enhancing SAV research and monitoring
- 4) improving collaboration through citizen involvement, education and outreach
- 5) addressing other contributing factors such as physical disturbance and climate change.

Because of observed links between nutrients, light limitation and SAV abundance, reducing nutrients by improving water clarity is the key objective to increase SAV abundance.<sup>78, 95</sup>

#### Support Water Quality Improvement Efforts

Water quality improvements through the implementation of standards and best management practices

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must be supported by data. North Carolina has large amounts of basic water quality data for estuarine waters, particularly in the tributaries and along the barrier islands, but data gaps do exist, especially in open water areas of the sounds. While much of the available chlorophyll *a* and turbidity data come from DWR's Ambient Monitoring System, other state agencies like DMF also collect water quality parameters, such as secchi disk depth, during routine surveys. Another large data set comes from the Neuse River estuary Modeling and Monitoring Project (ModMon) and a state ferry-based monitoring system for Pamlico Sound (FerryMon). Both are led through the University of North Carolina at Chapel Hill – Institute of Marine Science (UNC-IMS).<sup>65</sup> However, another light attenuating factor that is only collected by ModMon at limited stations is CDOM. CDOM is linked to river discharge and salinity, but is not nutrient related and may make areas such as the Neuse and other coastal rivers more difficult to address in terms of nutrient management. All of these data sources and others should be evaluated, standardized, and expanded where possible to support existing and future water quality management actions.

Current water quality improvement efforts include DWR's work toward a nutrient criteria plan for the Albemarle Sound and Chowan River. The DWR's goal is to develop a scientifically defensible criteria based primarily on the linkage between nutrient concentrations and the protection of designated uses. The NCDP SAC includes several SAV, water quality and nutrient cycling/primary production dynamics experts. The NCDP SAC and DWR are reviewing potential endpoints and parameters such as DO, chlorophyll *a*, algal density and biovolume, light penetration, SAV, and aesthetics, etc. to be included in the criteria. Ongoing work on an optical model relating chlorophyll *a* to water clarity will also be used to help inform the NCDP SAC's decisions. Considering SAV when developing plans like this, and others, such as watershed plans, will help improve water quality by expanding areas suitable for the growth and reproduction of SAV.

### Protect and Restore SAV

By consulting experts from Chesapeake and Tampa bays, NC can benefit from the lessons learned from their experiences, and NC can develop a similar process of protecting and restoring SAV.<sup>65</sup> Like both bay examples, establishing an SAV restoration goal and determining the light requirements for growth and reproduction for SAV across salinities will help narrow the management focus on water quality parameters such as chlorophyll *a* and nitrogen loading targets. This will require a multi-step and additive process to achieve the goals set forth and are described below. Figure 4.10 provides a conceptual framework of the process. Addressing suspended sediments can also aid water clarity. However, it was decided to focus on nutrients since they were thought to be having a greater influence on water clarity and SAV, and nonpoint runoff strategies for nutrient loading reductions will also reduce sediment loading.<sup>134</sup>

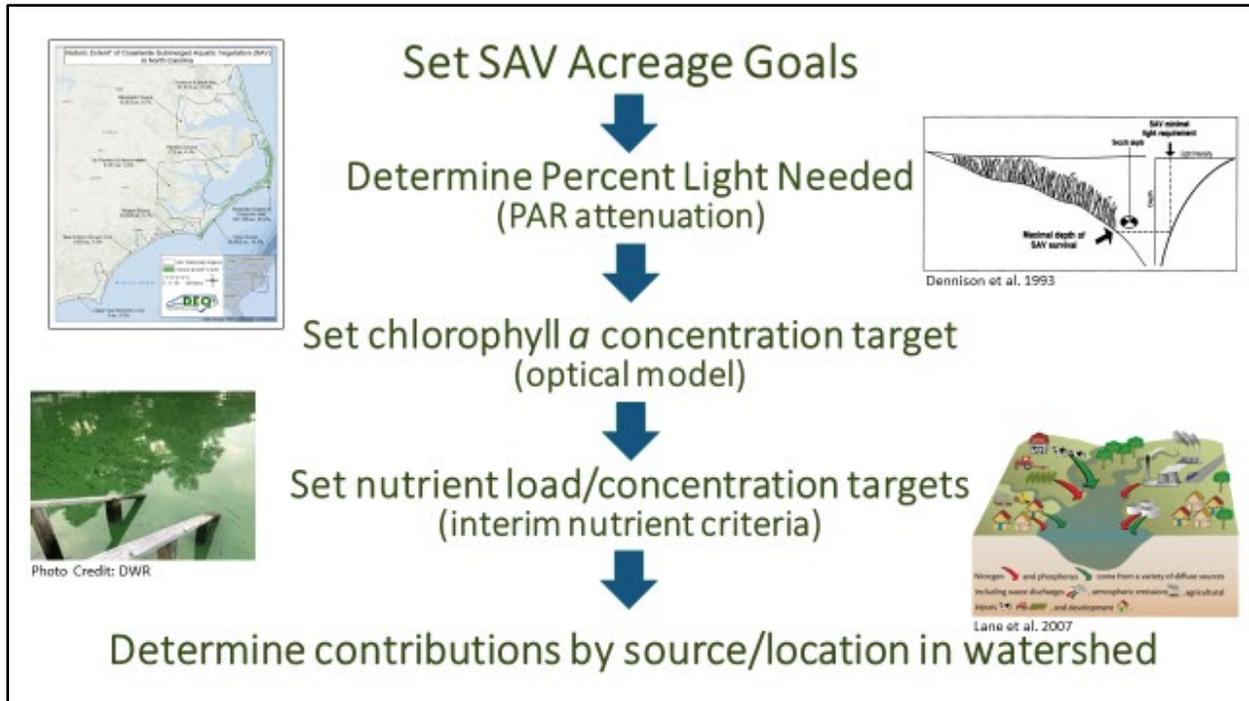


Figure 4.10. Conceptual framework depicting the steps to restore Submerged Aquatic Vegetation (SAV) through water quality improvements.

Adopt an Interim SAV Acreage Goal

As previously discussed, multiple individual mapping events have been compiled to make up the historically known presence and known habitat suitable for SAV along NC’s coast, suggesting a historic extent of approximately 191,155 acres of SAV in public trust waters in coastal NC (Table 4.5; Figure 4.1-4.9). This is currently the best known estimate of where SAV has persisted in the past, may currently persist, and will hopefully persist in the future. Therefore, the coastwide SAV protection and restoration goal is set as an interim goal of 191,155 acres. The NC coast and the known historic SAV extent is further divided into nine SAV regions to best represent regional variability of waterbodies, and are as follows: Currituck and Back Bay (Figure 4.1), Albemarle Sound (Figure 4.2), Tar-Pamlico and Neuse rivers (Figure 4.3), Pamlico Sound (Figure 4.4), Roanoke Sound to Ocracoke Inlet (Figure 4.5), Core Sound (Figure 4.6), Bogue Sound (Figure 4.7), Bear Inlet to Snow’s Cut (Figure 4.8), Cape Fear River to SC line (Figure 4.9; Table 4.5). Setting regional goals allow for targeted actions that will aid in meeting the interim coastwide goal as each region is continually evaluated and refined and as new mapping data become available.

Adopt a light target of 22 percent for high salinity SAV and 13 percent for low salinity SAV to the deep edge of the SAV beds

Water clarity and light penetration are two major limiting factors to SAV growth that can be managed with appropriate interventions. Light attenuation by non-algal particulates, phytoplankton, and CDOM therefore influence SAV growth and depth of growth.<sup>49, 92, 135</sup> In order to protect and restore SAV, studies indicate that water clarity needs to be maintained to the depth where 22 percent of subsurface irradiance (incident light) is available for photosynthesis for high salinity SAV and 13 percent subsurface irradiance for low salinity SAV.<sup>45, 50, 51</sup>

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### Validate a bio-optical model to define interim chlorophyll *a* targets for SAV waterbody regions

With funding support from APNEP, UNC-IMS scientists have conducted a validation exercise for a bio-optical model that is intended for use to develop chlorophyll *a* and turbidity standards that are protective of NC's high salinity and low salinity SAV habitats.<sup>49</sup> Results from this model can then be used to estimate chlorophyll *a* concentrations necessary to maintain water clarity needed for seagrass growth as it relates to 22 percent incident light to a depth of 1.7 m for high salinity SAV and 13 percent incident light to a depth of 1.5 m for low salinity. These concentrations can then be used as light penetration targets.

The bio-optical model was initially developed by Gallegos for use in Chesapeake Bay. However, Biber et al. re-calibrated the model using waters from the North River in NC, for intended use throughout the Albemarle-Pamlico estuarine system.<sup>39, 49</sup> Optical characteristics of particles and phytoplankton of the North River may, or may not, be similar to those of other areas within the Albemarle-Pamlico estuarine system, and those differences may impact the ability of the model to accurately predict relationships between light attenuation and concentrations of chlorophyll *a*, turbidity, and CDOM that attenuate light. To assess the validity of the model outside of the area where it was calibrated, the validation exercise compared model predictions of light attenuation to measurements of light attenuation from waters throughout the Albemarle-Pamlico estuarine system.

Preliminary results from the validation exercise showed that the bio-optical model accurately predicted observed light attenuation in high salinity waters similar to those of the North River.<sup>136</sup> In the high salinity waters, turbidity, both organic and inorganic, rather than chlorophyll *a* was the main light attenuating substance in the water. For the high salinity locations which included Bogue Sound, Core Sound, Back Sound, and eastern Pamlico Sound, a median chlorophyll *a* concentration of 10 µg/L would meet the 22 percent light target for SAV protection.

For low salinity waters of the Neuse River, Pamlico River, western Pamlico sound, and Albemarle and Currituck Sounds, the model underestimated light attenuation by approximately 50 percent. Estimates of target chlorophyll *a* concentrations required to meet the 13 percent light target for low salinity SAV would also be significantly underestimated, thus preventing the use of the current model to derive low salinity chlorophyll *a* targets. The bio-optical model will require recalibration for NC's low salinity estuarine waters before it can provide meaningful targets for chlorophyll *a* and turbidity for protection of NC's low salinity SAV habitats.<sup>136</sup> Through collaborative efforts from DEQ, APNEP, National Oceanic and Atmospheric Administration's (NOAA's) Beaufort Laboratory, and UNC-IMS, efforts to recalibrate the bio-optical model for low salinity estuarine waters are underway. Once the model is validated for high and low salinity, the model can be used to develop management scenarios for chlorophyll *a* reduction to meet water clarity targets that are supportive of SAV restoration goals. Scenarios can be used to develop GIS layers of areas where there will be sufficient light for SAV persistence and may be used to determine potential growing areas that will support SAV.

### Assess existing North Carolina water quality standards for chlorophyll *a* supporting sufficient light penetration for SAV growth and reproduction

Target concentrations of chlorophyll *a* and turbidity identified by the bio-optical model should be compared and considered in relation to existing water quality standards for class C waters to determine whether the standards need revising to protect critical SAV habitats. Preliminary results from the model showed that a median annual chlorophyll *a* concentration of 10 µg/l would be protective of NC's high salinity SAV habitats; this value is lower than the current 40 µg/l standard for chlorophyll *a* in NC surface

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waters. However, a direct comparison to the standard is difficult because the current standard is not assessed at the median (50 percent quantile) chlorophyll *a* level, rather the current 40 µg /l standard is assessed at the 90 percent quantile. Using the statistical, probability distribution of chlorophyll *a* from estuaries throughout NC waters, a 10 µg /l median value corresponds to a 90 percent quantile of 26 µg/l, significantly less than the current 40 µg/l standard.<sup>136</sup> Comparisons of chlorophyll *a* concentrations to revised standards will help identify regions where nitrogen load reductions are necessary to protect SAV. Relationships between nutrient loading and chlorophyll *a* will need to be determined and will help manage sources of nutrient loads by SAV waterbody region and ultimately throughout coastal NC.

### Enhance Submerged Aquatic Vegetation (SAV) Research and Monitoring

Understanding the distribution and health of SAV in NC is critical to understanding the dynamics of shifts in SAV species extent, distribution, and composition. As previously described, mapping of SAV has occurred at irregular intervals over the last 40+ years by several different agencies and universities, across different extents, and with varying methodologies and resolutions. A comprehensive monitoring and assessment program for SAV should be developed using the best available technology. The use of the most comprehensive, highest resolution, and cost effective methods available should be explored and used. This program should be developed by a team of partners, and should include a full-scale, routine (occurring every five years or sooner), coast-wide assessment and monitoring program. Sentinel sites should be re-evaluated and expanded along the coast, with regular groundtruthing using standardized metrics (i.e. water quality, species composition, density, and condition).<sup>10</sup> This will allow managers to account for changes in SAV over time, giving the ability to evaluate the success of management actions and determine causative relationships between changes in SAV species extent, distribution, and composition. Through regular monitoring and assessment, protection of this habitat can be improved and targeted, benefiting the diversity and resiliency of the entire coastal ecosystem.

### Improve Collaboration

Strong collaboration among scientists, managers, and the public is essential to achieve the goals and actions listed above. Regional collaboration among resource stakeholders was critical to success in both Chesapeake and Tampa bays.<sup>95, 96</sup> North Carolina should establish a similar collaborative process involving state agencies, local governments, academic institutions, NGOs and the public to monitor, assess, and adaptively manage regional areas. Collaboration to develop and adopt management goals, and to engage in the decision making process on needed management actions, changes, and adjustments leads to better public understanding and appreciation of the issues. This in turn helps to change public perception and behavior by engaging and informing stakeholders early in the process to play a role in implementation of management actions in their communities, such as voluntary citizen science monitoring programs.

## **4.4 Recommended Actions**

### **4.4.1 Funding**

4.1 By 2023, the DEQ will pursue recurring funding as well as from state, federal, and private sources that includes the adequate amount of staff to successfully evaluate and meet the SAV acreage goals and implement all of the SAV recommended actions that contribute to meeting the goals.

### **4.4.2 Planning**

4.2 By 2022, DEQ will commit to protecting and restoring SAV to reach an interim goal of 191,000 acres coastwide with specific targets by SAV waterbody regions (Table 4.5; Figures 4.1-4.9).

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- 4.3 By 2022, DEQ will form an interagency workgroup with non-government organizations (NGOs), and local governments to inform and guide development of watershed restoration plans to protect, restore or replicate natural habitats (i.e., SAV, water quality, coastal habitats) and hydrology through natural and nature-based solutions.
- 4.4 By 2022, DEQ will form a workgroup with the DWR, DEMLR, Division of Soil and Water Conservation, local governments, and other partners to increase BMPs to the extent possible related to water quality within the SAV waterbody regions consistent with current funding level and request increased state cost-share funding.

### **4.4.3 Mapping and Monitoring**

- 4.5 By 2023, DEQ will develop and implement a full-scale assessment program to conduct coastwide SAV mapping and monitoring at regular intervals ( $\leq 5$  years).
- 4.6 By 2023, DWR will evaluate and prioritize the incorporation of shallow water sites ( $< 1\text{m}$  mean lower low water (MLLW)) that currently or historically contain(ed) SAV into the statewide Ambient Monitoring System.

### **4.4.4 Potential Rulemaking**

- 4.7 By 2022, EMC will receive guidance from the NCDP SAC on establishing a water quality standard for light penetration, with a target value of 22 percent to the deep edge (1.7 m) of SAV for all high salinity SAV waterbody regions, and a light penetration target of 13 percent to the deep edge (1.5 m) for all low SAV waterbody regions (Table 4.5; Figures 4.1-4.9).
- 4.8 By 2022, at the request of the EMC, the NCDP SAC will evaluate the chlorophyll *a* water quality standard and as needed, recommend it be revised by the EMC to ensure protection of SAV in high and low salinity waterbody regions, beginning with the Albemarle Sound and Chowan River, and continuing with other waterbodies that support SAV (Table 4.5; Figures 4.1-4.9).
- 4.9 By 2024, the EMC will enact the rule making process to adopt scientifically defensible nitrogen and/or phosphorus criteria if recommended through the NCDP process, to help protect and restore ~12,900 acres of low salinity SAV habitat in the Albemarle Sound SAV waterbody region and continuing with other waterbodies that support SAV.

### **4.4.5 Research**

- 4.10 By 2025, DWR will determine with assistance from research academia, the loading and sources of nutrients and sediments, their quantitative linkages to chlorophyll *a* concentrations, and their effect on water quality and SAV.
- 4.11 By 2022, NC and DEQ, through the Secretary of Emergency Management, will request more accurate estuarine bathymetry data from the National Oceanic and Atmospheric Administration (NOAA).
- 4.12 By 2022, DWR will request the NC Policy Collaboratory to investigate the impacts of agricultural practices and land use change on water quality within SAV waterbody regions, to determine types and location of BMPs needed to effectively improve water quality.

### **4.4.6 Outreach**

- 4.13 By 2022, DEQ Office of Education and Public Affairs will work with local governments and NGOs to

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start the development of public education and stewardship programs with social media campaigns and citizen science monitoring to increase public awareness of SAV's importance for fish habitat and other co-benefits, as well as instill public commitment to SAV conservation.

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## 5. WETLAND SHORELINE PROTECTION AND ENHANCEMENT WITH FOCUS ON NATURE-BASED SOLUTIONS

### 5.1 Issue

Wetlands occur throughout NC's estuaries and provide critical fish habitat and other ecosystem services that enhance ecological and community resiliency. While protections for wetlands are in place, losses continue to occur and threats remain, varying by wetland type and location. Addressing wetland loss holistically will require a comprehensive approach incorporating: 1) an appraisal of existing and anticipated threats to wetlands within the CHPP region, 2) a synthesis of knowledge gaps, 3) a plan to build partnerships with local communities and encourage a participatory approach to coastal resource management, and 4) a list of high-priority, actionable policy or practice recommendations that could be implemented to offset past and expected losses.

### 5.2 Background

Wetlands are defined by the US Environmental Protection Agency (EPA) as “those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.” [40 CFR 230.3(t)] Wetlands have long been recognized for their importance in estuarine productivity, habitat functions for finfish and shellfish, and many other ecosystem services. These services collectively make wetlands one of the most critical estuarine habitats for countless species of fish and other wildlife. The large extent of wetlands in North America's Coastal Plain substantially contributes to the high biodiversity.<sup>1</sup> Salt marshes provide grazing, foraging, and breeding ground for numerous threatened marine megafauna (e.g., sea turtles, porpoises, sharks, rays, and otters).<sup>2</sup> In NC, more than 70 percent of species listed as federally or state endangered, threatened, or of special concern are wetland-dependent.<sup>3,4</sup> Some of NC's designated endangered species include mollusks (yellow lampmussel, *Lampsilis cariosa*); fish (Atlantic and shortnose sturgeon, *Acipenser* spp.; Cape Fear shiner, *Notropis mekistocholes*); reptiles (Kemp's ridley sea turtle, *Lepidochelys kempii*); amphibians (river frog, *Rana heckscheri*); mammals (manatee, *Trichechus manatus*); and birds, (piping plover, *Charadrius melodus circumcinctus*).<sup>5</sup>

There are multiple classification systems used to differentiate classes of wetlands. For the purposes of this paper, a simplified Cowardin System which splits wetlands within the CHPP region into two broad classes, palustrine and estuarine, is used. Palustrine wetlands are freshwater wetlands that include all non-tidal wetlands that are dominated by trees, shrubs, or emergent vegetation, as well as any tidal wetlands where ocean-derived salinities are less than 0.5 parts per thousand (ppt). Wetlands with salinities greater than 0.5 ppt are categorized as estuarine wetlands, which can be further divided by vegetation type into forested, scrub/shrub, and emergent estuarine wetlands. This differs from the CRC's regulatory definition of “coastal wetlands” (15A NCAC 07H .0205), which includes ten specific species of salt marsh or other marsh subject to regular or occasional flooding by lunar or wind tides.

#### 5.2.1 Ecological Value

##### Productivity

Wetland communities are among the most productive ecosystems in the world.<sup>6,7,8</sup> Some of the high primary production (creation of organic compounds through photosynthesis) of wetland vegetation is transferred to adjacent aquatic habitats via detritus and microalgae.<sup>9</sup> Primary production in salt/brackish marshes is converted into fish production in several ways. In Georgia, experiments using

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isotopes to trace organic matter flow in the salt marshes found the two major sources of organic matter used in fish production were from *Spartina* spp. detritus and algae.<sup>10</sup> A 2020 study conducted in Back Sound, NC, which used stable isotopes to analyze the diet of finfish and crustaceans within seagrass beds, found that consumers in these seagrass beds derived 20-23 percent of the basal primary production from saltmarshes, regardless of the proximity of the sampled seagrass bed to saltmarsh.<sup>11</sup> Benthic microalgae support herbivorous snails, whereas detritus supports finfish such as sheepshead, mummichogs, and their prey. Algae can be found on marsh grass, intertidal mudflats, and shallow subtidal bottom near the marsh. Saltmarsh edge is estimated to have production of 2.2 to 4.2 times greater than open water estuarine habitat for important fishery species (i.e., penaeid shrimp and blue crabs).<sup>12</sup> Primary production in tidal freshwater marsh, bottomland hardwood, and riverine swamp forest is similarly high and dependent on the frequency and duration of flooding.<sup>13</sup>

### Fish utilization

The high productivity of wetlands is in part why they are critically important to the productivity of the state's fisheries (Table 5.1). More than 90 percent of NC's commercial fisheries landings and 60 percent of its recreational harvest consist of species dependent on estuarine habitats including wetlands.<sup>14</sup> Of the wetland dependent species included in Table 5.1, seven commercial species ranked within the top ten for pounds landed in 2019 and seven recreational species ranked within the top ten for number of directed trips. The plant structure, high productivity, and landscape position in estuaries provide ideal conditions for small prey and juvenile fishery species. Similarly, palustrine wetlands are important habitat for many recreationally important freshwater fishes (e.g., largemouth bass, bluegill, crappie, chain pickerel) throughout their life histories.<sup>15</sup> A study in Virginia found that 79 percent of the number of fish collected at tidal freshwater marsh sites were larval and juvenile fish.<sup>16</sup> More information on how different species guilds use the estuarine and palustrine wetlands can be found in the 2016 CHPP source document.<sup>17</sup>

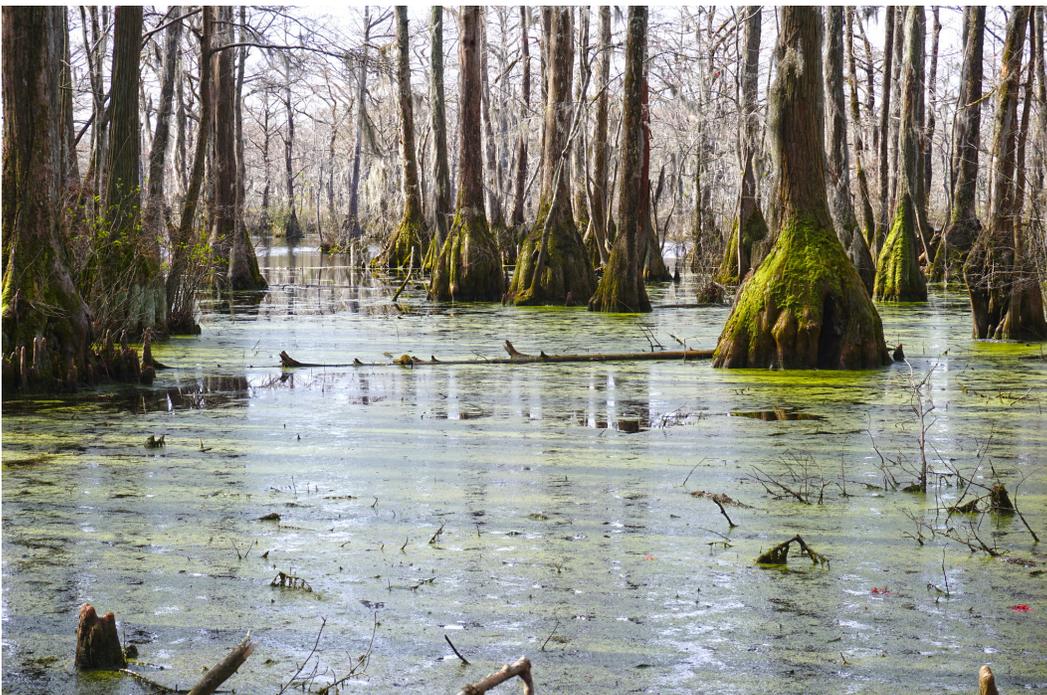


Photo Credit: NCWetlands.org

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Table 5.1. Finfish and crustaceans and their use of wetland habitats in NC.<sup>7, 9, 18, 19, 20, 21, 22</sup>

Species*	Wetland Functions					Fishery**
	Nursery	Foraging	Refuge	Spawning	Corridor	
<u>RESIDENT FRESHWATER OR BRACKISH</u>						
White perch	X			X		X
Yellow perch	X	X		X		X
Catfish	X	X	X	X	X	X
<u>ANADROMOUS AND CATADROMOUS</u>						
American eel		X	X		X	X
Sturgeon spp.	X	X	X		X	X <sup>†</sup>
<b>River herring (alewife &amp; blueback herring)</b>	X	X	X	X	X	X <sup>†</sup>
Striped bass	X	X	X		X	X
<u>ESTUARINE AND INLET SPAWNING AND NURSERY</u>						
Atlantic rangia clam	X	X	X	X		
<b>Banded killifish</b>	X	X	X	X		
Bay anchovy	X	X		X		
<b>Blue crab</b>	X	X	X		X	X
Cobia	X	X			X	X
<b>Grass shrimp</b>	X	X	X	X		
<b>Mummichog</b>	X	X	X	X		
Naked goby	X	X	X	X		
<b>Red drum</b>	X	X	X		X	X
<b>Sheepshead minnow</b>	X	X	X	X		
Silversides	X	X		X		
<b>Spotted seatrout</b>	X	X	X		X	X
<u>MARINE SPAWNING, LOW-HIGH SALINITY NURSERY</u>						
<b>Atlantic croaker</b>	X	X	X		X	X
Atlantic menhaden	X	X			X	X
<b>Shrimp</b>	X	X	X		X	X
<b>Southern flounder</b>	X	X	X		X	X
<b>Spot</b>	X	X	X		X	X
<b>Striped mullet</b>	X	X	X		X	X
<u>MARINE SPAWNING, HIGH SALINITY NURSERY</u>						
Black sea bass	X	X	X		X	X
<b>Pinfish</b>	X	X	X		X	X
<b>Summer flounder</b>	X	X	X		X	X

\* Species in bold font are species whose relative abundances have been reported in the literature as being generally higher in wetlands than other habitats. Note that lack of bolding may be due to lack of information rather than non-selective use of wetlands.

\*\* Existing commercial or recreational fishery. Fishery and non-fishery species are also important as prey.

† Fishery species under harvest moratorium.

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Wetland ecotones, the transitional landscapes between two adjacent habitats, are thought to be particularly important estuarine nursery areas. Juveniles of transient, estuarine-dependent species, which comprise a large portion of commercially and recreationally valuable species, often concentrate within the transition zones between marsh and other structured (e.g., seagrass beds, oyster reefs) or unstructured (soft bottom tidal creeks) habitats.<sup>23, 24</sup> These transition zones are thought to provide increased foraging opportunities that translate to higher growth rates, increased survivorship due to reduced mortality, and favorable physical environments for the development of juvenile nekton.<sup>11, 25, 26, 27, 28, 29, 30, 31, 32, 33</sup> As a dominant shoreline type within temperate estuaries, salt marsh complexes represent important foraging grounds for large mobile finfish and crustacean species, such as red drum, spotted seatrout, flounders, and blue crab.<sup>34, 35</sup>

The Fisheries Reform Act of 1997 requires DMF to prepare fishery management plans (FMP) for adoption by the NC Marine Fisheries Commission (MFC) for all commercially and recreationally significant species or fisheries that comprise state marine and estuarine resources. The goal of the plans is to ensure long-term viability of these fisheries. Fisheries habitat and water quality considerations are one of several requirements of these plans and are to be consistent with the CHPP. Several state FMPs recommend restoring wetlands, acquiring land to preserve wetlands and open space, reducing runoff from land use activities through voluntary and regulatory measures, restoring hydrology on developed, agriculture, and forestry lands using Best Management Practices (BMPs), and providing more incentives for low impact development (LID). The FMPs that included these wetland-related habitat and water quality actions are:

- Bay Scallop Amendment 2<sup>36</sup>
- Estuarine Striped Bass Amendment 1<sup>37</sup>
- Kingfishes<sup>38</sup>
- Red Drum Amendment 1<sup>39</sup>
- River Herring Amendment 2<sup>40</sup>
- Shrimp<sup>41</sup>
- Southern Flounder Amendment 1<sup>42</sup>
- Spotted Seatrout<sup>43</sup>
- Striped Mullet Amendment 1<sup>44</sup>

### Ecosystem Services

Wetlands in the Coastal Plain, including those abutting and those that are not directly connected with surface waters, provide numerous ecosystem services that benefit fish, other coastal habitats, water quality, and communities. These wetlands provide a wide variety of ecosystem services, such as wave energy dissipation, flood storage, shoreline stabilization, water filtration, open space, ecotourism opportunities, carbon sequestration, nursery grounds for commercially important species, and pollinator habitat. Updated valuations of selected wetland ecosystem services including storm protection, erosion protection, and wastewater treatment, estimate monetary values for tidal marsh/mangrove at roughly \$78,000 per acre per year.<sup>45</sup> While the co-benefits of interconnected coastal habitats and regional specificity make parsing out one single per-acre value of NC's Coastal Plain wetlands impractical, the ecosystem services they provide are clearly a valuable public trust asset to the citizens of NC.

### Storm Protection and Flooding

Wetlands along the coast aid in storm and shoreline protection by reducing wave energy along the shoreline.<sup>46, 47, 48</sup> These reductions in wave energy and flooding translate to considerable economic

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impacts. Analysis of 34 major hurricanes impacting the US since 1980 found that, on average, one acre of wetland loss resulted in an additional \$13,360 of storm-related damages.<sup>47</sup> The total value of wetlands in the US was estimated at \$23.2 billion per year in storm protection services. Storms and hurricanes present major threats to coastal communities and infrastructure, the severity and cost of which will be further amplified by sea level rise (SLR) and ocean warming attributable to climate change.<sup>49, 50</sup> Presence of wetland vegetation appreciably reduces property damage by imposing drag on water flow, which in turn reduces wave energy and inland flooding during storm events.<sup>51, 52</sup> Near complete dissipation of wave energy has been documented by marshes extending approximately 30 m from the shoreline; however, due to the non-linearity of wave damping, marshes <10 m in width are frequently capable of reducing wave heights by 50-80 percent.<sup>51, 53</sup> Wetlands in coastal areas were found to reduce flood heights and damages from Hurricane Sandy in 80 percent of the impacted region from Maine to NC.<sup>54</sup> Recent analyses found that over a 30-year period, the storm protection value of one square mile of wetlands exceeds \$2.5 million in eight of NC's 22 coastal counties, with the value approaching \$25 million per square mile in highly developed New Hanover County.<sup>55</sup>

While palustrine wetlands play a lesser role in mitigating storm surge, they can dramatically slow the conveyance of stormwaters to receiving waterbodies and can store up to 330,000 gallons of water per acre per day and recharge up to 100,000 gallons of groundwater per acre per day.<sup>7, 56</sup> In doing so, palustrine wetlands in coastal areas play an important role in reducing flooding in developed lands and reducing stormwater influx to coastal areas. This is a particularly important service when coastal regions have been inundated by storm related flooding.

### Shoreline Stabilization

As mentioned above, estuarine wetland vegetation, whether natural or restored, can dramatically reduce wave energy due to friction between above-ground biomass and waves.<sup>57</sup> Wetland vegetation along shorelines subsequently traps suspended sediments, which can accrete at rates that keep pace with rising sea levels.<sup>58</sup> Further, wetland vegetation's below-ground biomass (e.g., roots and rhizomes) has been shown to reinforce substrate and reduce erodibility of sediments.<sup>51, 59</sup> It was found that over a four-decade period that Cedar Island, NC shorelines with estuarine emergent wetlands had roughly half the rate of erosion of unvegetated shoreline types.<sup>60</sup> Research synthesizing retreat rates of marsh over decadal time scales (1956-2004) has shown that erosion rates of unvegetated sediment banks (-0.39 m/year) are greater than double the rate for vegetated shorelines (-0.18 m/year) in NC's New River estuary.<sup>61</sup>

### Water Quality Enhancement

In an analogy to human physiology, wetlands have been likened to nature's kidneys, serving as downstream receivers of contaminated waters, which they can help clean before the waters enter receiving waterbodies or are recharged to groundwater aquifers. In coastal regions, healthy wetlands are efficient at intercepting ground and surface water. As the flow of water is slowed by wetland vegetation, turbidity-causing suspended solids settle out, sediment-bound pollutants (e.g., phosphorous and heavy metals) are sequestered, and nutrients (e.g., nitrogen and phosphorous) are assimilated by plants and used by wetland-associated microorganisms.<sup>62</sup> This allows coastal palustrine and estuarine wetlands to appreciably improve coastal water quality. The biofiltration services of wetlands are increasingly critical as growing industrial use of artificial fertilizers and increasing extent of impervious surfaces increases runoff in coastal regions.<sup>63</sup>

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Many studies have documented the water cleansing ability of wetlands. A few examples include:

- Forested palustrine wetlands in agricultural drainage areas reduced nitrogen by 90 percent and phosphorus by 80 percent<sup>64</sup>
- Stormwater wetlands within the NC Coastal Plain reduced peak flows and runoff volumes by 80 percent and 54 percent, respectively<sup>65</sup>
- Stormwater wetlands within the NC Coastal Plain reduced nutrients and bacteria between 60-70 percent<sup>66</sup>
- Saltmarshes, which are often the terminal wetland biofilter, were able to assimilate nearly 100 percent of ambient nitrate loads from coastal stormwater<sup>67</sup>

### Carbon Sequestration

Coastal vegetated habitats (tidal marshes, seagrasses, mangroves, and macroalgae) are recognized for their ability to mitigate climate change via sequestration of disproportionately large amounts of carbon in both above- and below-ground plant biomass as well as within their soils.<sup>68</sup> Cumulatively, these vegetated habitats, which comprise 0.2 percent of the global ocean's surface, account for 50 percent of carbon burial in marine sediment.<sup>69</sup> Ranking among the densest carbon sinks globally, vegetated coastal habitats and their stores of carbon, dubbed "blue carbon", play a considerable role in addressing global climate change.<sup>70</sup>

Within tidal salt marshes, atmospheric carbon (CO<sub>2</sub>) is assimilated into plant biomass, becomes trapped within the vegetation's structurally complex root system along with other sources of organic carbon, and is ultimately buried below the sediment at concentrations 30-50 times those found in terrestrial forests.<sup>71</sup> The dense network of roots and rhizomes, which frequently account for greater than 50 percent of saltmarsh biomass, stabilize low oxygen soils where decomposition occurs slowly. The carbon is then buried for centuries to millennia, provided the habitat remains intact.<sup>72</sup> The accretion of carbon in the soil of tidal marshes is integral to the marsh's ability to maintain an inundation regime as sea levels rise. Coastal wetlands that can keep pace with SLR and not drown in place have a near limitless capacity to sequester carbon.<sup>73</sup> In NC, coastal marshes store an estimated 64 million metric tons of CO<sub>2</sub> and continue to sequester an additional 200,000 metric tons of CO<sub>2</sub> each year.<sup>74</sup> Saltmarsh's distinction of being among the highest, if not the highest vegetated habitat, to sequester carbon per unit area was noted in NC Risk Assessment and Resiliency Plan.<sup>75</sup> The plan notes that incentivizing conservation, protection of marsh migration corridors, and increasing active wetland restoration efforts are critical to coastal wetland's continued ability to sequester greenhouse gases. This sequestration is negatively correlated with the magnitude of anthropogenic disturbance in the form of physical, chemical, and biological stressors.<sup>70</sup>

Although rarely included in blue carbon accounting, both tidal wetlands in the upper reaches of estuaries and non-tidal freshwater wetlands in the Coastal Plain also have the potential to serve as major carbon sinks.<sup>76</sup> Palustrine wetlands in the US store nearly ten-fold more carbon (sometimes referred to as "teal carbon") than their tidal saltwater counterparts, due in part to their considerably greater areal extent.<sup>70</sup> Accounting for approximately 93 percent of the areal extent of NC's Coastal Plain wetlands, palustrine wetlands are a key part of the state's wetland carbon inventory.

### Recreation and Tourism

Tourism and coastal recreation support tens of thousands of jobs and contribute more than a billion dollars annually to the economies of NC's coastal counties.<sup>77</sup> Four coastal counties (Dare, Hyde, Currituck, and Carteret) rank within the top ten counties statewide in terms of average per capital

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economic contribution derived from tourism. Dare County ranked first in the state, with tourism contributing an average of \$27,290 per year per resident. Many tourist activities rely on a healthy and clean estuarine environment, whether for oystering around the marsh, fishing in a creek, swimming in the sound, or eating fresh seafood at a restaurant. More than a third of US adults participate in recreational and tourism opportunities found in wetlands, including hunting, fishing, birdwatching, kayaking, and wildlife photography. With participation rates in these activities exceeding world-wide averages, it is likely that the per acre recreational value of wetlands exceeds the \$451 acre/year estimated in recent global meta-analysis work.<sup>78</sup> As such, wetlands are integrally important to the economic development of NC's coastal counties. Highlighting the importance of these wetlands to the tourism industry, respondents to a survey of potential visitors to coastal NC ranked wildlife observation, state parks, national wildlife refuges, and wetland trails as four of the top five potential preferred activities.<sup>79</sup>

### 5.2.2 Status and Trends

Approximately 95 percent of NC's wetland resources are in the state's Coastal Plain.<sup>80</sup> The National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP) recently published 2011-2016 data, providing 20 years of NC Coastal Plain wetland change data over five-year time steps beginning in 1996. According to that, NC had a total of 4.59 million acres of wetlands within the Coastal Plain. Of that, there were 4.35 million acres of palustrine (freshwater) wetlands, of which 71 percent are forested wetlands, 23 percent are scrub/shrub wetlands, and 6 percent are emergent wetlands. Palustrine forested wetlands can include bottomland swamp, pocosins, and wet pine flats. North Carolina also has 235,425 acres of estuarine wetlands, of which 97 percent are emergent wetlands (Table 5.2; Figure 5.1).<sup>81</sup> According to the 2011 National Land Cover Database (NLCD), there was a total of 3.7 million acres within the four CHPP regions. That figure is lower because the CHPP region does not include the entire Coastal Plain.<sup>82</sup>

It is estimated that nearly half of NC's 11 million historical acres of wetlands were lost between pre-colonial times and the 1980s.<sup>83</sup> The percent of wetlands impacted to the point of no longer supporting their original function exceeded 50 percent by the 1980s.<sup>84</sup> These alterations were not evenly distributed between wetland types, with 52.4 percent of palustrine wetlands in the Coastal Plain having been altered by the 1980s, in contrast with 12.2 percent of estuarine wetlands. Unfortunately, wetland loss is not a relic of NC's past. Approximately 40 percent of total documented coastal wetland losses occurred between 1950 and 2000.

Table 5.2. Acres of palustrine (freshwater) and estuarine wetlands in the NC Coastal Plain.<sup>81</sup>

Wetland Class	Extent (acres)
Palustrine Forested Wetland	3,069,690
Palustrine Scrub/Shrub Wetland	1,008,552
Palustrine Emergent Wetland	272,932
Estuarine Forested Wetland	166
Estuarine Scrub/Shrub Wetland	7,747
Estuarine Emergent Marsh	235,425
Total	4,594,513

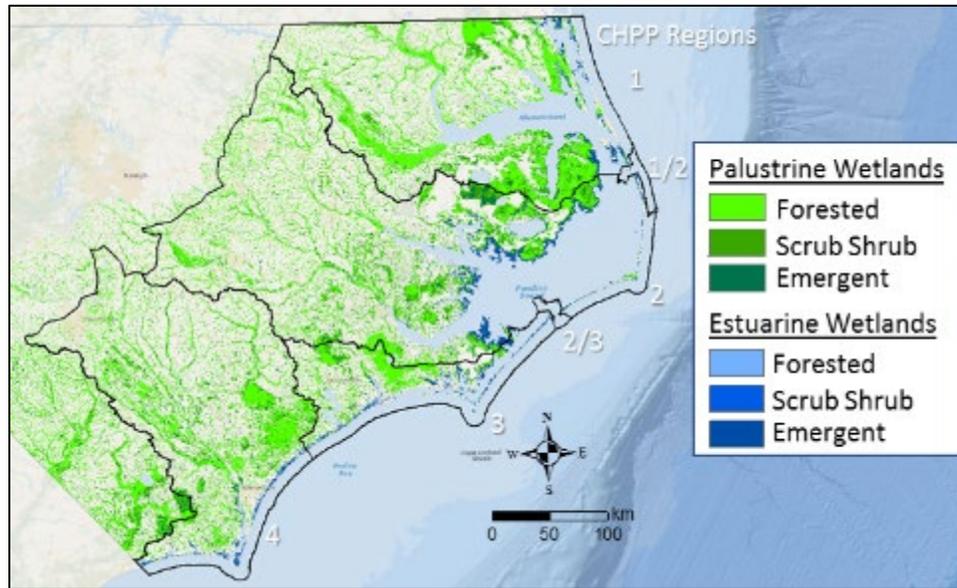


Figure 5.1. Distribution of palustrine and estuarine wetlands with the Coastal Habitat Protection Plan (CHPP) regions.<sup>81</sup>

The loss of NC’s Coastal Plain wetlands has continued into the 21st century. Using the latest C-CAP data, wetland change was calculated over five-year intervals from 1996 to 2016. Documented within the 20-year period, 135,000 acres of palustrine wetland were lost in NC’s Coastal Plain (Table 5.3).<sup>81</sup> Conversion to uplands was the land use change contributing most to palustrine wetland losses over the 20-year period, likely due to ditching and filling. Conversion to development, agriculture, and open water also contributed to loss. Roughly 72 percent of all documented coastal freshwater wetland losses occurred from 1996 to 2001. Over the 20-year period, the rate of net coastal freshwater wetland loss decreased. There was a reported net increase from 2011 to 2016 due to 3,128 acres gained from open water and upland.

Table 5.3. Net loss or gain of NC’s coastal palustrine wetland acreage to other land cover classes, by conversion type. Negative values represent a loss of coastal palustrine wetlands to the specified land cover class and positive values represent a gain. Net change represents net change from all land conversions during that time.<sup>81</sup>

Palustrine Wetland Conversion To:	Time Period				
	1996-2001	2001-2006	2006-2011	2011-2016	20-Yr Total
Development	-6,450	-2,172	-3,001	-1,317	-12,940
Agriculture	-9,218	-2,476	127	0	-11,567
Upland	-77,636	-13,493	-9,748	637	-100,240
Estuarine Wetlands	0	0	0	0	0
Unconsolidated Shore	46	16	-39	-144	-121
Open Water	-3,255	-6,840	-3,973	3,952	-10,116
Net Change	-96,513	-24,965	-16,633	3,128	-134,983

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While the magnitude of cumulative losses to coastal palustrine wetlands are very high, the proportion of loss was not evenly distributed among palustrine subclasses. Palustrine forested wetlands, which account for 71 percent of all coastal palustrine wetland acreage, accounted for 99 percent of overall net losses incurred across all three classes over the 20-years of NOAA C-CAP data (Table 5.4).

Table 5.4. Net loss or gain of NC's coastal palustrine wetland acreage by wetland type. Negative values represent a net loss of coastal palustrine wetlands and positive values represent a net gain of coastal palustrine wetlands.<sup>81</sup>

Time Period	Palustrine Wetland Type		
	Forested	Scrub/Shrub	Emergent
1996-2001	-279,324	147,607	35,204
2001-2006	-150,287	89,661	35,664
2006-2011	-115,836	99,574	-265
2011-2016	-42,969	40,277	5,816
20-Yr Total	-588,416	377,119	76,419

These losses, totaling 588,524 acres of forested palustrine wetlands between 1996 and 2016, were offset by gains to scrub/shrub and emergent wetlands over the same period (Table 5.5). Palustrine scrub/shrub wetlands were the only palustrine wetland class in which net gains in acreage were observed across all periods between 1996 and 2016 (Table 5.5). The gain of 377,119 acres of palustrine scrub/shrub wetland was likely due to conversion from palustrine forested wetland (64 percent) and palustrine emergent wetland (35 percent). Conversion from palustrine forested wetland was also the major contributor (>99 percent) to palustrine emergent wetland acreage gains between 1996 and 2016 (Table 5.5). While 219,520 acres of palustrine emergent wetland were gained by conversion from palustrine forested wetland, 135,360 acres of palustrine emergent wetlands were lost by conversion to palustrine scrub/shrub wetland, negating more those potential gains.

A loss of forested wetlands co-occurring with a gain in scrub/shrub and emergent wetlands is more likely a conversion than a loss since wetland trees harvested for timber can regrow if hydrology has not been altered. Despite conversion to other wetland types, there was a net loss of palustrine forested wetlands. Furthermore, it's difficult to distinguish permanent wetland loss versus conversion from the land cover dataset. Recent analysis of palustrine wetland losses in coastal counties of the conterminous US found that 80 percent of palustrine wetland losses occurring between 1996 and 2010 occurred in five states, with NC ranking fifth and accounting for 8 percent of all losses incurred nationally over the period.<sup>85</sup>

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Table 5.5. Net loss or gain of NC's coastal palustrine forested, scrub/shrub, and emergent wetland acreage by type of conversion to other land cover classes. Negative values represent a net loss of the coastal palustrine wetland class and positive values represent a net gain of the coastal palustrine wetland class.<sup>81</sup>

Conversion Type	Time Period				
	1996-2001	2001-2006	2006-2011	2011-2016	20-year period
<b>Palustrine Forested Wetland To:</b>					
Development	-6,027	-1,281	-1,530	-870	-9,708
Agriculture	-7,784	-1,783	227	0	-9,340
Upland	-77,143	-10,993	-7,755	367	-95,524
Palustrine Scrub/Shrub Wetland	-122,149	-54,957	-57,626	-10,816	-245,548
Palustrine Emergent Wetland	-63,038	-77,125	-45,049	-34,308	-219,520
Estuarine	0	0	0	0	0
Unconsolidated Shore	11	-2	-2	-66	-59
Open Water	-3,193	-4,149	-4,206	2,724	-8,824
Net Change	-279,324	-150,290	-115,941	-42,969	-588,524
<b>Palustrine Scrub/Shrub Wetland To:</b>					
Development	-296	-719	-280	-297	-1,592
Agriculture	-704	-159	-33	0	-896
Upland	-37	-197	-783	-3	-1,020
Palustrine Forested Wetland	122,149	54,957	57,626	10,816	245,548
Palustrine Emergent Wetland	26,295	36,153	42,727	30,185	135,360
Estuarine	0	0	0	0	0
Unconsolidated Shore	4	1	7	-16	-4
Open Water	197	-376	310	-407	-276
Net Change	147,607	89,661	99,574	40,277	377,119
<b>Palustrine Emergent Wetland To:</b>					
Development	-127	-172	-1,190	-150	-1,639
Agriculture	-729	-534	-67	0	-1,330
Upland	-455	-2,303	-1,210	272	-3,696
Palustrine Forested Wetland	63,038	77,125	45,409	34,308	219,880
Palustrine Scrub/Shrub Wetland	-26,295	-36,153	-42,727	-30,185	-135,360
Estuarine	0	0	0	0	0
Unconsolidated Shore	31	16	-44	-62	-59
Open Water	-258	-2,315	-77	1,634	-1,016
Net Change	35,204	35,664	-265	5,816	76,419

In contrast to coastal palustrine wetlands, net change in estuarine wetland acreage exhibited an inverse temporal pattern (Table 5.6). Specifically, net gains of estuarine wetlands were observed from 1996 to 2006, while net losses were observed in the more recently from 2006 to 2016. The land conversion type that accounted for the greatest loss in each five-year period shifted considerably through time.

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Conversion of estuarine wetlands to agriculture and upland accounted for 48 percent and 42 percent of losses, respectively, between 1996 and 2001. Conversion to agriculture accounted for 80 percent of estuarine wetland losses between 2001 and 2006, while conversion to development and upland accounted for 37 percent of losses each between 2006 and 2011. From 2011 and 2016, conversion to unconsolidated shore and open water were the leading sources of estuarine wetland losses, accounting for 38 percent and 32 percent, respectively.

Table 5.6. Net loss or gain of NC's estuarine wetland acreage by type of conversion between estuarine wetlands and other land cover classes. Positive values represent a net gain of estuarine wetlands from the specified land cover class and negative values represent a loss of the estuarine wetlands to the specific land class cover.<sup>81</sup>

Estuarine Wetland Conversion To:	Time Period				
	1996-2001	2001-2006	2006-2011	2011-2016	20-yr period
Development	-6	-16	-77	-15	-114
Agriculture	-30	-62	-1	0	-93
Upland	-26	4	-77	-9	-108
Palustrine	0	0	0	0	0
Unconsolidated Shore	252	1	-54	-31	168
Open Water	400	75	146	-26	595
Net Change	590	2	-63	-81	448

North Carolina has wetland standards (15A NCAC 02B.0231) that provide protection of wetland functions. The NC 401 and Buffer Permitting Branch enforces the 401 certification, isolated waters permitting, buffer authorization, and buffer variance processes. Proposed projects may be exempted, deemed approved, approved with written notification (with or without mitigation requirements), requesting more information, or denied depending on the size and type of project. Some permitted projects may also require wetland, stream, and/or buffer mitigation to account for losses due to impacts above the mitigation thresholds (15A NCAC 02H .0506 and 15A NCAC 02H.1305). Mitigation impact thresholds for Wetlands (WLs) and Saltwater Wetlands (SWLs) are 0.10 acres. For isolated wetlands, thresholds are less than or equal to one acre in the coastal region, and less than or equal to 0.5 acres in the Piedmont region. The DWR tracks wetland, stream and buffer impacts that are permitted through the 401 Wetland Program.

Information on cumulative impacts to wetlands can be summarized from data in DEQ's Basinwide Information Management System (BIMS). The database records DWR issued permits and certifications. The data represents an underestimate of impacts for several reasons. In 2005 the database system was changed, and possibly as much as 50% of the records did not pull into the new system successfully. The database was designed primarily for NPDES permits, rather than 401 wetland certificates, leading to some issues. Also, some records do not have all the fields recorded, which may be needed to filter out the wetland type, location, or activity type. However, based on the information that is in the BIMS database, approximately 17,984 acres of wetland impacts were permitted statewide through 12,386 issued 401 certifications and Isolated Wetlands and Waters permits between January 1, 1990 and December 31, 2019 (Figure 5.2). The areas having the most impacted acres were frequently coastal counties, particularly in the 1990s. Brunswick, Onslow, and Carteret consistently had high impacts across the three decades. The DWR permit data for the 20 coastal counties indicate that in the 1990s, most impacts were attributable to "boat-related and bulkheads", followed by dredging. Boat-related and

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bulkheads includes water dependent structures such as boat basins, marinas, docks, and bulkheads. From 2000 to 2010, there was a large increase in mining impacts. Since 2010, most impacts were associated with transportation (Figure 5.3). Some of the impacts are offset by mitigation.

For any CAMA permit, a 401 certification is also required, so the wetland impacts recorded in the BIMS database does include impacts to salt/brackish marsh. While the database can't distinguish between CAMA and 401 permitted impacts, the data can be filtered by wetland type. Based on that, over the 30-year period (1990-2019), 208 of 6,799 records involved impacts to salt/brackish marsh, with a total impact of 48.1 acres. The impacts reported for “boat-related and bulkheads” in Figure 5.3 could include impacts to 401 or CAMA wetlands, or both.

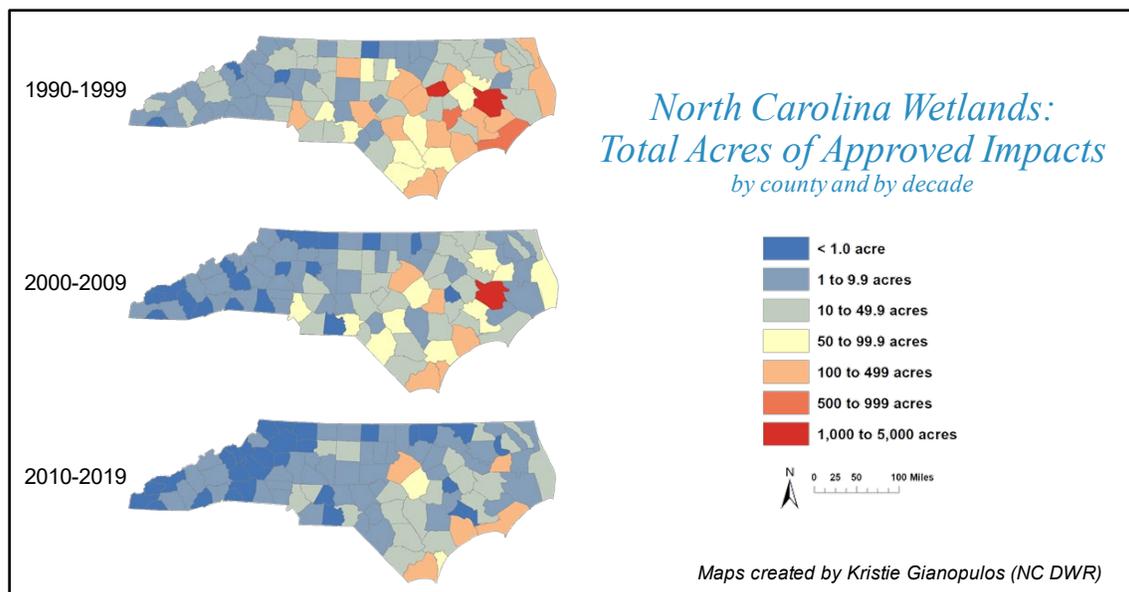


Figure 5.2. Total acres of approved wetlands impacts across NC, 1990-2019.<sup>86</sup>

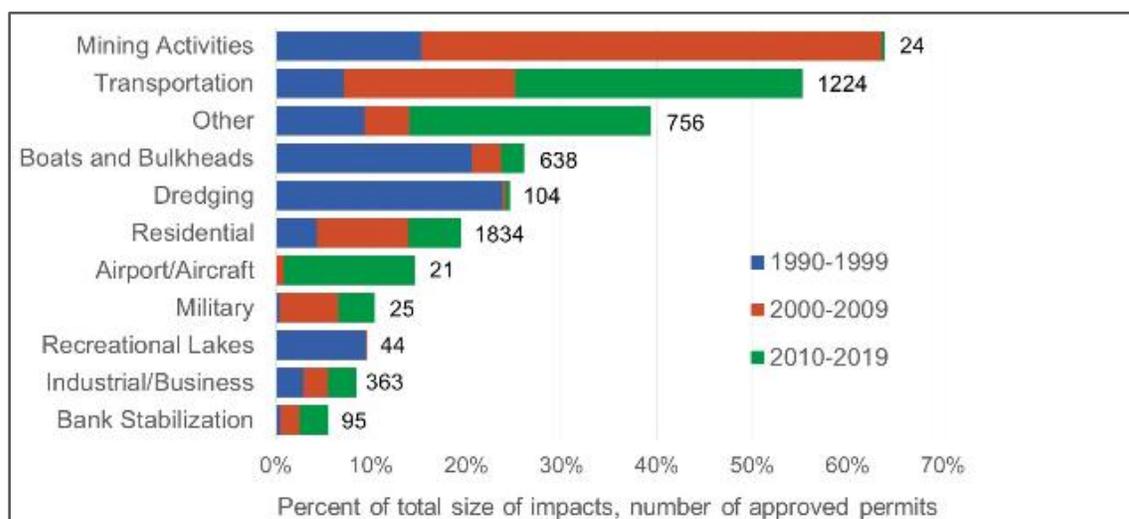


Figure 5.3. Permitted wetland impacts by primary activity type in NC's 20 coastal counties, 1990-2019.<sup>86</sup>

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### 5.2.3 Current and Future Threats

#### Dredge and Fill Alterations Associated with Development

In NC, the US Army Corps of Engineers (USACE), DWR through the Environmental Management Commission (EMC) and Division of Coastal Management (DCM) through the Coastal Resources Commission (CRC) have authority to regulate wetlands. The CRC has authority to regulate coastal wetlands and activities within the 20 Coastal Counties from the Coastal Area Management Act (CAMA) and NC Dredge and Fill Law. Coastal development rules are included in 15A NCAC 07B and 07H. Impacts to coastal wetlands (estuarine species listed in rule) must be avoided and minimized. The CRC rules do not allow mitigation for coastal wetland impacts unless the project is deemed to have a significant public benefit. The USACE has authority to regulate wetlands from Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act. If a federal 404 permit is to be issued, DWR must also review the project and issue a 401 certification (Section 401 of the CWA and 15A NCAC 02B and 02H). Avoidance and minimization must be pursued before mitigation for impacts is considered.

The EMC has wetland standards for all classifications of wetlands (15A NCAC 2B .0230-.0231). The standards are used to assure existing uses of wetlands are protected. The uses include storm and flood water storage and retention, moderation of water level fluctuations, hydrologic function (groundwater discharge and recharge), filtration or storage of pollutants, shoreline protection, habitat for wetland dependent aquatic organisms including fish, as well as other wildlife species. The 401 Certification rules (15A NCAC 02H .0500) and NC Isolated Wetland and Waters rules (15A NCAC 02H .1300) allow property owners to apply for approval to conduct projects in wetlands. Projects exempted, deemed approved, or in receipt of an approval letter under these permitting rules satisfy the wetland standards in 02B .0231. However, thresholds exist under which wetland impacts are allowed without mitigation being required. As described in the previous section, the permitted impacts can be cumulatively significant over time.

A new concern is loss of jurisdiction over wetlands, due to changes in the EPA and the US Department of the Army's joint Navigable Waters Protection Rule (NWPR, 85 FR 22250) which redefined "Waters of the United States" (WOTUS, CWA Section 502(7)) on June 22, 2020. The revised definition of WOTUS eliminates certain waters and wetlands due to lack of direct surface water connectivity; therefore, reducing the scope of waters federally regulated under the CWA (CWA, 33 U.S.C. §§ 1251–1387). Under the modified definition, WOTUS includes all wetlands adjacent to: traditional navigable waters (including territorial seas); tributaries to those waters; jurisdictional ditches, lakes, and ponds; and impoundments of otherwise jurisdictional waters. Under this rule, wetlands continue to be defined as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." Wetlands that do not directly abut or have a direct surface water hydrologic connection are not considered "adjacent" under the NWPR.

An analysis of the potential impacts of WOTUS, found that wetland types most at risk included floodplain pools, pine flats, pine savanna, non-riverine swamp forest, seeps, headwater wetlands, bottomland hardwood forest and bogs.<sup>87</sup> The study indicated that approximately 28 percent of headwater wetlands in the Coastal Plain would no longer be jurisdictional. Due to their position at the upper tributary, headwater wetlands are critical for filtering pollutants from the immediate watershed and storing large amounts of floodwaters, thereby improving downstream water quality and reducing flooding. Numerous state agencies provided comments in response to the proposed rule. The DWR,

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DEQ, and Office of the Attorney General of the State of NC (OAG) relayed concerns with the loss of wetlands that were previously covered under federal jurisdiction, and how the proposed rule would affect jurisdiction, regulation, and protection of these vital resources.

Since the recent adoption of the NWPR, which no longer uses the term “isolated,” there is now a category of federally non-jurisdictional wetlands that is no longer eligible for coverage under the 401 permitting regulations, nor are they eligible for coverage under the isolated wetlands permitting rules since they do not meet the definition of “isolated.” Without a permitting mechanism, proposed impacts to these federally non-jurisdictional wetlands will not satisfy 02B .0231. There is also concern that impacts could occur. To maintain the wetland permitting mechanisms at levels like those in existence prior to the NWPR, EMC has adopted temporary rules to provide landowners with a mechanism for approval to conduct work in NC’s federally non-jurisdictional and non-isolated wetlands. The EMC did not propose any modification to existing wetland protections or “exempted” features (e.g., man-made ponds, stormwater/wastewater measures, ditches). Permanent rules to replace the temporary rules are expected to be presented to the EMC for approval. This would provide beneficial protection to wetlands.

### Ditching and Draining for Agriculture, Forestry, and Development

As noted in the status and trends section, conversion of wetlands for forestry and agriculture has been a major source of wetland loss historically and in more recent decades. Ditching is done to drain water and lower the water table, allowing agricultural crops to grow and allowing heavy equipment to harvest forested wetlands. Ditching has also been done to lower the water table to allow development, leading to wetland loss and increased runoff. The process of ditching and draining not only alters the hydroperiod of the wetlands to non-optimal conditions that may not support wetlands, but also impacts their ability to store water onsite.<sup>88, 89</sup> Consequently, runoff to surface waters increases and is flashier during large rain events, resulting in less filtration of pollutants. Nutrients from loosened organic soils and fertilizer, as well as pesticides are transported in the runoff to surface waters. In Carteret County, when a 6,000-acre tract of ditched farmland was partially restored to wetlands with natural hydrology, water drainage from the site went from taking hours to taking days.<sup>90</sup>

The federal Clean Water Act exempts most agriculture and forestry activities from having to obtain a permit to disturb wetlands, described in Section 404(f)(1) of the CWA. While permitting is not required, the CWA still requires that the wetland not be converted to a non-wetland, and also requires those activities to implement measures prescribed in the CWA to minimize overall wetland disturbance, as well as the deployment of BMPs.<sup>91</sup> Vegetated buffers are one BMP that would be beneficial for wetlands and water quality.

However, in areas designated as NSW and having nutrient management rules (i.e., Neuse, Tar-Pamlico), agricultural nutrient loading requirements are included. In NC, the performance standards defined by 02 NCAC 60C .0100 to .0209 Forest Practices Guidelines Related to Water Quality must be met if a forestry operation is to remain exempt from submitting an erosion and sedimentation control plan, obtaining permits and meeting other requirements described under the state’s Sedimentation Pollution Control Act. The NC Department of Agriculture and Consumer Services (DA&CS) Forest Service relies on education and monitoring for FPG compliance to ensure that operations are complying. If a violation is not corrected, the agency will notify the DEQ to take potential enforcement action. The “Forestry Best Management Practices Manual to Protect Water Quality” provides a suite of BMP options to protect water quality and meet the criteria required in rule. The manual is on track to be updated in 2021, and in consultation with the USACE, some notable revisions are being made to the BMPs for silvicultural

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activities in wetlands, including more than a dozen new BMPs for harvesting timber in bottomland swamps, and new BMPs for minimizing erosion and sedimentation impacts when managing minor drainage.<sup>92</sup>

### Shoreline stabilization

Since the 1980's, land use along coastal NC has shifted from agricultural uses to urban and rural development.<sup>93, 94</sup> These levels of development among the 20 coastal counties of NC have only continued to increase. The NC Office of State Budget and Management reported a 9.98 percent population increase from 2010 to 2019 (Table 5.7).<sup>95</sup> Between 2019 and 2039, the populations of numerous NC counties within the Coastal Plain are predicted to increase by more than 16 percent and multiple counties with estuarine coastlines are predicted to grow by greater than 30 percent (Figure 5.4).

Table 5.7. Estimates of the total population of NC's 20 coastal counties for April 2010 and July 2019, as well as absolute and percent change over the same period.<sup>95</sup>

County	Total Population Change			
	April 2010	July 2019	Number	Percent
Beaufort	47,784	47,436	-348	-0.7
Bertie	21,275	19,630	-1,645	-7.7
Brunswick	107,429	143,169	35,740	33.3
Camden	9,980	10,559	579	5.8
Carteret	66,463	70,986	4,523	6.8
Chowan	14,793	14,141	-652	-4.4
Craven	103,498	102,989	-509	-0.5
Currituck	23,547	27,677	4,130	17.5
Dare	33,920	37,599	3,679	10.9
Gates	12,185	11,954	-231	-1.9
Hertford	24,677	23,857	-820	-3.3
Hyde	5,817	5,145	-672	-11.6
New Hanover	202,683	233,062	30,379	15
Onslow	177,801	207,252	29,451	16.6
Pamlico	13,143	13,286	143	1.1
Pasquotank	40,661	39,953	-708	-1.7
Pender	52,196	63,153	10,957	21
Perquimans	13,452	13,740	288	2.1
Tyrrell	4,407	3,773	-634	-14.4
Washington	13,193	12,113	-1,080	-8.2

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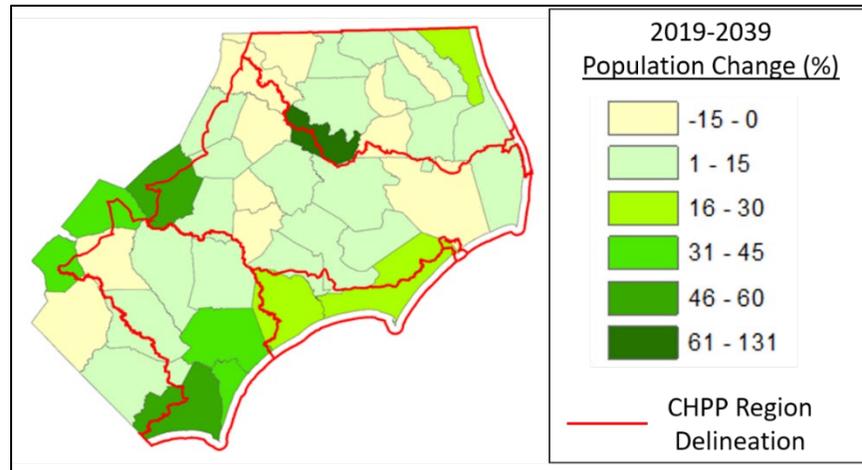


Figure 5.4. Predicted population growth for counties falling entirely or in part within Coastal Habitat Protection Plan (CHPP) regions, 2019-2039.<sup>95</sup>

Increasing development on the coast is expected to bring increasing demand for shoreline stabilization. More than 48,000 properties valued at \$13 billion are predicted to become chronically inundated by 2100 under relatively conservative SLR estimates values that could more than double under more extreme SLR scenarios. In 2012, DCM delineated the shoreline and stabilization and docking structures.<sup>96</sup> Bulkheads were the dominant type of stabilization structure. Of 10,658 miles of shoreline, the study identified approximately 500 miles of bulkheaded shoreline directly abutting surface waters, 75 miles with bulkheads with some amount of marsh waterward of the structure, and 17 miles of bulkhead with sediment bank waterward of the structure. Riprap was the next most common structure with 182 miles. As of 2012, there were roughly 815 miles of armored shoreline and only 4.9 miles of marsh sill, the term for living shorelines in rule (Figure 5.5). In the time since, the amount of shoreline armoring in NC has increased to 1,100 miles.<sup>97</sup>

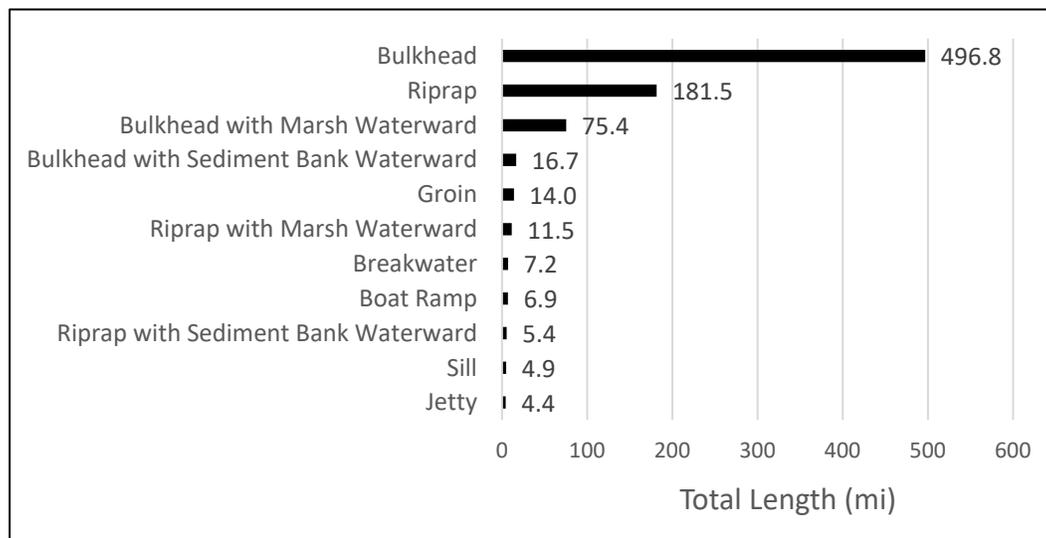


Figure 5.5. Coastwide extent of shoreline with shoreline structures within NC's 20 coastal counties, based on 2012 aerial imagery.<sup>96</sup>

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In total, eight percent of the shoreline had some type of shoreline stabilization structure. In the US, it is estimated that approximately 14 percent of all estuarine shoreline has been hardened.<sup>98</sup> Shoreline hardening may, effectively maintain shoreline position in the short-term, but their exacerbation of erosive processes via reflection of wave energy (Figure 5.6) and their reduced structural complexity compared to shoreline vegetation or fringing oyster reefs can lead to the loss of ecosystem services (e.g., fish habitat, water quality enhancement) provided by the shoreline habitats they replace.<sup>99, 100</sup>

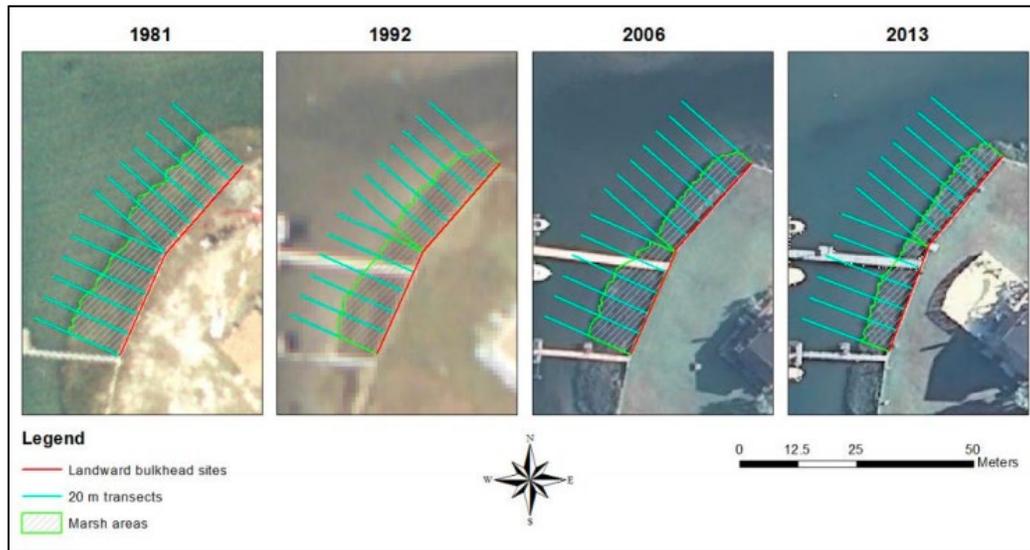


Figure 5.6. Time series of two bulkhead sites illustrating changes in marsh width, 1981-2013.<sup>100</sup>

### Shoreline Erosion

Wetland loss also occurs along natural shorelines due to wave energy from wind and boat wakes. As noted in the ecosystem services section, shorelines with wetland vegetation are much more resilient to erosion. In a study looking at wave energy along different shoreline types, the presence of wetland vegetation had a stronger effect on erosion rates than wave energy, suggesting the value of living shorelines to reduce shoreline erosion.<sup>101</sup> Wave attenuation was positively correlated with stem density. A study in Carteret County that examined the effect of boat wake energy on shoreline erosion noted that in low wave energy settings, marshes that were subject to greater boat wake energy (closer to navigation channels or high boat dock density) were narrower than marshes subject to less boat-induced wave energy.<sup>102</sup> Measurements confirmed that boat wakes can contribute more to wave energy than wind in some settings. Studies indicate that severe storms and hurricanes do not significantly impact marshes. Since water levels are usually higher than normal, waves pass over the top of the plants, transporting sediment into the marsh, which in turn helps build elevation.<sup>103, 102</sup> Low to moderate storms that occur more frequently have a greater impact on salt marsh erosion, especially when they occur at low tide.

Living Shorelines are a viable and desirable alternative to vertical shoreline hardening and a solution to wetland erosion that include a suite of options for shoreline erosion control. The structures are designed to provide erosion control and maintain existing connections between upland, intertidal, estuarine, and aquatic areas, allowing ecosystem services such as fish habitat, water quality enhancement, and flood control to continue. Unlike vertical stabilization measures such as bulkheads, living shoreline techniques use native materials such as marsh plants, oyster shells, as well as rock or concrete-based material.

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While coastal wetland vegetation can effectively buffer shorelines in areas with low to moderate wave energy, in some locations or situations, other nature-based structures (e.g., oyster reef breakwaters, sills) may be needed to augment the coastal protection services of natural or restored vegetation on shorelines in areas with high wave energy (Figure 5.7).<sup>104</sup>

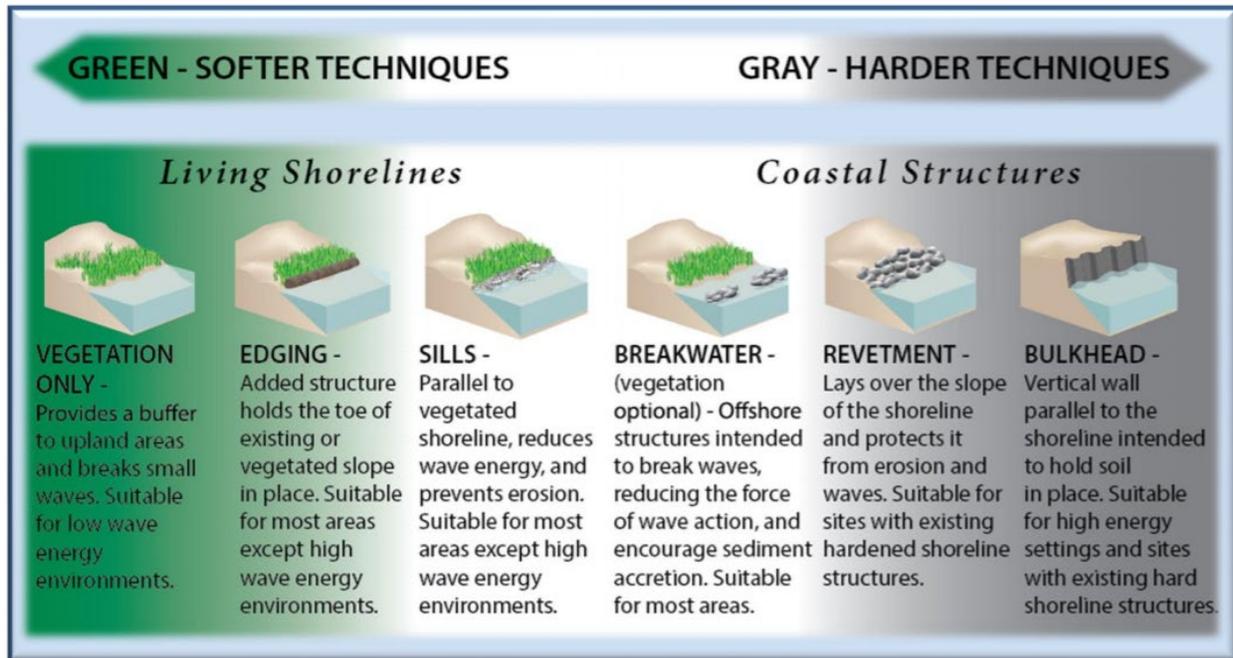


Figure 5.7. Continuum of shoreline stabilization methods, from most natural and softest (green) to least natural and hardest (gray), with the greenest methods being more effective in low to moderate wave energy, and grayest methods being more effective for high wave energy.<sup>105</sup>

Multiple studies from NC support use of living shorelines as an effective method of shoreline stabilization that also provides substantial ecosystem service benefits, including provision of fish nursery habitat.<sup>85, 106, 107, 108, 109</sup> A comparison of natural marsh shorelines to living shorelines with restored marsh and sill found that the living shorelines had 1.5 to 2 times greater sediment accretion rates, indicating their effectiveness in controlling erosion.<sup>110</sup> A study comparing shoreline change rates pre- and post-installation of living shorelines with sills found that 12 of 17 monitored living shorelines sites along the coast showed reduced erosion rates, and six of those sites showed accretion.<sup>111</sup> Research has also looked at the efficacy of living shorelines for erosion control during more extreme events, such as hurricanes and surveyed sites were more durable than bulkheads.<sup>104, 106</sup> Post-hurricane shoreline surveys in NC following Hurricane Irene found that, in contrast to the 76 percent of surveyed bulkheads that incurred damage, none of the estuarine marsh shorelines, with or without sills, experienced damage.<sup>106</sup> Other research has documented the value of wide-scale use of living shorelines for carbon sequestration and nitrogen removal.<sup>107, 112</sup> With mounting evidence of the damaging impacts of shoreline armoring to estuaries, there is a critical need to embrace alternative, environmentally friendly shoreline stabilization techniques.

### Marine Debris

An emerging and less understood threat to wetlands is marine debris. The Marine Debris Act of 2006 defines marine debris as “any persistent solid material that is manufactured or processed and directly or

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indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or Great Lakes". Worldwide, greater accumulation of marine debris is being observed in the oceans and estuaries, with plastic comprising 80 percent of coastal debris. Wetlands are susceptible to marine debris deposition from both ocean and land-based sources due to storms and tides pushing debris in from offshore, and drainage systems or stormwater discharges that bring debris from nearby developed land. Marine debris in wetlands can range in size from microplastics, abandoned fishing gear, sections of wooden docks, up to large items such as derelict vessels. Due to the complex structure of the wetland plants, debris often becomes trapped once in the wetland, and macroplastics break down over time to micro- and nanoplastics, where they aggregate with natural particles, becoming biologically available to organisms in the sediment. While larger marine debris can have negative effects on the physical and aesthetic condition of wetlands, small plastic pieces can alter carbon and nutrient fluxes within the water column and sediments, altering biological processes.<sup>113</sup> In January 2020, the NC Coastal Federation (NCCF) published the "North Carolina Marine Debris Action Plan", providing a strategic plan for prevention and the removal of marine debris in NC.<sup>114</sup>

The extent to which wetland habitat quality is impacted by marine debris is uncertain.<sup>113</sup> Previous research has predominantly focused on the role that plastics play in the environment. Studies have shown an accumulation of nano- and microplastics in water, sediment, and in the tissues of invertebrates and nekton in estuaries within proximity to urbanization. In Mosquito Lagoon, FL, a riverine system that has seen high increases in development in the last 30 years, elevated concentrations of microplastics were found in the organic tissues of the eastern oyster and Atlantic mud crab. Both species, which are common in tidal marshes, are potentially high-risk animals for microplastic accumulation.<sup>115</sup> More research is needed to determine the impact of degrading plastics and other litter on wetlands, and associated sediment and benthos.<sup>113</sup>

### Climate change

The rate of SLR is expected to continue increasing as the oceans warm.<sup>116</sup> Coastal wetlands are highly vulnerable to SLR impacts.<sup>75, 117</sup> As sea levels rise, coastal wetlands only have two mechanisms to adapt to prolonged periods of inundation. The first mechanism is to adjust vertically within the water column through sediment accretion. Analyses of long-term monitoring sites in NC have shown many of the fringing marshes were failing to keep pace with rates of SLR and are essentially drowning in place.<sup>118</sup> These results indicate that marshes in these areas will require the ability to migrate upslope rather than building in elevation of existing habitat.

The second mechanism is for coastal wetlands to migrate inland. As sea levels rise, estuarine water inundates landward and increases soil salinity, making these areas less habitable for saltwater-intolerant species in low-lying forests and agricultural lands. Terrestrial and freshwater plants are eventually replaced by halophytic marsh vegetation as the marsh-upland boundary moves landward (Figure 5.8). There are many environmental factors that influence the ability of wetlands to transgress into adjacent areas, such as topography, hardened structures, or drainage features, but among the most impactful is land use. The ability of a marsh to transgress along its natural path of migration is impeded in areas where hardscapes, such as roads or urban development, are present. Where this occurs, the marsh erodes at the waterward extent and remains stationary at the landward extent. Trapped between rising sea levels and impediments to inland migration, marsh width decreases, a phenomenon referred to as coastal squeeze. The proximity of development along the waters of NC is restricted by buffer rules. However, as sea levels rise and affect tidally influenced shorelines, established buffers will be reduced.

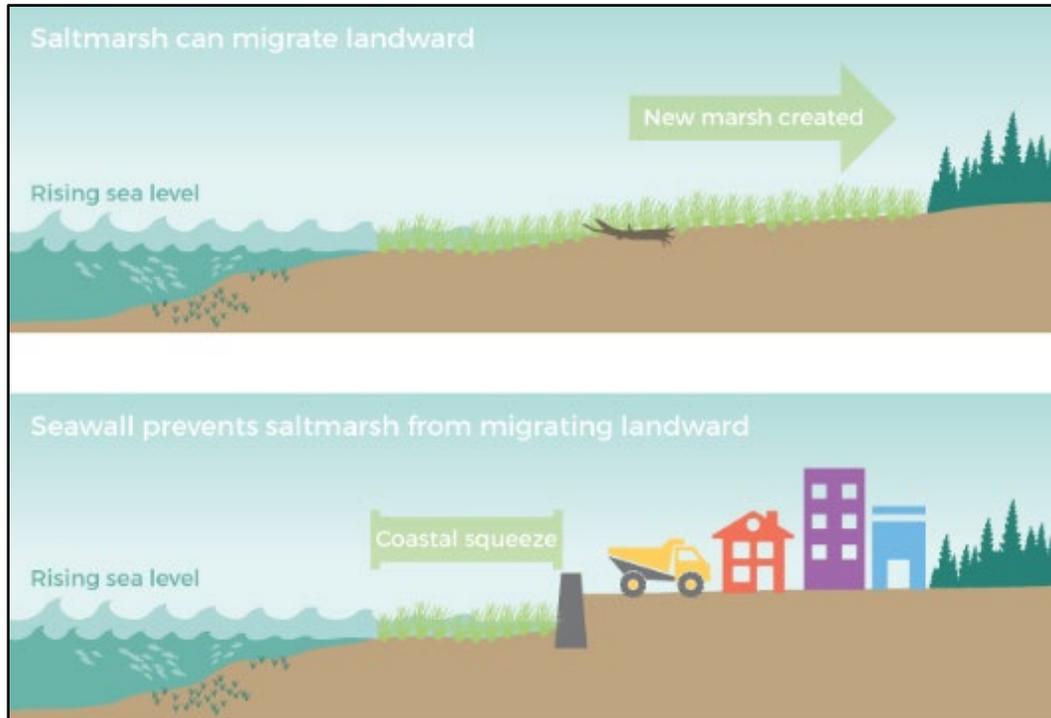


Figure 5.8. Conceptual diagram of process of natural marsh migration with sea level rise (SLR), and coastal squeeze when migration is impeded.

Rising sea levels also introduce the concern of increased saltwater intrusion along the coast. Saltwater intrusion (SWI) is the hydrological alteration of the interface of freshwater and saltwater caused by several environmental and anthropological factors. Natural influences of SWI may include storm surges from extreme weather events, droughts, periods of heavy rainfall, climatic changes, and subsidence or rebound. Human-induced SWI can be caused by land drainage, aquifer drawdown, reduction in freshwater discharge from dam operations, and land use changes.<sup>119</sup>

Shifts in salinity threaten native wetland habitats that are not salt-tolerant. Saltwater intrusion introduces saline water to soils and changes biochemistry which produces sulfides that are toxic to salt-intolerant species. Prolonged exposures and increasing frequencies of flooding tides containing higher salinity waters can result in permanent shifts in plant communities and conversion of tidal swamp to tidal marsh habitats.<sup>120</sup> Ghost forests, areas of dead trees in former freshwater forests, typically due to saltwater intrusion, are present along the coast and increasing, particularly on the Albemarle-Pamlico peninsula.<sup>121</sup> Once trees in tidal swamps cannot tolerate salinity and biogeochemistry changes, the habitat is replaced by herbaceous vascular plant species with higher salinity tolerances. Analysis of land cover change in the Alligator River National Wildlife Refuge (NWR) from 1985 to 2019 found 11 percent of the forested cover became ghost forest. Additionally, 2,844 acres of land were lost to erosion and 47,691 acres of forest converted to shrub or marsh. The ghost forests and land loss were attributed to SLR, salinization, and storm surge.

### 5.3 Discussion

In August 2020, three virtual wetland workshops were held by the CHPP Team to solicit input from coastal and palustrine wetland subject matter experts regarding wetland concerns and potential

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solutions. Seventy participants from state and federal agencies, non-government organizations, and academia participated. Topics of the three workshops were mapping and monitoring, threats and conservation, and restoration and living shorelines. Information and input gathered from these workshops was incorporated into this issue paper, particularly the discussion.<sup>122</sup> Meeting materials and a summary document are available at <http://portal.ncdenr.org/web/mf/habitat/chpp/07-2020-chpp>.

### 5.3.1 Mapping and Monitoring

#### Mapping

Comprehensive inventories of natural resources, including wetlands, are recognized as critical components for informed management, policy, conservation, and restoration actions. Inventories informed by robust mapping efforts provide managers the information needed to assess the impacts of anthropogenic activities, changes over time that are attributable to natural phenomena, and the outcomes of management actions and restoration efforts. Consequently, shortcomings in wetland mapping, either in their resolution or comprehensiveness, can impede the development of comprehensive wetland inventories, pose a challenge to conducting robust environmental impact assessments, and broadly hinder data-driven natural resource management. Therefore, safeguarding NC's natural resources, while allowing for sustainable development, hinges on the collection and availability of comprehensive data on the distribution, characteristics, and function of NC's wetlands, 95 percent of which occur within the Coastal Plain.

The two primary wetland mapping sources that provide coastwide wetland distribution data include DCM's Wetland Inventory, and the National Wetland Inventory (NWI). The NWI produces wetland and deepwater habitat maps throughout the United States using photo interpretation of aerial imagery and is the most extensive inventory of wetlands in the United States. Imagery costs and the lengthy time to delineate imagery deter the ability to produce new or update existing wetland maps. Further, the accuracy of imagery interpretation that informs NWI maps coming from multiple sources, is dependent on the quality of the imagery, availability of groundtruthing data, and repeatability by photo-interpretation analysts.

The DCM created a coastwide wetland inventory in the mid-1990's using NWI data, landcover classification from satellite imagery (Landsat data), and county-level soils data. The resolution and accuracy of DCM's wetland inventory, along with the older age of the imagery limits the products utility today.<sup>123</sup> Other federal mapping efforts related to wetlands are conducted by the United States Geological Survey (USGS), US Department of Agriculture Natural Resources Conservation Service (NRCS), and NOAA at different time intervals and mapping protocols. NOAA's C-CAP inventories coastal intertidal areas, wetlands, and adjacent uplands on one- to five-year intervals at a spatial resolution of 30 x 30 m pixels using Landsat data, aerial photography, and field observations.<sup>124</sup> Landsat data remains challenged by the relatively long period between revisits (16-18 days), cloud cover obstructing data collection, and shadows confounding interpretation.<sup>125</sup> As a result, the C-CAP has an accuracy target of 85 percent overall and 80 percent per habitat class.<sup>126</sup>

National and state inventories for land cover and wetlands are important tools used to formulate and evaluate the effectiveness of wetland policies and are integral to models used to predict the aerial extent of wetlands under a variety of future scenarios.<sup>127</sup> Therefore, the accuracy and resolution of these datasets have cascading effects throughout natural resource management and the research by which it is informed. While the spatial and temporal resolution of current NOAA C-CAP data has proven valuable for detecting large-scale changes in wetlands, particularly when the conversion occurs between

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distinct land cover types, numerous studies using higher-resolution imagery have documented wetland conversions that were not depicted using C-CAP data.<sup>128, 129</sup> Fortunately, there are efforts underway by NOAA C-CAP to generate spatially robust, high resolution (1m x 1m pixel) land cover inventories and map products. High resolution NOAA C-CAP mapping remains limited to a select few partner cost-share pilot projects around the country.<sup>130</sup> While nationwide one meter resolution mapping is a goal of NOAA C-CAP within the coming decade(s), acquiring this data in the near-term and deriving the competitive advantage will require collaboration and funding through establishing partnerships.

The dramatically improved maps resulting from these pilot projects hold considerable promise to improve natural resource managers' ability to track wetland loss, gain, and land conversions (Figure 5.9). Further, higher resolution mapping of land cover has appreciable potential to improve predictive models critical to allocating scarce conservation and restoration resources. For example, high-resolution mapping of impervious surfaces and other barriers to marsh transgression is imperative to the identification of priority marsh migration corridors.<sup>131</sup> During the CHPP Wetland Workshop, NOAA representatives indicated the possibility of including NC mapping at the one-meter resolution as a pilot project, however state matching funds would be required. The value of high-resolution land cover mapping extends well beyond coastal resource management applications, providing information invaluable to planning and administration of transportation, agriculture, utilities, infrastructure, habitat management, and other purposes. As such, coastal resource management agencies should consider working with other state agencies to pull together the funding necessary to commission one-meter land cover mapping.

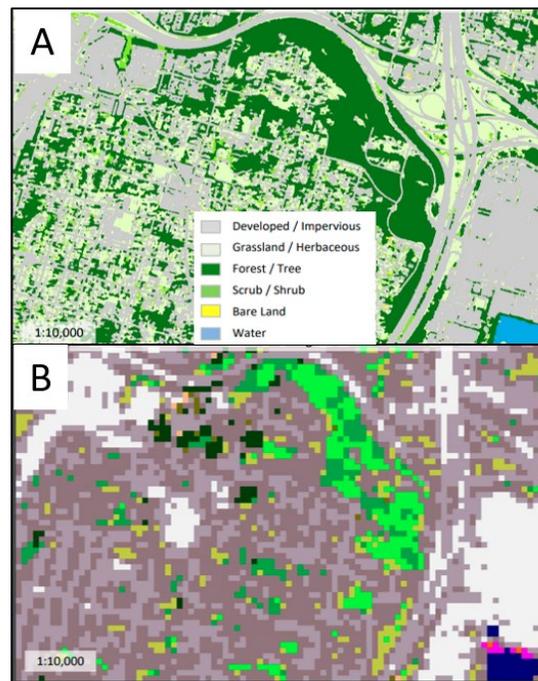


Figure 5.9. Land cover map of Seattle Tacoma, Washington with (A) 1 m baseline draft mapping and (B) 30 m existing National Oceanic and Atmospheric Administration's (NOAA) Coastal Change Analysis Program (C-CAP) data.<sup>132</sup>

There are several emerging technologies that have potential to allow more precise mapping with greater efficacy. Satellite data (Landsat) and aerial imagery are more available but have low to moderate

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resolution. Unmanned Aircraft Systems (UAS) (i.e., drones), can provide rapid high resolution mapping but are not practical for a coastwide assessment.<sup>133</sup> A process known as data fusion, can use the high resolution UAS imagery, that has been field verified, to train classifications of lower resolution satellite imagery, such as WorldView (1.24 m resolution) or RapidEye (5.0 m resolution), improving accuracy of habitat classification with the satellite imagery, and is a method to generate 3D data.<sup>122, 134</sup> Another technique known as deep learning neural network uses a time series of satellite imagery to evaluate land cover change in a way that reduces post-processing time and increases speed of map creation. The Duke Marine Lab evaluated change in land cover in the Albemarle-Pamlico peninsula between 1989 and 2011 with Landsat imagery and this deep learning technique. They were able to depict where farmland had transitioned to wetlands, particularly along ditches and canals, and wetland forests along the estuarine shoreline converted to ghost forests. Once proven, this technique would allow automated habitat classifications and rapid change analysis. The ability to assess wetland change rapidly and accurately is critical to focusing management and restoration actions in priority areas in a time-effective manner. Ury et al. (2021) similarly examined change in land cover in the Alligator River NWR using LandSat imagery from 1985 to 2019.<sup>121</sup>

### Monitoring

North Carolina's official wetland monitoring program was initiated by the Division of Water Quality (now DWR) in 2004. Since its inception, wetland monitoring conducted by DWR has been funded primarily by the EPA's Wetland Program Development Grants (WPDGs). While the first grant primarily supported efforts to monitor headwater wetlands, subsequent grants have provided funding to monitor basin wetlands, riverine swamp forests, and bottomland hardwood forests located across multiple watersheds. Between 2004 and 2015, projects funded largely by the EPA resulted in the monitoring of 248 wetland sites, 132 of which were within the CHPP region (Figure 5.10; Table 5.8). Due to the grant duration and project objectives, most (147 of 248, or 59 percent) were monitored for one year or less.

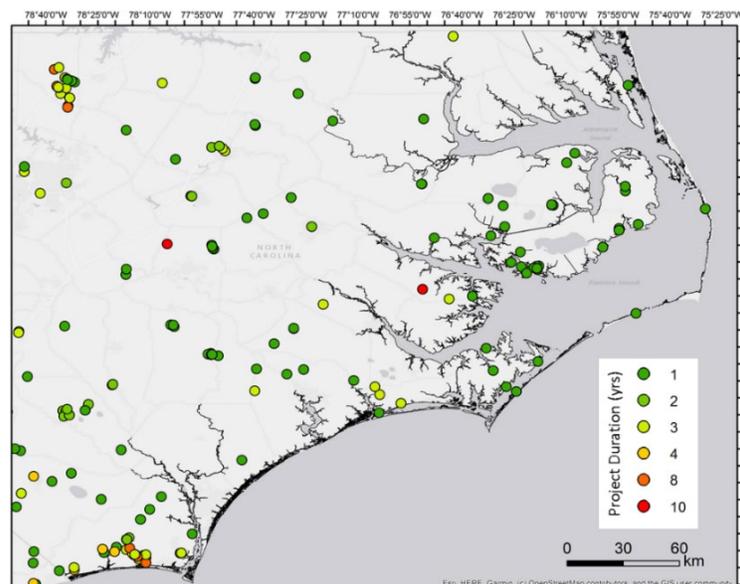


Figure 5.10. Location and sampling duration of wetland monitoring projects conducted by the NC Division of Water Resources (DWR) and partners, 2004-2015.

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Since 2004, wetland projects have conducted field evaluations of restored mitigation wetlands, studied headwater wetlands, characterized isolated wetland hydrologic connectivity, water quality, and biota, and assessed use of natural wetlands for stormwater assimilation, among others.<sup>135</sup> The Wetland Program Plan (NCWPP) was developed by DWR in 2015 and is updated every five years to guide actions to research and protect wetlands.<sup>136</sup> The plan is currently being updated and will be finalized for approval by the EPA in 2021. The Division of Mitigation Services (DMS) compiles monitoring reports for compensatory mitigation projects, and the Wildlife Resource Commission (WRC) has conducted monitoring to assess abundances of select fauna of interest.

Since the dissolution of the Wetland Program Development Unit in 2013, wetland monitoring efforts by state agencies have continued but on a short-term basis and much more limited scale. To provide a spatially robust inventory of the condition of the state’s wetland resources over ecologically meaningful temporal scales, there is a need to move away from a dependence on external grant funding, which can be intermittent and variable in their research objectives, to a recurring state appropriation for standardized wetland monitoring that is critical to generating the data needed for science driven management.

Table 5.8. Number of sample sites by wetland type within Coastal Habitat Protection Plan (CHPP) regions. Includes sampling by the NC Division of Water Resources (DWR) and partners, 2004-2015.

Wetland Type	CHPP Region				Total
	1	2	3	4	
Basin	0	1	2	27	30
Bottomland Hardwood Forest	0	4	0	2	6
Brackish/Salt Marsh	2	12	3	0	17
Estuarine Woody	0	4	0	0	4
Hardwood Flat	4	4	0	0	8
Headwater	1	11	1	6	19
Non-Riverine Swamp Forest	0	0	1	0	1
Non-tidal Freshwater Marsh	1	1	0	0	2
Pine Flat	1	4	0	2	7
Pocosin	1	2	1	4	8
Riverine Swamp Forest	7	8	1	14	30
Grand Total	17	51	9	55	132

In contrast to the short-term monitoring typical of EPA WPDG-funded projects that took place between 2004 and 2015, the NC Sentinel Site Cooperative (NCSSC), one of five cooperatives established throughout the US with NOAA funding in 2012, has established long-term monitoring surface elevation in coastal habitats in eastern NC. The cooperative consists of partners from NOAA, NC Coastal Reserve, DCM, NC Sea Grant, Department of Defense, National Park Service, the NC Aquarium at Pine Knoll Shores, academia, and town governments, with the goal of leveraging resources across organizations to provide stakeholders with information to address SLR and coastal inundation. A component of the work the NCSSC conducts is the monitoring of coastal habitats to address impacts of SLR. This has entailed leveraging existing and establishing new sites for the long-term monitoring of elevation change using surface elevation tables (SET), which are portable mechanical instruments that provide high-resolution measurements of elevation change within wetland sediments.<sup>137</sup> There are currently over 125 SETs

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throughout coastal NC generating information on the degree to which coastal marshes are keeping up with SLR (Figure 5.11).

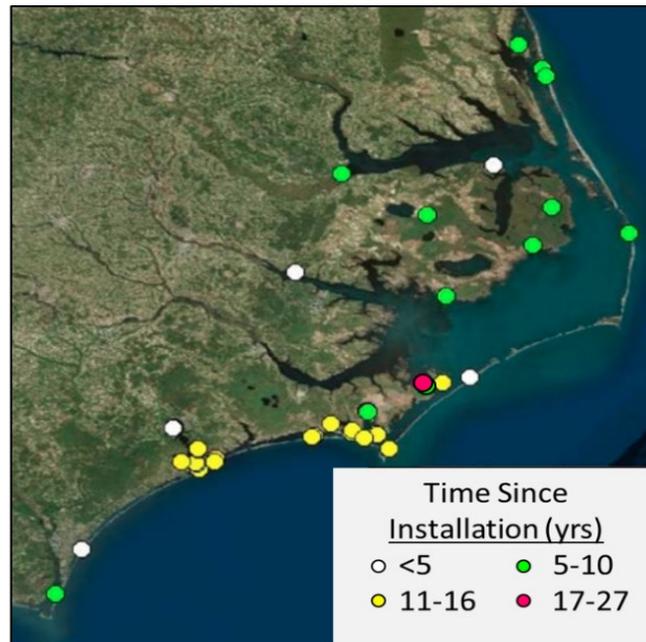


Figure 5.11. Surface elevation table (SET) locations in NC.<sup>138</sup>

Numerous NC universities and non-governmental organizations (NGOs) are conducting research involving coastal wetland monitoring. However, the various sampling methodologies in these studies have impeded efforts to combine data to generate a meaningful picture of habitat condition at broader spatial or temporal scales. The development of standardized protocols to monitor wetlands, coupled with a central repository to submit reports or standardized data would facilitate policy managers and natural resource managers' ability to formulate actions based on robust, scientifically validated information. A repository of standardized wetland monitoring data, which would include information from both published and unpublished studies, could minimize redundant sampling by researchers unaware of similar projects and facilitate synergistic collaborations. At the 2020 CHPP Wetland Workshop, most participants recognized the value of standard sampling protocols but noted that it would be difficult to implement due to different research objectives and funding sources. There was strong support for a central repository that included a database of who and where monitoring was occurring and completed reports. Both the formulation of some minimum standardized sampling protocol and the development of a centralized repository will require an inclusive process of consultation between practitioners, managers, and other user groups.

### 5.3.2 Coastal Resilience Planning

In NC and globally, the long-term sustainability of coastal populations is inextricably linked to coastal ecosystem services, including fisheries production, storm protection, water quality enhancement, flood control, and carbon sequestration. Coastal resilience planning is a crucial first step to reducing vulnerability of coastal communities, including loss of habitats and ecosystem services due to climate change. Climate change is expected to bring an increasing rate of SLR and an increasing intensity of hurricanes, storms, and heavy rain events. These changes will increase flooding, shoreline erosion, and

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damage to community infrastructure, and consequently impact the coastal economy. Impacts to fish habitats are also expected due to changing water levels, water quality, and chemical properties (temperature and salinity). Expected impacts were described in detail in the CHPP 2021 climate change chapter, the NC Climate Science Report and the 2020 Resilience Plan.<sup>75, 139</sup>

Vulnerability assessments are valuable tools to assess where communities are most susceptible to hazard risks, including climate-change related weather events, and to provide these communities with actions that can be taken to prepare, adapt, and lower risks. Assessments can inventory extent and location of natural infrastructure that provides flood, erosion, and water quality benefits. The Nature Conservancy (TNC) and the National Centers for Coastal Ocean Science (NCCOS), along with other partners developed a coastal resilience decision support tool.<sup>140</sup> The tools show areas at risk under different flood events and SLR scenarios, wetland distribution change under various SLR scenarios, and a living shoreline suitability tool. The USACE also conducted a regional assessment of risk from storms and SLR to support resilient communities and habitats.

Another resilience project was developed as part of the Natural and Working Lands component of the 2020 Resilience Plan. The project is intended to help state and local government, land conservation trusts, and landowners identify natural and working lands that can provide the most benefit if they are protected or restored.<sup>141</sup> One ArcGIS story map prioritizes marsh for their importance to protecting assets, such as populated areas, historic sites, and key natural areas. Another depicts the distribution of marsh and SAV, natural habitats that provide water quality value. Potential future marsh migration, if not blocked by stabilization structures or development, are shown for different SLR scenarios (Figure 5.12). This could help communities decide where to strategically conserve land to allow for marsh migration.<sup>74</sup>

The NC Resilient Coastal Communities Program was a recommendation of the 2020 Resilience Plan. The program, a partnership with NC Office of Recovery and Resiliency (NCORR), NC Sea Grant, TNC, and DCM, provides financial grants and technical assistance to support proactive local efforts to improve community resilience to climate change. The program aims to assist communities with risk and vulnerability assessments and development and implementation of prioritized projects that improve resiliency.<sup>142, 143</sup> Grant funding for developing watershed restoration plans is available through DWR's 319 grant program.<sup>144</sup> Watershed restoration plans often utilize nature-based solutions to address runoff and water quality issues.

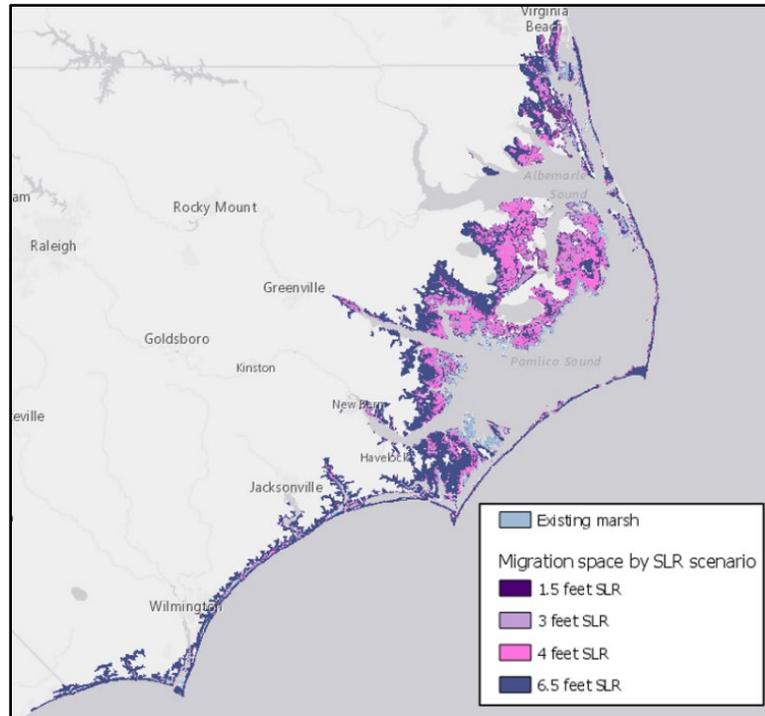


Figure 5.12. Migration space necessary for marsh to move inland to avoid inundation under four sea level rise (SLR) scenarios. The spaces shown do not identify where this is possible or not due to existing development.<sup>141</sup>

### 5.3.3 Nature-based Solutions

Despite NC's support of the Federal No Net Loss of wetlands policy objective, it is increasingly clear that this overarching policy goal has not been realized due to many factors, including policy choices exempting certain impacts from regulations, non-compliance, and the lack of mechanisms to address losses that cannot be attributed to discrete human activities. As such, it is increasingly recognized that conservation alone is likely insufficient to maintain the extent and function of NC's invaluable coastal wetland resources and that wetland restoration will be an integral component of a multipronged strategy to compensate for losses.

Nature-based solutions include a suite of strategies that use natural systems, mimic natural processes, or work in tandem with traditional approaches to address specific hazards. Communities across the country can incorporate nature-based solutions in local planning, zoning, regulations, and built projects to help reduce their exposure to flood and erosion impacts. Nature-based solutions, is based on the understanding that a habitat provides multiple ecosystem services.<sup>145</sup> Nature-based solutions can range from land preservation for creation of parks or open space, to constructing engineered structures like stormwater BMPs and living shorelines that include plants alongside nature-inspired features, such as oyster reef breakwaters. Protecting and restoring existing natural habitats is also a component of nature-based solutions. Conserving wetlands in the floodplain has been one tool used by towns to prevent development in vulnerable locations, which maintains flood and erosion protection provided by the wetlands, reduces infrastructure damage, provides community recreation (greenway trails), while protecting fish habitat and water quality.

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### Wetland Restoration

Wetland restoration methods can be classified as passive restoration, active restoration, or creation. Passive restoration methods are those that mitigate factors that induce degradation or destruction of wetlands, allowing the wetland to “self-restore” once stressors are ameliorated.<sup>146</sup> Active restoration typically involved interventions to restore, improve, or recreate the processes and function of wetlands through techniques such as topographic or hydrologic modification, adding sediment, and/or vegetation planting.<sup>147</sup> Creation involves the wholesale conversion of non-wetland land types (e.g., upland, agricultural land, subtidal flats), requiring hydrological modification, replication of soil physiochemical properties, and wetland plant introduction (Broome et al. 2019). Each of these forms of wetland restoration have been strategically used in projects throughout NC. These include various forms of living shorelines, hydrologic restoration, beneficial use of dredge material, and nature-based stormwater BMPs.<sup>75</sup>

Maintaining vegetated buffers is a passive nature-based solution to protecting wetlands and water quality. Due to the expected loss of wetlands associated with climate change, evaluation of the existing development buffer rules by a technical committee would be helpful to assess the future efficacy of those buffers when evaluating SLR, and whether changes to those rules are needed.

Work on nekton recovery following the restoration of salt marshes and other wetlands has demonstrated that fish use recovered following wetland restoration efforts.<sup>148, 149, 150, 151</sup> Further, there is mounting evidence that living shorelines combining salt marsh with some form of nature-inspired structural feature (e.g., oyster breakwater, stone sill) can not only slow or reverse the retreat of salt marsh shorelines but can also increase their value as a nursery habitat for both finfish and crustaceans.<sup>108, 110</sup>

While wetlands are highly effective at trapping sediment and nutrients it is important to note that they cannot assimilate an indefinite amount of nutrients. Excess nutrient enrichment experiments have shown that eutrophication can increase above ground biomass while reducing bank-stabilizing below ground biomass.<sup>152</sup> Therefore, wetlands can provide water quality enhancement benefits only if nutrient mitigation efforts are also in place.

### Living Shorelines

Living shorelines, as defined by the DCM and the Living Shoreline Steering Committee (LSSC), are a suite of options for shoreline erosion control that maintain existing connections between upland, intertidal, and aquatic areas which are necessary for maintaining water quality, ecosystem services, and habitat values. Unlike vertical stabilization measures such as bulkheads, living shoreline techniques are a nature-based solution to shoreline erosion, typically using native materials such as marsh plants, oyster shells, and occasionally structural materials (e.g., stone) to stabilize estuarine shorelines, minimize erosion, and enhance habitats for native species.

As previously noted in **Chapter 2. Implementation Progress on Priority Habitat Issues (2016-2021)**, since 2005, substantial progress has been made in documenting the benefits and limitations of living shorelines. This research verifies that living shorelines support a higher diversity and abundance of fish and shellfish than bulkheaded shorelines, effectively deter erosion, survive storm events well, and provide additional ecosystem services. Consequently, this alternative to bulkheading has been supported by the CRC and included as a recommendation of CHPP.<sup>109, 153</sup> Encouraging living shorelines as the preferred shoreline stabilization method is a key nature-based solution that can protect and restore wetlands, as well as oysters in some areas. Outreach efforts have been done to increase awareness of

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this technique to the public and contractors. NGOs and DCM have constructed several demonstration projects. The CHPP Steering Committee requested that efforts continue to focus on encouraging living shorelines to protect property, restore shoreline habitat, and improve water quality.<sup>75</sup>

The LSSC was formed during the summer of 2018 to bring together federal and state agencies, NGOs and universities to communicate and collaborate on education and outreach, research, and implementation of living shorelines to support sustainable management of estuarine shorelines. This Committee also acts as the Albemarle-Pamlico National Estuary Partnership (APNEP) Living Shoreline Implementation Team and is co-led by APNEP and NCCF. The Living Shoreline Steering Committee meets multiple times a year to discuss ongoing research, outreach, and implementation of living shorelines in NC. In the past five years, research and monitoring efforts have continued. Outreach and education efforts have increased the awareness and shown the benefits of living shoreline techniques to professionals (e.g., real estate agents, contractors, engineers) and the public. Efforts to install living shorelines has resulted in the construction of nearly 2,400 feet of living shorelines along NC's coast in 2019.

A major regulatory accomplishment for increasing use of living shorelines in NC was the establishment of a new Regional General Permit (RGP) for living shorelines by the Wilmington District of the USACE in March 2019. The USACE RGP is consistent with the state general permit for living shorelines. The CRC adopted 15A NCAC 7H .2700 General Permit for Construction of Marsh Sills for Wetland Enhancement in Estuarine and Public Trust Waters in July 2019. These new federal and state permits do not require any coordination with state and federal agencies if the permit conditions are met; therefore, creating a streamlined general permit process that is consistent with other CAMA general permits. An increase in applications has already been observed by DCM staff.

The Nature Conservancy and NOAA scientists have developed a Living Shoreline Explorer application tool for Carteret and Onslow Counties to assist users with determining where it is suitable to use a living shoreline.<sup>140</sup> The Nature Conservancy's [Restoration Explorer application](#) on the Coastal Resilience Tool helps users identify where they can use oyster reefs to stabilize their shoreline.<sup>154</sup> Using this online tool helps identify sites for subtidal shoreline oyster reef restoration within the Pamlico Sound, which could also aid in living shoreline siting.

Other actions implemented through the 2016 CHPP include outreach and education by the National Estuarine Research Reserve's (NERRs) staff who hosted numerous living shoreline workshops to educate real estate agents, homeowners associations, marine contractors, engineers, land use planners, landscape architects, and coastal decision-makers in the promotion of living shorelines for erosion control.<sup>75</sup> Construction events hosted by NCCF and University of North Carolina – Wilmington (UNC-W) were held up and down the coast hosting hundreds of volunteers who assisted in plantings and construction of living shorelines.

Research and monitoring of living shorelines are ongoing with results from studies on response of natural and sill-stabilized fringing marshes to SLR, impacts of hurricane on natural and stabilized living shorelines, as well as research on wave attenuation by natural marshes and living shorelines. Alternative living shoreline construction materials such as concrete-coated burlap, oyster shell and rock gabions are being tested. The NCCF is also working on the development of a degradable alternative to traditional plastic mesh bags for use for oyster shells. Additionally, research is ongoing on socioeconomic impacts of shoreline management strategies and how to effectively incentivize property owners to use living shorelines. It has been found that small economic incentives, such as cost-share programs, can

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substantially alter homeowner decisions to select living shoreline methods over other harder stabilization techniques.<sup>155</sup>

At the CHPP Wetland Workshop on living shorelines and restoration, attendees discussed thoughts on incentives versus disincentives and strategies to encourage use of living shorelines. They agreed that more attention needs to be given to the science regarding post-storm success of living shorelines in shoreline stabilization. The living shoreline portion of the workshop noted that despite NC having many successful living shorelines throughout the coast and growing research demonstrating their efficacy for shoreline stabilization and value for ecosystem services, they continue to be under-utilized compared to vertical hardened structures. Attendees concluded that the greatest needs for advancing the use of living shorelines was strong state agency support for their use; financial incentives; increased awareness and installation of living shorelines by the public and marine contractors; and business programs for marine contractors.

The 2021-2025 NC Oyster Blueprint, produced by NCCF with support from a collaboration of agencies, universities, and NGOs, is an oyster protection and restoration plan that provides stakeholders direction and guidance as a united force to implement restoration, management and economic development strategies that benefit both the environment and the economy.<sup>156</sup> The Oyster Blueprint identifies strategies and actions needed to rebuild NC's oyster resources. An additional approach in this plan is identifying living shorelines that include oysters as a distinct strategy to restore and protect oyster habitat. The overarching goal for the living shoreline strategy is to expand the use of living shorelines to become the most used stabilization method in estuaries that support oyster habitats.

When living shorelines are constructed with oyster reef materials, such as recycled shells, oyster castles, or reef balls, they provide intertidal habitat for shellfish resources. Building living shorelines along eroding waterfront properties where oysters grow, is one way to expand oyster habitat, reduce shoreline erosion, and protect and improve water quality. With the inclusion of living shorelines to the Oyster Blueprint, strategies to expand their use in estuaries will provide additional substrate to support oyster habitat, while also protecting and restoring wetlands.

### Protection of Oyster-Based Living Shorelines from Harvest

With the 2021 Oyster Blueprint including construction of oyster-based living shorelines as a strategy for enhancing oyster habitat, there are concerns of allowing the harvest of oysters from living shorelines. Presently oyster harvesting from living shorelines is not prevalent, but as the use of living shorelines increases, the issue may become more widespread. Oyster harvesting is managed by DMF through a Fisheries Management Plan and is subject to management through gear types, area, harvest limits, and seasons. In addition, the Shellfish Sanitation Section of DMF is responsible for monitoring and classifying coastal waters for their suitability for shellfish harvesting for human consumption based on bacteriological sampling. The DCM permits living shorelines. To address this issue, DMF has developed a living shoreline oyster protection committee. The group will evaluate management area protection, conservation leasing/easement, or another management mechanism to protect oysters on constructed living shorelines. These options will most likely require statutory changes in current statutes to address contractual agreements, marking and enforcement.

### Hydrologic Restoration

Humans have directly and indirectly changed the hydrology of wetlands in the CHPP region through ditching and draining, installation of levees and dikes, and reducing natural infiltration of runoff due to impervious surfaces in developed watershed. The history of hydrologic alteration in Hyde County in the

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Lake Mattamuskeet watershed was summarized in the Lake Mattamuskeet Watershed Restoration Plan.<sup>157</sup> This lake, the largest natural lake in NC, was extensively modified by a series of canals and pump stations for drainage. The canals allow fish movement into the lake, and blue crab and several anadromous fish species occur in it. The lake receives runoff from ditching and landscape changes in the surrounding area and is highly eutrophic. This has caused harmful algal blooms and extensive loss of SAV since the 1980s.<sup>158</sup> The lake waters were classified by DWR as impaired in 2016. Additionally, shellfish harvest closures have occurred in Pamlico Sound tributaries receiving canal waters that drain the lake. While these hydrologic modifications were carried out largely to protect agricultural lands from flooding and flood-related damage, many communities surrounding these modifications now face increasing flooding impacts due to altered hydrology exasperated by climate change. There is growing science that a better approach for flood prevention is by use of nature-based methods that replicate natural hydrology.

Efforts to reverse these hydrological modifications and return wetlands to their pre-impact hydrology fall under the umbrella of hydrological wetland restoration. The Mattamuskeet Drainage Association, NRCS, and NCCF developed a watershed restoration plan in 2013 for a 42,500-acre area located northeast of Lake Mattamuskeet and operated by the Association.<sup>159</sup> With input from agencies and stakeholders, the watershed plan with management actions was developed. The plan called for reducing and treating stormwater that was traditionally pumped through canals into Otter Creek and Berry Bay, Pamlico Sound, and the Alligator River. The altered drainage was contributing to impairment of shellfish harvest waters. Several of the strategies involve pumping water from the canals to low-lying areas of farmland and managing water levels to establish bottomland hardwood trees and other wetlands. It was thought that runoff historically flowed in this northwest direction. Approximately 2,000 acres were restored and more is underway.

Another watershed restoration plan, the Lake Mattamuskeet Watershed Restoration Plan (LMWRP) was developed in 2018 to address the deteriorating conditions in the lake and its surrounding watershed.<sup>160</sup> Concerns included 1) extensive SAV loss and water quality degradation in the lake, 2) flooding in the surrounding watershed, and 3) declining performance of the existing drainage system that relies on canals and tide gates. The plan called for improving drainage management through several actions, including conducting engineering studies to evaluate the feasibility of redirecting water in the current drainage canals to re-establish and replicate the natural movement of water from the lake to the Alligator River drainage area. The preferred design alternative is to identify, design, and prioritize projects where water diverted from the lake could move via sheet flow over created or restored wetlands, allowing nutrients and sediment to be absorbed before discharging into surface waters.<sup>157</sup>

One successful example of large-scale hydrologic restoration is North River Preserve. The 6,000-acre wetland restoration project undertaken by NCCF was completed on former farmland, primarily by restoring the hydrology.<sup>161</sup> Before restoration, runoff from the farmlands at North River Farms, which had been smoothed, crowned and ditched, often left the fields and discharged into the surrounding estuaries on the order of hours to days. Various wetland restoration techniques used across the farm increased the surface storage and controlled the outflow. This increased the time it took for the runoff to leave the site - often on the order of weeks to months, depending on wetland restoration design and proximity to the estuary. In addition, because of additional evapotranspiration and infiltration that occurred in the wetland environment, the volume of runoff was also often reduced.<sup>90</sup> Another example of nature-based solutions in NC involved TNC and US Fish and Wildlife Service (USFWS) collaboration to restore hydrology of pocosin through installation of water control infrastructures, such as culverts,

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weirs, flashboard risers, berms, and beaver dam analogs. This work was focused on Alligator River, Pocosin Lakes, and Great Dismal Swamp NWRs.<sup>162</sup> Atlantic white cedar and bald cypress were planted at Pocosin Lakes. Oyster reefs have been constructed adjacent to Alligator River and Cedar Island NWRs to reduce wetland shoreline erosion.

It is imperative that nature-based solutions be developed and/or incorporated into drainage or watershed restoration management plans to minimize the unintended negative impacts resulting from the interaction of hydrologic alteration and future SLR. Many goals and objectives included in watershed restoration plans can be achieved by restoration or enhancement of wetlands. For example, rather than using sheet piling to prevent flooding of farmland, wetlands could be restored to provide natural flood management and reduce nutrient loading. Continued use of manmade structures such as tide gates can be beneficial hydrologically when properly planned and maintained but can impede fish migration. A more active approach to drainage management could work in conjunction with wetland water storage capacity to minimize flooding impacts. Combining adaptive hydrologic management strategies with wetland easements can provide a multi-pronged approach to restoration. By utilizing wetland easements or grant programs, communities can minimize the economic cost of wetland restoration and instead use those funds to implement hydrologic restoration projects.

### Beneficial Use of Dredge Material for Marsh Creation or Restoration

Beneficial use of sediments is a term used by USACE for environmentally and economically positive uses of dredged material, including fish and wildlife habitat enhancement. Dredged materials have been used for decades in wetland creation and restoration efforts.<sup>163</sup> Historically, this has consisted of dredge materials being deposited within unvegetated areas adjacent to the shoreline until a target elevation has been reached.

There is increasing data that suggests given the rate of SLR, sediment supply dynamics in many areas are insufficient to sustain upward and landward marsh migration.<sup>118, 164, 165</sup> Using dredge material as a supplement sediment supply for existing marshes is a potential strategy to enhance the ability of a marsh to keep pace with SLR. Building marsh elevations with sediment delivered from nearby dredging projects, referred to as thin-layer sediment placement, deposition, or dispersal, is potentially valuable for creating, restoring, and maintaining coastal marshes, and may slow or reverse losses of wetlands due to coastal development, geological or drought related subsidence, and SLR.<sup>166, 167</sup> Sediment is applied to the marsh surface by spraying a slurry of water, sand, and silt. The resulting increase in elevation reduces the marsh inundation period and improves soil drainage, resulting in greater marsh productivity.<sup>168</sup> The optimum elevation varies based on local tide conditions. Sediment additions that are too thin may not be sufficient to reduce flood stress to plants and limit the marsh's ability to keep up with SLR. Conversely, sediment additions that are too thick may reduce plant and invertebrate recolonization success and make the marsh vulnerable to invasive species such as *Phragmites australis*.<sup>169</sup> While higher marsh elevation increases marsh resilience, fish access to the marsh increases when marshes are lower in elevation and inundated more. Therefore, the resulting elevation is critical to the success of this type of restoration for overall continuation of marsh ecosystem services.<sup>168, 170, 171</sup> When done correctly, dredged sediment additions to marshes can be beneficial, converting dredged materials from a waste product to a resource that benefits sediment limited marshes.<sup>169</sup> A primary goal of using dredge material to restore wetlands should be to build the marsh surface to an elevation that allows vigorous growth of desired plant species, so that natural processes can then maintain the marsh for future years and allow fish use to continue.

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There are limited published studies on the efficacy of thin-layer placement specific to NC. Peer reviewed research from Masonboro Island,<sup>170</sup> grey literature from studies in Wysocking Bay,<sup>172</sup> and unpublished data from the New River estuary,<sup>173</sup> all point to the potential value of thin-layer placement as an approach to mitigate the effects of SLR on NC's coastal wetlands. However, given the diversity of factors that can influence the outcome of thin layer placement, further research is needed, a point emphasized by participants at the CHPP Virtual Wetland Workshops.

### Stormwater Best Management Practices

Urbanization of coastal watersheds has led to appreciable conversion of natural land covers to impervious surfaces. Impervious surfaces in coastal watersheds prevent infiltration on land and increase the volume of polluted stormwater that is received by wetlands. The resulting changes to the timing, quantity, and quality of the stormwaters received by wetlands dramatically alter the species composition and ecological function of wetlands.<sup>174</sup>

While using natural wetland features to capture runoff can improve water quality and reduce flooding, negative impacts can occur to the wetlands. In a DWR study, in certain circumstances, stormwater discharge to natural wetlands caused channelization, sedimentation, tree mortality and change in wetland vegetation.<sup>175</sup> When directing stormwater to natural wetlands, impacts can be minimized by proper site selection (sufficiently large and disturbed rather than pristine wetlands), dense vegetation, and diffuse entrance flow.

Increasing use of stormwater best management practices (BMPs) that retain and filter more runoff on-site is needed to address the threats that urbanization induced hydrodynamic changes pose to susceptible wetlands. A promising approach to reduce stormwater volume received by wetlands is the use of low-impact development (LID), which is the practice of using techniques that recreate the natural processes and landscapes, resulting in infiltration (e.g., permeable pavements) and evapotranspiration (e.g., bioretention ponds, rain gardens) of stormwater or the use of stormwater as a resource (e.g., vegetated rooftops). Such practices can dramatically reduce stormwater runoff, which is the leading source of surface water degradation across the US.<sup>176</sup>

Studies have found LID successful at reducing the concentration of nutrients, pathogens, and other pollutants in stormwater. A NC State University (NCSU) study on bioretention cells found that these cells were capable of reducing phosphorous loading by 22-65 percent, nitrogen loading by 40-70 percent, copper and zinc loading by 56-99 percent, and fecal coliform by over 90 percent at sites throughout NC.<sup>177</sup> A NC study comparing LID to conventional development practices at commercial development sites found runoff and nutrients to be 95 percent lower at the LID sites.<sup>178</sup> Additional studies have shown that runoff from developments with low impact design can be comparable to export from forested watersheds.<sup>179</sup> Small modifications, such as replacing impervious surfaces with permeable pavers or disconnecting and redirecting gutter ends to vegetated areas has been shown to dramatically reduce, and in some cases completely eliminate, runoff otherwise destined for receiving wetlands and coastal waters.<sup>180, 181, 182, 183</sup> While there is a common misconception that LID is often more costly and requires greater maintenance than projects that use conventional design, research has shown that LID often requires considerably less maintenance and is frequently (11 of 12 LID projects evaluated in Pender County, NC) less expensive than conventional design alternatives.<sup>184, 185</sup>

The DEMLR updated the Stormwater Design Manual in 2020.<sup>186</sup> The revised manual includes an increasing number of nature-based BMPs and LID that focus on mimicking natural hydrology and on-site infiltration. The manual now includes Runoff Volume Match and LID as a component of stormwater

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design options, incentivizing methods that are nature-based and retain runoff onsite. Storm Control Measures (SCMs) that enhance or restore wetlands include infiltration systems, bioretention cells, wet ponds, and stormwater wetlands. Ratings of the SCMs for removal of bacteria and nutrients indicate that infiltration outperforms all other SCMs.

In 2021, NCCF and Pew Charitable Trusts developed an action plan for nature-based stormwater strategies (NBSS).<sup>187</sup> The effort involved work groups that discussed and made recommendations on nature-based stormwater strategies to reduce flooding and improve water quality in four areas: 1) new development, 2) stormwater retrofit of existing land, 3) roadways, and 4) working lands. A committee was formed for each of these four areas. The report notes that new approaches are needed to address increasing rain associated with climate change. The foundation of the plan is that restoring and mimicking natural watershed hydrology is the most cost-effective approach, and therefore a critical first step is development of watershed restoration plans. These voluntary plans can be done by state agencies, local government, or NGOs. Funding is available through DWR's 319 grant program.<sup>144</sup> By effectively improving water quality, advancing this effort will also directly benefit oysters and SAV (for more information, see **Chapter 4. Submerged Aquatic Vegetation Protection and Restoration through Water Quality Improvements**). The key impediments to advancing nature-based stormwater strategies were lack of awareness, inflexible planning, regulations, and policy, design challenges, and funding.

A few examples of recommendations from each of the four committees are listed below:

- State and local government should lead by example using nature-based stormwater strategies when constructing or repairing facility property.
- Develop detailed information maps to assist with watershed management plans (i.e., Duke, TNC, NCCOS resiliency maps).
- Use nature-based stormwater strategies to bring failing stormwater systems into regulatory compliance (also supports the **Chapter 6. Environmental Rule Compliance to Protect Coastal Habitats** Issue Paper recommendations).
- Increase economic incentives from local, state, and federal sources to landowners to preserve wetlands within forest lands, and to preserve forested and agricultural floodplains.
- Begin a collaborative effort to pursue additional funding from the Farm Bill and other programs for conservation, wetland restoration, conservation easements, and large-scale hydrologic restoration projects.
- Work with the military to identify priority properties used for training and where hydrologic restoration is feasible.

Recognizing the damaging impacts of stormwater runoff and the value of LID, in 2007, the US Congress enacted Section 438 of the Energy Independence and Security Act (EISA). EISA Section 438 stipulates that the sponsor of any development or redevelopment project involving a federal facility with a footprint that exceeds 5,000 ft<sup>2</sup> shall use strategies to design, construct, and maintain, to the maximum extent feasible, the predevelopment hydrology of the property. The mandate requires that, to the extent technically feasible, annual runoff from sites post-development must be no greater than the percentage before development. Following the federal government's lead in adopting a policy requiring that state funded construction utilize low impact design practices would be a major step towards protecting NC's Coastal Plain wetlands. This would benefit wetlands, SAV, and the overall health of the estuary.

The NC Soil and Water Conservation Commission and Division of Soil and Water Conservation, through funding from NRCS, provide cost share funds for qualified BMPs under the Agricultural Cost Share

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Program (ACSP) and Community Conservation Assistance Program (non-agricultural) (CCAP). The purpose of CCAP is to reduce nonpoint source pollution from existing development through installation of BMPs. Some of the BMPs allowed under the CCAP include constructing living shorelines, rain gardens, stormwater wetlands, and bioretention areas. However, funding for the program, which became effective in 2020, has been very low, receiving approximately \$136,000 annually in state appropriations for the entire state.

### Land Acquisition and Conservation

One solution that has been utilized to offset the natural and anthropogenic impacts to wetlands is the acquisition of land for wetland conservation and restoration. The ability to preserve a privately owned area in its natural or restored state are goals that are most effectively achieved through land acquisition by governments (local, state, or federal), NGOs, or government-NGO partners via a purchase or easement agreement with the private landowner. As a coastal resource management approach, land acquisition has an important role in offsetting damages via active restoration, passive restoration, wetland creation, and allowing for the natural migration of coastal wetlands with SLR. Land conservation can reduce sediment and nutrient pollution that reaches waterbodies, as wetlands produce less pollutants than crops, and are naturally able to remove pollutants from soil.

In NC, the leading NGO's involved in land acquisition for wetland conservation and restoration are NCCF, TNC, Coastal Land Trust, and Conservation Trust for NC. At the local and state levels of government, municipalities' stormwater management and water conservation divisions, and The NC Department of Cultural and Natural Resources, Wildlife Resources Commission, and the NC Coastal Reserve are typically partners in land acquisition for wetland management purposes.

There are three state conservation trust funds in NC. The NC Land and Water Fund (NCLWF), formerly known as the Clean Water Management Trust Fund, was created in 1996 to finance projects that improve water quality, including land acquisition. The NCLWF is a primary source of grants allowing local governments, state agencies, and conservation nonprofits to address water pollution, protect clean water, and conserve lands that are ecologically, culturally, or historically significant. Through this program, landowners sell their land to the state or establish a perpetual easement; after completion of the project, the property is owned and protected by state or local government as public land or remains private land that is managed for conservation. Projects funded through this program involve development/restoration of riparian buffers, providing greenways, stream restoration and enhancement, and innovative improvements to stormwater management. Appropriations have declined since 2009, going from \$100 million/year from 2005 to 2008, to \$13 million in 2019.<sup>188, 189</sup> The Parks and Recreation Trust Fund is used for land acquisition, improvements within the state's park system, and beach and estuarine access. The Agricultural Development and Farmland Preservation Trust Fund funds programs that support working family farms through conservation easements on threatened farmland and agricultural development projects. Funding for all three programs has declined significantly since 2009.

The US Department of Agriculture (USDA) offers a variety of financial assistance programs for landowners in NC, with funding through the Farm Bill.<sup>190</sup> NRCS purchases eligible land through the USDA's Wetlands Reserve Easement (WRE). Currently, NRCS has over 54,000 acres enrolled in the Wetland Reserve Program nationally, with approximately 99 percent being in the Atlantic Coastal Plain.<sup>191</sup> Once the land has been acquired, the NRCS develops and implements a wetlands reserve restoration easement plan to restore and expand wetlands. The NRCS offers various options for

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enrollment in this program, including permanent easements, 30-year easements, term easements, and 30-year contracts. Under these options, NRCS will pay more than half of the easement value, and cover most of the restoration costs. This program provides private landowners an opportunity to maximize restoration/protection potential while minimizing their costs. This is critical in many agricultural areas of coastal NC where socioeconomics often impact the ability of landowners to conduct these activities. Between 2014 and 2019, the NRCS's Agricultural Conservation Easement Program (ACEP), a program that helps to conserve agricultural lands and wetlands and their related benefits, awarded over \$28 million dollars in funding to NC projects, ranking eighth in the US. The Forest Legacy Program, operated by the USDA-Forest Service, strives to conserve working forests through acquisition or easements, and includes priority areas that are within the CHPP regions.<sup>192</sup>

Additionally, NRCS offers a Wetland Reserve Enhancement Partnership (WREP), which allows NRCS to enter into agreements with eligible partners (i.e., state/local government, tribes, and NGOs) to carry out restoration/enhancement projects that are a high priority for wetland protection, restoration, and enhancement. This program allows sharing of costs and staffing, which is beneficial to all parties by alleviating some of the budgetary and staffing constraints that often coincide with implementing restoration projects.

State agencies or eligible entities in coastal states may also apply for a USFWS programs including National Coastal Wetlands Conservation grants and North American Wetlands Conservation Act (NAWCA) grants. Awarded grants provide funding that can be used for acquiring property from private landowners and using it for long-term wetlands restoration and enhancement. Funds provided through these grants may also be used to manage wetlands (as opposed to just the acquisition of the land) to meet an agency's goals. Like the WREP, these funds can alleviate many cost restrictions faced by those looking to conduct wetland restoration/enhancement projects. Since 1991, \$21.3 million in NAWCA grant funding and \$69.3 in partner contributions have protected or restored a total of 116,367 acres of wetlands in NC.

The USDA also offers enrollment in the Conservation Reserve Enhancement Program (CREP), which provides funds to restore wetlands, improve water quality, reduce soil erosion, and reduce the amount of sediment, nutrients, and pollutants entering surface waters. This program allows landowners to convert agricultural lands in sensitive areas from land that is farmed or ranched to land that provides conservation benefits. Property owners can enroll in 10 or 15-year programs that involve removal of agricultural production and replace it with native vegetation to restore wetland habitat. Typical eligible practices are tree planting, establishing filter strips or riparian buffers, and wetland restoration. Eligible landowners may receive up to 50 percent of the cost to install the conservation practice, an annual rental payment, and a cost-share payment, as well as additional incentives for longer easement enrollments.

Conservation and restoration of wetlands through land acquisition represents an increasingly valuable approach to safeguarding the continued existence and functioning of NC's coastal wetland resource. By reducing nutrients and sediment reaching nearby waterways, wetlands help to improve water quality conditions, also benefiting SAV and oysters. Federal grants have proven to be a reliable source of funding for land acquisition but, importantly, a number of available federal grant programs have a state match requirement. As such, availability of state funds directly influences NC's ability to effectively leverage these opportunities to safeguard existing or restored wetlands. Given the challenges facing NC's coastal wetlands, increasing recognition of the need for marsh migration space to accommodate SLR, and a surplus of evidence that coastal restoration and conservation supports the state's continued

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economic development, increasing state funding for coastal land acquisition is likely a cost-efficient and effective approach within a multi-faceted strategy to conserve wetlands and their services.

The Natural Working Lands Action Plan includes strategies to build ecosystem and community resilience, provide ecosystem benefits, sequester carbon, and enhance the economy.<sup>193</sup> The plan recommends developing incentives with state and local governments and other public and private stakeholders to protect coastal habitats and migration corridors to allow for future landward migration. These actions would help facilitate conservation and restoration of wetlands.

### Funding Restoration

Wetland restoration and nature-based solutions have been embraced as a tool to address coastal wetland losses in NC. However, a recent synthesis of federally-funded, voluntary wetland restoration in coastal counties of the conterminous United States found that coastal wetland restoration is failing to keep pace with losses and will likely need to increase dramatically in coming decades to compensate for losses.<sup>85</sup> Over the most recently reported decade of federally funded coastal wetland restoration (2006-2015), NC ranked third out of 22 coastal states in cumulative acreage of coastal palustrine wetlands restored, with 15 projects restoring a total of 12,988 acres. While considerable, the approximately 13,000 acres of palustrine wetland restoration that occurred within NC's coastal counties during this decade fell well short of compensating for losses incurred over the previous decade. North Carolina was less competitive in terms of the acreage of estuarine wetland restored through federally funded projects between 2006 and 2015, ranking seventh out of 22 coastal states, with the restoration of 5,067 acres of estuarine wetlands. However, as the proportion of estuarine wetland losses increases due to SLR and storms, the need for voluntary wetland restoration is likely to grow.

While wetland restoration can be resource intensive, studies quantifying the value of ecosystem services of restored wetlands suggest that benefits frequently exceed costs.<sup>194, 195, 196, 197</sup> For example, an estimated return of \$46.5 billion dollars in economic benefits is anticipated from a \$12.1 billion investment in restoration of the Florida Everglades, a return of \$4.04 dollars for every dollar invested in restoration.<sup>198</sup> Economic benefit analysis of coastal ecosystem restoration projects in San Francisco Bay and Virginia's Seaside Bays have reported benefit-cost ratios as high as 18:5 and 26:5.<sup>199</sup> In NC, analyses found that a \$2.4 million investment to conduct the North River Farms restoration project, the largest coastal restoration project in NC history, increased business revenue in coastal NC by \$5.2 million and household income by \$1.8 million while creating 66 full-time jobs.<sup>200</sup> The growing body of research indicates that coastal wetland restoration can serve as an important component of coastal community economic development in NC.

The federal government provides the majority of wetland restoration funding in the United States through federal funding programs administered by multiple agencies, including the USDA, the USFWS, NOAA, and the USACE. In addition to their federal regulatory roles, multiple federal agencies administer funding programs. Not all, but many of these funding opportunities require state matches for wetland restoration grants. Low availability of state funds as match has therefore limited the ability to fully utilize available federal funds.

The DMS is a statewide In-Lieu Fee program that provides a variety of mitigation types to offset unavoidable impacts for the NC DOT as well as other developers. DMS provides wetland mitigation for impacts to riparian, non-riparian, and coastal wetlands. DMS has three types of wetland credit it can produce: wetland restoration, wetland enhancement or wetland re-establishment. In general, compensatory wetland mitigation does not increase the amount of natural resources (i.e. wetlands) but

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rather offsets impacts to support no net loss of these resources. The DMS applies payments from its various programs to implement mitigation where the need and opportunity is greatest by utilizing watershed planning and working with state and local partners. Successful project procurement and implementation requires DMS to work with mitigation providers, regulatory agencies, and landowners to locate, design and construct wetland mitigation projects. In 2020, NC legislature passed HB 1087, which establishes a program within DMS to develop flood storage capacity projects in targeted watersheds, through creation or restoration of wetlands, streams and riparian areas, temporary flooding of fields or forests, and other nature-based projects. While this will assist somewhat, providing matching state funds is still problematic.

### 5.4 Recommended Actions

The 2021-2025 NC Oyster Blueprint, NC Natural Working Lands Action Plan, and the Action Plan for Nature-based Stormwater Strategies include numerous actions that would protect or restore wetlands, consistent with the CHPP. A subset of these recommendations specifically supported by the CHPP Steering Committee (CSC) are provided in **Chapter 9. Summary of Recommended Actions**, Table 9.1. Refer to the individual plans for a complete list of actions.

#### 5.4.1 Mapping and Monitoring

- 5.1 By 2023, DEQ will obtain state matching funds for the NOAA C-CAP program to map NC's Coastal Plain at 1m resolution and additional funding to expand wetland monitoring conducted by DWR and other state agencies.
- 5.2 By 2024, DEQ will pursue the use of emerging technologies such as data fusion or deep learning neural networks, that rely on a combination of satellite imagery, drone imagery, and field verification for Coastal Plain wetland mapping and change analyses.
- 5.3 By 2022, DEQ will form an interagency workgroup to develop a Coastal Plain wetland mapping and monitoring plan, including a minimum set of standardized metrics and a potential centralized location to store relevant reports and information.
- 5.4 By 2026, DEQ will determine the status and trends of Coastal Plain wetland acreage, condition, and function, based on the additional mapping and monitoring data obtained.

#### 5.4.2 Conservation

- 5.5 By 2022, DEQ will provide information to NC legislators regarding the need for increased appropriated funds for the three state conservation trust funds to increase conservation of critical wetland properties and critical corridors that will allow for future marsh migration.
- 5.6 By 2022, DEQ will actively participate in and support the development of a Southeast Regional Marsh Conservation Plan, which is a partnership with the Department of Defense along with federal, state, and private groups that have been initiated by the Southeast Partnership for Planning and Sustainability (SERPPAS).
- 5.7 By 2026, DEQ will work with researchers, federal and local governments and NGOs to facilitate marsh migration through the conservation of migration corridors, including participation in the Pew Charitable Trusts-SERPPAS Salt Marsh Initiative.

#### 5.4.3 Restoration and Living Shoreline

- 5.8 By 2022, the DMF will determine potential mechanisms to prevent harvesting from living

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shorelines constructed with oysters.

- 5.9 By 2025, DEQ will determine if living shoreline projects can be built in a manner that qualifies for salt marsh or nutrient mitigation credits.
- 5.10 By 2025, DEMLR and other divisions should increase education, outreach, and training to consultants, local government, and landowners for nature-based stormwater and watershed management strategies.

### 5.4.4 Research

- 5.11 By 2024, DEQ should partner with other organizations to facilitate coastwide completion or enhancement of coastal vulnerability assessment tools, such as living shoreline siting, and marsh migration and wetland restoration prioritization.
- 5.12 Determine optimal parameters for thin layer sediment deposition to ensure wetland success.
- 5.13 Assess trends in salt marsh elevation, inundation, and distribution to prioritize areas for wetland restoration.
- 5.14 Determine the impact of degrading plastics and marine debris on wetlands, sediment, and the benthos.
- 5.15 Research the nutrient (nitrogen, phosphorus) reduction benefits provided by living shorelines and use that information to provide incentives for living shoreline projects.
- 5.16 Study the effects of silvicultural timber harvesting in bottomland swamp forests on hydrology, water quality, and wetland condition; include assessment on the efficacy of forestry BMPs to minimize ecological impacts.
- 5.17 By 2022, DEQ should support efforts to incorporate Coastal Plain wetlands and other coastal habitats into NC's Greenhouse Gas (GHG) Inventory.

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- <sup>190</sup> <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmland/>
- <sup>191</sup> Bill Edwards, NRCS (US Department of Agriculture Natural Resources Conservation Service), personal communication
- <sup>192</sup> [https://www.ncforestservice.gov/fsandfl/PDF/Forest\\_Legacy\\_Areas.pdf](https://www.ncforestservice.gov/fsandfl/PDF/Forest_Legacy_Areas.pdf)
- <sup>193</sup> NCDEQ (North Carolina Department of Environmental Quality). 2020. North Carolina Climate Risk Assessment and Resiliency Plan, Appendix B: North Carolina Natural and Working Lands (NWL) Action Plan. Raleigh, NC.

## Chapter 5. Wetland Shoreline Protection and Enhancement with Focus on Nature-based Solutions

<https://files.nc.gov/ncdeg/climate-change/resilience-plan/Appendix-B-NWL-Action-Plan-FINAL.pdf>

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<sup>196</sup> Barbier, EB. 2019. The value of coastal wetland ecosystem services. Pages 947–964 *in Coastal Wetlands*. Elsevier.

<sup>197</sup> Scholte, S.S., M. Todorova, A.J. Van Teeffelen, and P.H. Verburg. 2016. Public support for wetland restoration: what is the link with ecosystem service values? *Wetlands* 36(3):467-481.

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<sup>199</sup> Conathan, M., J. Buchanan, and S. Polefka. 2014. The economic case for restoring coastal ecosystems. Center for American Progress & Oxfam America, Washington, DC.

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Photo Credit: Joe Facendola

### 6. ENVIRONMENTAL RULE COMPLIANCE AND ENFORCEMENT TO PROTECT COASTAL HABITATS

#### 6.1 Issue

The River and Harbors Act (RHA) of 1899 represented the beginning of federal laws that provided authority to regulate discharges to navigable waters. The passing of the Water Quality Improvement Act (WQI) in 1970 established a state certification procedure to prevent degradation of waters that was subsequently followed by an amendment to the Federal Water Pollution Control Act commonly referred to as the Clean Water Act (CWA) of 1972. Additionally, the Coastal Zone Management Act (CZMA) of 1972 was passed as a national policy to preserve, protect, develop, and where possible, restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations.

Since that time, an emphasis has been placed on permitting impacts to wetlands and the surface waters of the United States. To meet mandated 401 wetland and other permit processing deadlines, issuing permits often takes precedence over compliance and enforcement programs due to staff and funding shortfalls. There is limited literature on the effectiveness of compliance and enforcement program efforts associated with wetland protections that exist at the state level.<sup>1</sup> With the unknowns of compliance and enforcement programs, the estimates of further loss and impairment of the existing wetlands and surface waters can only be inferred. However, we do know that the extent of impaired waters in NC's coastal waters is significant. There is a need to quantify this loss and impairment to stop future loss through the measured success of current and future management actions.

A more balanced approach between compliance and enforcement program efforts and the process of written authorizations for impacts to wetland and surface waters, will ensure transparency and fairness within the application of regulatory framework. The predictability of compliance efforts and possible enforcement action would serve to reinforce the reason for property owners and/or permittees to adhere to written authorization conditions and other applicable laws and regulations. It also serves as a deterrent for potential violators to adhere to the applicable regulations and laws for the risk of receiving monetary loss in civil penalties and/or criminal penalties. There is strong support from the public to enforce existing rules to improve effectiveness in wetland and water quality protection.<sup>2, 3</sup>

#### 6.2 Background

##### 6.2.1 *Scale of the North Carolina's Wetland and Surface Waters and their Services*

North Carolina has the tenth largest acreage of wetlands and surface waters in the Nation. The 2010 National Resources Inventory Summary Report utilizing the non-regulatory Cowardin classification system estimates that approximately 7.4 million acres of NC lands (non-federally owned) are wetlands.<sup>4</sup>

<sup>5</sup> According to the 2011 National Land Cover Database (NLCD), there were approximately 3.7 million acres of woody and emergent herbaceous wetlands present in the CHPP Regions, representing 21 percent of total land area.<sup>6, 2</sup> More information on wetland trends and stressors is provided in the priority habitat issue papers, **Chapter 5. Wetland Protection and Restoration through Nature-Based Solutions** and **Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends**.

Wetlands provide a variety of functions that include surface and subsurface water storage, nutrient cycling, particulate removal, maintenance of plant and animal communities, water filtration or purification, and groundwater recharge.<sup>7</sup> Because of the many water quality benefits provided by wetlands, their protection and enhancement benefits the water column and all other aquatic habitats. Loss of wetlands can lead to increased stormwater runoff and increased loading of pollutants, leading to

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increased shellfish closures, impaired conditions for survival of SAV and shell bottom, algal blooms, and fish kills.

There are eight coastal draining river basins, of which only four (Cape Fear, Neuse, Tar-Pamlico, and White Oak) are entirely contained within the State. The major rivers and sounds within the four CHPP Regions include the Roanoke River, Chowan River, Pasquotank River, Albemarle and Currituck Sounds, Pamlico Sound, Neuse River, Tar-Pamlico River, Core Sound, Bogue Sound, New River, White Oak River, and Cape Fear River. The Albemarle-Pamlico Sound estuary with an estimated area of 31,478 square miles is the second largest estuary by area in the eastern United States. Approximately 20 percent of the total CHPP area, which includes the Coastal Plain up to the fall line consists of surface waters (2,813,620 acres).<sup>2</sup> Streams and waters can be ephemeral, intermittent, and perennial in nature and serve to protect communities from flooding by storage of surface waters, retain harmful pollutants, keep sediment and nutrients from reaching downstream waters, provide habitat throughout all life stages for a diverse assemblage of flora and fauna, and provides economic benefits such as fishing, hunting, manufacturing, and agriculture.<sup>8</sup>

North Carolina's coast hosts a wide diversity of waters and wetlands, from the Black River, containing some of the world's oldest trees (2,624 years old) to the pocosin wetlands, the most critically endangered wetland in the US. North Carolina is home to some 61 federal threatened or endangered species and 604 State species that are listed as threatened, significant concern, or significantly rare.<sup>9, 10</sup> Most of these species spend a portion, if not all, of their life cycles within the wetlands and waters of the State.

### **6.2.2 Demography and Demands on the Wetland and Surface Waters of NC**

A 2020 estimate of NC's population has approximately 10.6 million people residing in the State. The estimated State's population has increased by 10.3 percent since 2010 with the majority of the increase resulting from in-migration from other states.<sup>11</sup> The NC Office of Budget and Management projects the State's population will increase by approximately 1.4 million people by 2030.<sup>12</sup> Although the majority of the projected growth is concentrated within Charlotte and Triangle Regions (74 percent of State growth), additional projected growth ranging from six to more than 18 percent is also to occur in the Coastal Plain counties of Currituck, Dare, Pitt, Carteret, Duplin, Cumberland, Onslow, Pender, New Hanover, and Brunswick.<sup>13</sup>

As NC's population continues to expand, the stress on the State's waters and ecosystems will also intensify. Development pressure will cause a rise in impervious surface coverage thus compounding the amount of stormwater runoff entering downstream receiving waters and amplifying the potential for both point and nonpoint pollution. The current estimate from the EPA is approximately 7 million of NC's residents depend on the State's surface water as their primary potable water source. Over 750,000 acres of the State's waters (encompassing the streams, sounds, and Atlantic Ocean) are considered impaired and listed on the Section 303(d) of the CWA.<sup>14</sup>

The Coastal Plain contains the majority of wetland resources in the State and serves as the discharge point for seven of the major rivers into the Atlantic Ocean. The wetlands within these river basins and others serve as protections to neighboring communities by storing and slowing rapid runoff of stormwater thus minimizing the danger of damaging floods. One estimate found one acre of wetlands can store approximately 330,000 gallons of water. When an acre of wetland is filled, the 330,000 gallons of water is not retained but rather is discharged directly into the waterway thus increasing the risk of flooding.<sup>15</sup> Additionally, hurricanes have had a significant influence on flooding and coastal damage over

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the past two decades or more, emphasizing the importance of protecting and restoring wetlands to enhance coastal resiliency. For additional information, see **Chapter 3. Climate Change and Coastal Habitat Resiliency**.

Wetlands also serves as a “sink” for suspended sediments by acting as a filter that serves as a retention area that slow down the flow of water allowing sediments to be assimilated by the wetlands prior to reaching waters of the US. In addition, excess nutrients such as nitrogen and phosphorus are only a few of the ecological services that wetlands provided to clean waters and ensure the best usage. When wetlands are under drained conditions, nitrogen and phosphorus otherwise bound in the soil matrix or held in the biomass of plants can be transported by ditches or other drainages features allowing possible pollutant source to migrate to receiving waterways.

From the headwaters of coastal rivers where recreational fisheries are popular, to the estuaries of the coast that bolster the State’s commercial fisheries, wetlands play a vital role in both protection of the existing water quality and supporting the livelihood of the State’s citizens. Over 90 percent of NC’s commercial fisheries landings and 60 percent of the recreational harvest (by weight) are comprised of estuarine-dependent species.<sup>2</sup> In NC during 2018 over \$77.8 million of revenue was generated from commercial fishery landings and approximately \$156.9 billion of economic impact was generated from recreational anglers, hunting and wildlife watching.<sup>16</sup>

### **6.2.3 Introduction to North Carolina Regulatory History for Wetlands and Waters**

Precise historic estimates of total area of wetlands in NC are lacking and only anecdotal estimates of wetlands exist. A common reference is approximately 11 million acres of wetlands existed prior to the European pre-colonization of NC and by mid-1980s only 5.7 million acres or about one-half of the historic acreage remained.<sup>17</sup> From the mid-1970’s to mid-1980’s, NC experienced a conversion of approximately 1.2 million acres of wetlands to silviculture, agriculture or other uses representing the highest acreage of wetland losses in the southeastern US.<sup>18</sup> In 2011, estimates of wetland acreage was approximately 3.7 million acres within the four CHPP regions and approximately 4.6 million acres within the entire NC Coastal Plain.<sup>19, 20</sup>

The foundation of NC’s authority to regulate discharge to wetland, streams, and waters of the State can be traced to the State’s passage of the Dredge and Fill Act of 1969 and the federal passage of the CWA and CZMA of 1972. Subsequently, state and federal laws and regulations have followed that have sought to clarify jurisdiction and define regulatory authority. In 1985, Congress passed key provisions within the Farm Bill commonly known as “Swampbuster” to financially discourage the conversion of jurisdictional wetlands or highly erodible lands to produce agricultural uses, although loss of jurisdictional wetlands acreage continued through the use of ditching and draining. Over the years, federal laws have had a major influence on wetland loss, particularly from regulatory changes associated with the 1993 Tulloch Rule, which resulted in approximately 11,580 acres of wetlands being drained in the Coastal Plain.<sup>2, 21, 22</sup> In 1999, after determining that wetland ditching and draining activities were under the state’s authority, the EMC adopted a wetland drainage policy. Inspections of previously ditched wetlands resulted in restoration of 50 percent of the wetlands area found to be in violation of the wetland standard.<sup>2</sup> In 2002, the NC Court of Appeals upheld that wetlands were considered part of the definition of “waters” of the State and therefore, subject to enforcement under the State wetlands standards.

The DWR has the regulatory authority to issue permits for impacts to isolated and other non-404 jurisdictional wetlands and waters. The agency also has regulatory authority over riparian buffer programs in two coastal watersheds – Neuse and Tar-Pamlico. The National Pollution Discharge

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Elimination System (NPDES) program, established under the Section 402 of the CWA of 1972 and succeeding federal and state rules and regulations, granted the regulatory authority to permit a discharge of wastewater or stormwater from a known point source to surface waters. The regulatory oversight under the NPDES program is shared between the DWR and the DEMLR. The DEMLR also has authority established under the Sedimentation Pollution Control Act (SPCA) of 1973, and other related laws, regulations, and amendments to regulate activities associated with erosion and sediment control, mining, dam safety activities, and stormwater management.

Currently, NC's programmatic approach to proposed development impacting jurisdictional wetlands, streams, and/or waters begins with the applicable permitting requirements of the USACE and/or the DCM. The USACE under authority of Section 404 of the CWA and Section 10 of RHA regulates the discharge of dredge and fill material into waters of the United States. The DCM regulates and issues permits for development in or affecting an Area of Environmental Concern (AEC) within NC's 20 coastal counties under the Coastal Area Management Act (CAMA) and State Dredge and Fill Law. Any permits issued by either the USACE, DCM, or other federal licensing and permitting agencies that propose impacts to jurisdictional wetlands, streams and/or waters will require a corresponding Section 401 of CWA Water Quality Certification (401-WQC) issued by DWR. This is to ensure the proposed activity does not violate wetland or water quality standards under authority of Section 401 of the CWA and other state regulations and laws.

Traditionally, DWR's staff reviews about 1,500 to 2,000 individual and nationwide permits per year via 404 and DCM permits, Section 10 permits and Federal Energy Regulatory Commission permits to ensure compliance with 401-WQC and other State regulations and laws.<sup>23</sup> Over the period of 1999 to 2019, DWR issued 11,591 401-WQC within the seven coastal draining river basin that represents 8,125 acres of wetland and 1.3 million linear feet of stream of impacts.

The DEMLR stormwater post-construction program is responsible for providing oversight on existing stormwater permits, as well as reviewing and issuing permits for new stormwater permit applications. Since stormwater permits do not expire, the number of permits continues to grow over time. In 2020, there were over 15,000 permittees. The 10 staff are responsible for 50-70 new permit applications per year in addition to assisting about 1,500 existing permittees per year, leaving little time for compliance.<sup>24</sup>

### **6.2.4 Compliance and Enforcement Programs**

Different agencies have varying ways of achieving compliance within their established regulatory authorities. For the purpose of this report, compliance will be defined as an inspection of a site to determine if it conforms to either the conditions of a written approval (i.e., a permit or certification) or the relevant State regulations associated with a development activity resulting in a discharge or impacting wetlands, streams, waters or riparian buffer.<sup>1</sup> The State agencies with regulatory authority over these activities included the DCM, DEMLR, and DWR.

Typically, site inspections are the result of complaints or referrals received from the general public, an organization, or government agencies concerning activities that do not comply with the regulatory mandates of the respective agencies. Other inspections can be routine in nature such as a site inspection associated with application review or monitoring of a site for compliance with written approvals. Inspections may also result from self-reporting of a violation. The failure of authorized persons, parties, and/or entities to comply with written approval or relevant state rules may result in the issuance of notice of deficiency (NOD), notice of violation (NOV), after-the-fact written approval,

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cease and desist order (C&D), injunctive relief, enforcement action, and/or civil penalty. In extreme cases, even criminal charges with penalties may result from non-compliant inspection.

Reporting on the effectiveness of individual state's compliance and enforcement programs associated with wetlands, streams, and waters regulations are limited. Generally, only specifics on guidance associated with compliance and enforcement policies for individual states (Vermont and Southern Florida 2014) or federal jurisdiction (Sacramento District 2014) are available.<sup>1</sup> Variations in state laws that establish states authority to protect wetlands and waters and how each implements their authority compounds the task of comparing the individual states regulatory success. For example, in 2016, 23 states had a wetland permitting program that complemented their states' 401 certification program, but only six states had adopted some sort of water quality standards specific to wetlands, and ten were in the process of developing standards.<sup>25</sup> The specifics of those programs between states vary greatly. Other states rely solely on EPA and the USACE to perform compliance and enforcement on sites that are non-compliant with conditions of 401-WQC.

Published information regarding the historic effectiveness of compliance and enforcement programs associated with development activities that impact wetlands and waters across the State's regulatory agencies is lacking. General discussion regarding past work indicated that overall compliance was less than 50 percent for NC Sedimentation and Erosion Control Program during their study period.<sup>1, 26</sup> Due to concerns regarding the lack of adequate information pertaining to compliance and enforcement programs, DWR applied for and was awarded an EPA Wetland Development Grant CWA Section 104(b)(3) in 2005. Before the grant was awarded, DWR estimated that staff visited less than one percent of all permitted site per year, mainly based on complaints received by the Regional or Central Office.<sup>1</sup> The grant funded three full time inspection positions (one per regional office in Washington, Raleigh, and Mooresville) to conduct compliance and enforcement activities for written authorization and unauthorized activities associated with 401-WQC, riparian buffer, state stormwater, and water quality and wetland standards for a period of three years.

Over the period from 2007 to 2011 (2010 and 2011, grant was extended two years), compliance rates rose from 15 percent in 2007 to 82 percent in 2011 for permitted sites and 10 percent in 2007 to 69 percent in 2011 for unpermitted sites. In addition, the amount of civil penalty assessments dropped from \$151,000 in 2007 to \$41,579 in 2011.<sup>1</sup> The end goal of the grant was met by inspecting at least 15 percent of the sites authorized in the previous year and demonstrating the outcome of the addition of a limited number of compliance and enforcement staff on overall compliance. Unfortunately, at the conclusion of the grant, the three compliance positions were not funded by DWR.

From 2008 to 2018, substantial decrease in funding and positions occurred in DEQ. The additional regulatory burden associated with the elimination of staff has led to a decrease in number of compliance inspection and an increase in the number of non-compliant sites. Inspection data were requested from the DWR, DCM, DEMLR and NC Department of Agriculture and Consumer Services (DA&CS) Forest Service (Forest Service) in order to understand any correlation between the staffing of individual agencies and its effects on regulatory compliance and enforcement program within the agency's respective authority. These divisions provided results of initial site inspections conducted within the four CHPP Regions over the period of January 1, 2014 through December 31, 2019 (reporting period) to gain an understanding of the rate of compliance for any subject written authorization or regulation prior to conducting a follow up compliance inspection.

The DWR staff conducted 3,517 initial site inspections within the four CHPP Regions for the reporting

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period for projects with written authorization for NC Department of Transportation (DOT) and non-DOT projects for 401-WQC and/or buffer authorization or in response to a complaint or referral of possible violations of wetlands or stream standards for water quality or riparian buffer regulations. Of the total reported initial inspections, 2,230 inspections were associated DOT projects. Compliance with the written authorizations and/or other regulations associated with DOT projects were reported at 88.7 percent with only three inspections in response to citizen complaints. DWR staff inspections of non-DOT projects encompassed the remaining 1,287 inspections. Of the total number of initial inspections, 493 inspections were in response to citizen complaints regarding possible unauthorized activities and 794 were considered routine inspections. Reported compliance for complaint inspections were 22.5 percent and the routine inspection were 68.2 percent. The total unauthorized impacts for the wetlands, streams, waters, and riparian buffer (if applicable) for the four CHPP Regions within the reporting period are summarized in Table 6.1.<sup>27</sup> Looking at the same time period, there were 1.54 acres of unpermitted wetland impacts for every one-acre of permitted wetland impacts, indicating that non-compliance is a significant issue.

Table 6.1. Summary of reported NC Department of Transportation (DOT) and non-DOT unauthorized 401 wetlands and buffer resource impacts annually within the Coastal Habitat Protection Plan (CHPP) region.

Annual Unauthorized Resource Impacts	2014	2015	2016	2017	2018	2019
Wetlands (ac.)	1.91	37.16	15.62	41.7	2,028.47	7.06
Stream (ft.)	13,653	16,248	5,130	1,825	12,008	3,880
Waters (ac.)	0.07	0.10	0.00	1.00	0.56	0.00
Buffers (ac.)	1.09	2.07	10.29	2.53	2.49	4.06

Within the four CHPP Regions, DWR has seven regulatory staff (non-DOT projects) and four regulatory staff (DOT projects) in four regional offices that are responsible for review and processing of 401 and buffer authorization applications, review and providing comment for other regulatory agency permits for compliance with wetlands standards, water quality standards, riparian buffer rules, and conducting compliance and enforcement activities. The agency's central office in Raleigh has additional regulatory staff responsible for permit review for DOT and non-DOT projects for 401-WQC and buffer authorization and oversight of the State's compliance and enforcement programs for the Section 401, stream and wetland water quality standards, and riparian buffer programs.

The number of site inspections and percent compliance by agency from 2014 to 2019 is shown in Table 6.2. Division of Coastal Management staff conducted 4,688 initial site inspections associated with processing of general or CAMA major development permits, monitoring of site conditions, routine site inspections, or responding to complaints over the reporting period.<sup>28</sup> Only nine site inspections resulted in significant violations of CAMA regulations, and an unknown amount of minor violations were brought into compliance without formal action. The DCM has three district offices and the central office in Morehead City. The DCM regulatory staffing commonly consists of a district manager, three to four county field representatives (non-DOT projects), one representative (DOT-projects), and a district land use planner. The Morehead City office also oversees compliance and enforcement programs supervision, public policy, permitting, and are within the administration. Local Permitting Officers for townships or counties can issue minor CAMA development permits. Regulatory staff issue minor and general, process applications for review of major CAMA development permits and conduct compliance and enforcement activities under the authority of the CAMA and State Dredge and Fill Law.

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Table 6.2. Compliance inspections and percent compliance by agency, 2014-2019.

Agency	Program Type	Initial Site Inspections (#)	Compliance (%)
Division of Water Resources (DWR)	401 WQC, buffers, wetland and stream standards - DOT	2,230	88.7
	401 WQC, buffers, wetland and stream standards - non-DOT; routine inspection	794	68.2
	401 WQC, buffers, wetland and stream standards - non-DOT; complaint	493	22.5
Division of Coastal Management (DCM)*	GP and Major permits	4,688	99.8
Division of Energy, Minerals, and Land Resources (DEMLR)	NPDES State and Phase 2 Stormwater	4,910	72
	Erosion and Sedimentation Control	8,188	38
NC Department of Agriculture and Consumer Services (DA&CS) - Forest Service (Forest Service)	Forest Practice Guidelines Related to Water Quality	11,545	98.5

\*One year of data within this time period was not available for DCM.

The DEMLR staff conducted 4,910 initial compliance inspections under the NPDES programs for state stormwater and stormwater Phase II Rule (Phase II) associated with development within the four CHPP Regions over the reporting period. Of the reported initial inspection, 1,401 sites were reported to be non-compliant with the associated written authorization or stormwater regulations. Compliance rates for initial inspection for NPDES state and Phase II over the reporting period was 72 percent. In addition, DEMLR staff also conducted 8,188 initial site inspections for compliance with approved Erosion and Sediment Control Plan (ESCP), NPDES General Permit No. NCG100000 (Construction stormwater permit), and other related regulations. Of the reported initial inspection, 5,075 sites were reported to be non-compliant with their associated written authorization or construction stormwater regulations. Compliance rates for initial inspection for ESCP, Construction stormwater permit (NCG01) and associated regulations over the reporting period was 38 percent.

The DEMLR regulatory staff within the four CHPP Regions for ESCP and NPDES programs are composed of 37 regulatory staff within the four regional office and 12 regulatory staff within the Central Office in Raleigh. The regulatory staff are responsible for processing ESCP, state stormwater, and Phase II applications, and enforcement and compliance activities under the authority of the SPCA and NPDES rules and regulations. Please note, that sites that were reported as non-compliant may not have required the issuance of an NOD or NOV.

Stormwater permit compliance has been a concern of agencies, the General Assembly, and others. In 2005, a study conducted in five counties within the Wilmington Regional Office district found compliance rates for permitted projects at high-density and low-density sites were 26.9 and 34.9 percent, respectively. Non-compliance was primarily due to improper maintenance for engineered ponds, and improper installation of stormwater control measures for low-density sites. Follow-up

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inspections in the same counties two years later found 91 percent non-compliance, primarily due to poor or no maintenance.<sup>29</sup> Permit education is one of the primary reasons for low compliance since permits are transferred in new developments from the developer to homeowner associations and from owner to owner on individual property. In 2019, the General Assembly raised concerns about stormwater permit transfer and compliance, and subsequently DEMLR conducted a program review.

The Forest Service is responsible for inspecting forestry-related land-disturbing activities to determine compliance with the standards required by the state's Forest Practices Guidelines Related to Water Quality, (02 NCAC 60C) as part of the Sedimentation Pollution Control Act. Forest Service staff conducted 11,545 initial site inspections within the reporting period with a compliance rate of 98.3 percent.<sup>30</sup> The Forest Service is composed of eight district offices within the four CHPP Regions with technical assistance staff in each district generally composed of a district forester, assistant district forester, one to two district rangers, and one to two service foresters. Water quality inspections are often carried out by county rangers and assistant county rangers, after they have completed training specific to water quality. Each county generally has one county ranger, with one to three assistant county rangers. Regionally, Water Quality Foresters cover two to three districts, and deal specifically with BMP and water quality technical assistance, answering compliance questions, communicating with loggers and landowners, and handling violations. The CHPP Regions are covered by four separate Water Quality Foresters.

### 6.3 Discussion

The effectiveness of a successful compliance and enforcement program has been documented.<sup>1</sup> As previously discussed, an EPA Program development grant provided funding for three full time position (one position per regional office) compliance positions (one position per regional office) over the period of 2007 to 2011. Over the grant period the reported number of annual site inspections associated with written approvals rose along with the rate of compliance. In addition, the amount of civil penalties assessed dropped over the reporting period. When comparing the reported results of the DWR grant with the current inspection data over the past five fiscal years, routine inspection compliance rates for non-DOT projects have dropped from 82 percent in 2011 to 69 percent in 2019. In addition, the rate of compliance for non-DOT project complaint inspections has fallen from 68.2 percent in 2011 to 22.5 percent to 2019. Subsequent to the completion of the grant, legislative budget cuts resulted in the compliance positions not being funded by the DWR.

Additional staff could help conduct stormwater and sedimentation compliance inspections with written authorizations associated with 401-WQC, riparian buffer authorization, water quality standards for stream and wetland, and riparian buffer rules. Staff could also be responsible for the issuance of any NODs, NOVs, review of response letters and associated site restoration plans, review of applications for after-the-fact written authorizations, oversight of site restoration activities, and pursuing any enforcement action needed to bring the site back into regulatory compliance.

The DCM and Forest Service, with a greater staff to need inspection ratio, have reported higher compliance rates associated with initial inspections over the reporting period of 2014-2019. Conversely, DEMLR reported a higher rate of compliance (72 percent) with regards to inspections of the NPDES program permits under state stormwater and Phase II, but reported lower compliance rates (38 percent) associated with inspections of ESCP and NCG01 permitted sites. There is further evidence that increased site inspections improve regulatory compliance.<sup>31</sup> When the CWA permit inspections declined between 2015 and 2018, there was a 10 percent increase in serious water pollution incidents. Similarly, with

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Clean Air Act (CAA) inspections, there was a 28 percent increase in permit violations. In a 2005 study, 63 percent of the companies examined took additional compliance related actions after learning that other companies had received penalties for environmental law violations.<sup>32</sup> This is attributed to the “deterrence model”. Applicants are deterred from violating environmental regulations if the risk of penalties is real, compliance is cheaper than the expected penalties, as well as concern over reputation.<sup>31, 33</sup>

Although there is some overlap in regulatory jurisdiction among DWR, USACE, and DCM, there are differences in permitting and enforcement authority. Due to these differences, as well as limited staffing resources, implementation of any effective compliance and enforcement program is difficult and complex. Additionally, exemptions exist from both State and federal permitting and regulatory requirements resulting in impacts to wetlands and waters for certain silvicultural, farming and ranching practices, dam maintenance, maintenance of drainage ditches, construction of temporary sediment and erosion or best management practices (BMPs) required by NC ESCP, and construction of farm roads, forest roads, and temporary roads for moving mining equipment. With DWR’s regulatory authority differing in scope from DCM and USACE, as well as limited staffing resources, implementation of any effective compliance and enforcement program has become more problematic.

A possible solution to address the lack of an effective compliance and enforcement program within the DWR 401 and buffer section could be the hiring of additional staff for the regional offices within the four CHPP Regions whose sole responsibility is to conduct inspections and implement any needed enforcement actions. Although these positions would be non-revenue generating, and therefore more likely subject to budgetary cuts, the historic data indicates the existence of a more consistent compliance and enforcement program reduces the number of and rate of non-compliance and overall enforcement costs. Over the period of 2014 to 2019, DWR reported wetlands impacts authorized under 401-WQCs of approximately 1,499 acres within the seven coastal draining river basins. Conversely, DWR’s reported unauthorized impacts to jurisdictional wetlands within the same period totaled approximately 2,312 acres within the seven coastal draining river basins.

To address compliance and other concerns with DEMLR’s stormwater program, a stakeholder group met and developed a 2020-2022 action plan.<sup>24</sup> In addition to securing additional staff, key recommendations to improve compliance included conducting permittee training and outreach, requiring an annual electronic certification on new, transferred, and renewed permits, adding a chapter in the Stormwater Design Manual on permit renewal and transfer to provide guidance on how to comply, launch an electronic permitting system, and modify stormwater control measures where possible that encourage disconnecting impervious surfaces and utilizing onsite infiltration (nature-based solutions, LID). These techniques are cost-effective and technically sound.

Other strategies to address environmental compliance when staff limitations continue include improving detection of non-compliance through technology, lowering compliance costs through focused inspections, and increasing public disclosure. It has been suggested that remote sensing and machine learning can be used to focus compliance inspections on companies predicted to have the highest risk of non-compliance and focus on areas of the greatest environmental risk.<sup>33</sup> Requiring self-inspection assessments has been shown to result in improved compliance rates where agency inspections cannot get to at least 12 percent of the permitted sites. Making the public aware of violators (naming and shaming) can damage reputations and trigger public scrutiny, and consequently serve as an incentive to comply. For example, when EPA’s Clean Air Act began publicizing a facility “watch list”, violations decreased 10 to 23 percent.

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Currently, NC Division of Environmental Assistance and Customer Service (DEACS) assists in the routing of complaints to the applicable agencies through the DEACS public portal and telephone inquiries received by DEACS staff. Both, DWR and DEMLR have maintained a list of recent civil assessments on a period basis. However, no active or long-term lists of assessments or repeat violators exist and the formulating of such lists should be vetted through upper management of the Divisions and legal staff prior to the implementation. Utilizing citizen science and public reporting portals has been utilized to supplement site inspections and increase public awareness.<sup>33</sup>

The historical losses of wetland and water resources from unauthorized development have not been well documented. Lack of regulatory staffing have resulted in a larger number of sites that do not comply with regulations related to water quality. Over the last five fiscal years, the DWR reported unauthorized jurisdictional wetland impacts exceeded authorized impacts by a margin of 1.54:1. Given this relatively high proportion of wetland impacts due to non-compliance, actions are needed to address it.

### 6.4 Recommended Actions

#### 6.4.1 Funding

- 6.1 By 2023, through legislative appropriations or budget reallocations, DEQ will increase staffing in DWR and DEMLR by a minimum of two staff (one per office, per agency) in the Washington and Wilmington regional offices.
- 6.2 By 2023, DEQ will seek funding through grants or other sources to supplement state-appropriated compliance efforts.

#### 6.4.2 Outreach

- 6.3 By 2022, DWR and DEMLR should work with the DEACS to establish a public portal on DEQ's website that provides information on compliance issues, allows the public to submit complaints, and potentially highlights a list of repeat violators.
- 6.4 By 2023, DWR, DEMLR, and DCM should develop and hold outreach workshops for NGOs, HOAs, and other interested public, on rules related to land disturbing activities that affect wetlands and water quality, and how to identify violations to improve the effectiveness of public complaints.
- 6.5 By 2022, DEMLR will initiate and continue outreach to stormwater permit holders on rules and required maintenance of stormwater control measures and structures.

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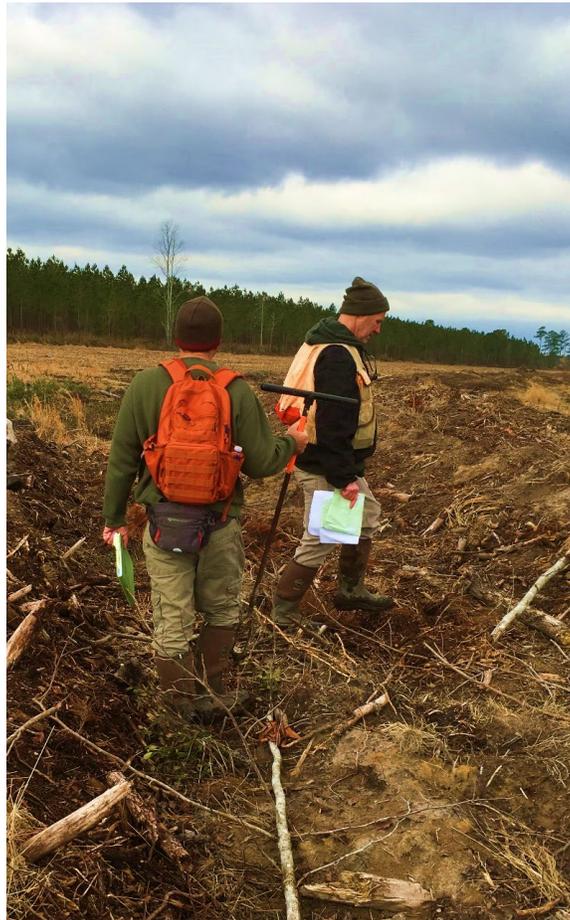


Photo Credit: Anthony Scarbraugh

### 7. WASTEWATER INFRASTRUCTURE SOLUTIONS FOR WATER QUALITY IMPROVEMENT

#### 7.1 Issue

The water column provides essential conditions for fish survival and healthy habitats, and therefore good water quality is key to a healthy coastal ecosystem. There are many contributing sources of water quality degradation.<sup>1</sup> Sanitary sewer overflows (SSOs) from wastewater collection systems are one pollutant sources that contribute to water quality degradation and impact coastal habitats. Failing and deteriorating wastewater infrastructure, often referred to as inflow and infiltration (I & I), is often the underlying cause of SSOs. Untreated or incompletely treated sewage entering estuaries after a SSO can increase bacteria, nutrient, and toxin levels, potentially resulting in shellfish closures, algal blooms, fish kills, and contaminated water and sediment that can impair aquatic life.

#### 7.2 Background

Effective management of wastewater is critical to protection of surface waters, fish habitat, public health, and the economy. Pollutants entering estuaries degrade water quality, impairing its ability to support healthy fish habitat, fish populations, and fisheries. Untreated wastewater can enter surface waters when SSOs occur due to failures associated with collection infrastructure, lift stations, or wastewater treatment plants. Inflow and infiltration is a significant problem in coastal NC that results in raw wastewater entering estuarine waters.

A sanitary sewer or collection system is an underground pipe system used to convey wastewater to a treatment facility and is comprised of conventional gravity lines, pump stations, and force mains. Inflow and infiltration (I & I) is the term for groundwater and stormwater entering a sewer system. Inflow refers to the entry of stormwater into the sewage collection system during storm events, whereas infiltration refers to the movement of groundwater into the sewer pipe system. There are multiple mechanisms contributing to I & I (Figure 7.1). Gutters connecting to lateral pipes (the pipe from an individual building to the roadside main line), uncapped sewer line cleanouts, faulty sewer manhole covers, and improper cross connections of stormwater lines with sewer lines are all possible ways stormwater can enter sewer lines. Groundwater can enter the sewer pipes through cracks, leaky pipe joints, deteriorated manholes, and broken lateral pipes.



Photo Credit: CFPUA

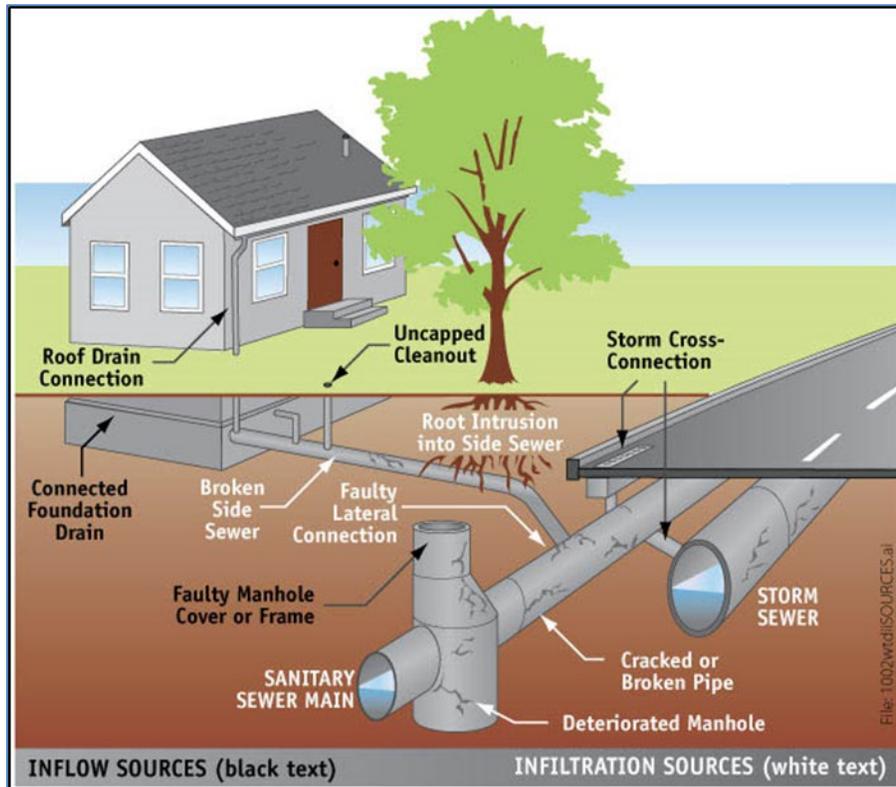


Figure 7.1. Example of inflow and infiltration (I & I) pathways.<sup>2</sup>

Together, these two processes increase the volume and overload the sewage collection system, particularly during wet weather, which in turn can cause SSOs to occur.<sup>3</sup> Climate change may further exacerbate the problems with increased rainfall and higher groundwater levels. Nearly all sanitary sewer systems and receiving wastewater facilities in coastal NC are subject to issues and complications resulting from I & I due to aging infrastructure, proximity to waterways, severe storms, and high ground water levels.

Sewer collection systems vary in age and construction materials. Older pipes and certain construction materials, such as metal and masonry, are more susceptible to deterioration. The degree and magnitude of I & I within a sewer collection system can be based on several factors. Along with system age, sewer line construction material, and poor construction methods, the following operational challenges can also contribute to I & I problems:<sup>4</sup>

- Insufficient maintenance of lateral pipes connecting to sewer lines (responsibility typically lies with property owner)
- Insufficient maintenance and clean out of main sewer lines (responsibility of facility owner, such as a municipality)
- Removal of clean-out caps by property owners
- Damage from road work (can result in increased flows)
- Disposal of fats, oils, and greases down the drain, causing pipe blockages and subsequent overflows
- Illicit connection of stormwater from roof drains, parking lots, etc., into the collection system

The severity of I & I is often a factor of groundwater table and weather conditions. Inflow often peaks during heavy or prolonged rainfall events. Chronic rainfall may result in an elevated groundwater table

## Chapter 7. Wastewater Infrastructure Solutions for Water Quality Improvements

intersecting sewer pipes, resulting in higher infiltration rates.

Sewer lines, pump stations, and wastewater treatment plants (WWTPs) are designed for specific flows and peak flow volumes and rates. Contribution of flow from I & I is not a standard design component for most sewer systems and receiving wastewater systems. Consequently, flows in excess of the sewer system capacity may result in SSOs, which is a release of untreated or partially treated sewage from a sanitary sewer at unpermitted locations. These sewage spills often occur at manholes and pump stations when pumps cannot keep up with incoming flows. Excessive I & I can also result in reduced level of treatment at the receiving WWTP, discharge of insufficiently treated effluent to surface waters or land-application fields, overflows at WWTPs of untreated or insufficiently treated wastewater, and discharge of residual solids from WWTPs.<sup>4</sup>

The SSO spill volumes may range from hundreds to millions of gallons. Excessive flows at WWTPs may result in potential of discharge of residual solids depending on actions taken by facility operators. Discharge of residual solids creates a potential for solids to settle on surface water sediments, with multiple water quality implications.

The location of discharging and non-discharging wastewater treatment facilities along coastal NC is widespread and consequently, so is the extensive network of collection lines carrying raw wastewater to those facilities (Figures 7.2 and 7.3). In 2020, there were 282 National Pollution Discharge Elimination System (NPDES) program wastewater treatment facilities and 295 non-discharge facilities permitted within the Coastal Habitat Protection Plan (CHPP) region and managed by the DWR (Table 7.1 and 7.2).<sup>5</sup> Facilities with wastewater discharge permits release treated effluent directly from a pipe into surface waters. Facilities with non-charge permits apply treated effluent on land, retention ponds, or reuse it for other purposes such as irrigation.

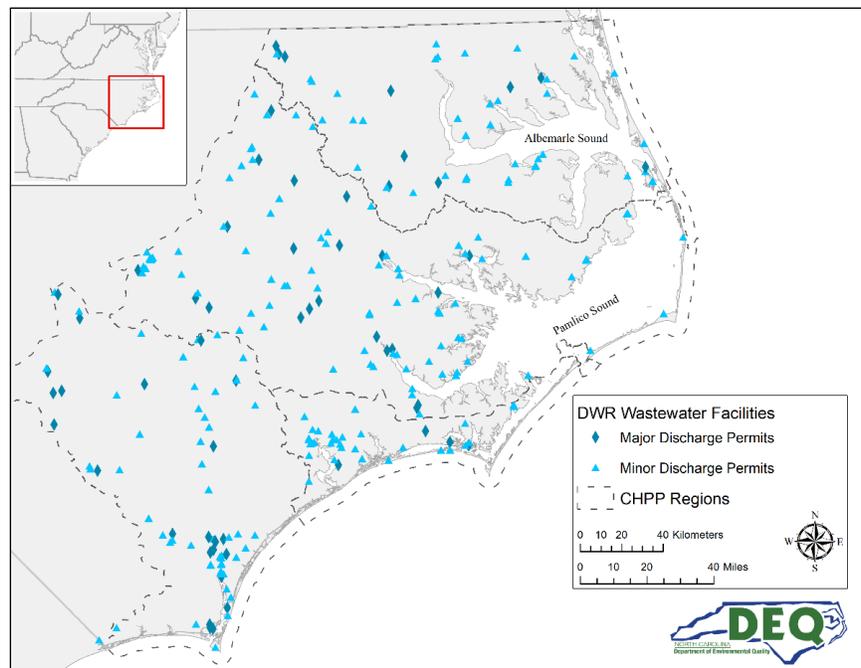


Figure 7.2. Wastewater discharge facilities located across coastal NC.<sup>6</sup>

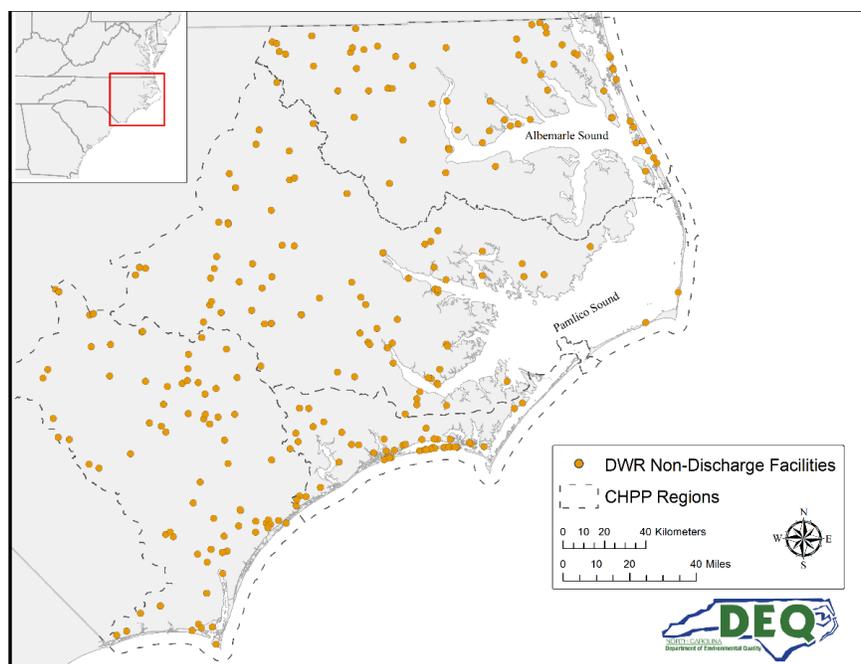


Figure 7.3. Wastewater facilities with non-discharge permits located across coastal NC. Note: Identified facilities also include residual land application facilities and “other” types of non-discharge systems.<sup>6</sup>

Discharge facilities are categorized as industrial/commercial, municipal, domestic only, drinking water plants, water conditioning, and groundwater remediation. Municipal and domestic wastewater facilities (combined) are the most common type of facility. There are several categories of non-discharge wastewater facilities. The most common is wastewater irrigation, where treated wastewater is applied to land via spray irrigation, drip irrigation or other technology. High-rate infiltration is increasingly permitted in coastal areas where the water table is high. With this method, groundwater is often lowered around a disposal area to increase the depth of “dry” soil under a retention area by installing perimeter sub-surface drainage pipes, wells, or ditching around the perimeter and discharging the clean groundwater to nearby surface waters. Treated wastewater is then discharged to a retention area with permeable soils and allowed to seep into the ground. For each of these systems, particularly municipal systems, there are many miles of sewer lines beneath the ground transporting wastewater to a treatment plant.

Table 7.1. Numbers of National Pollution Discharge Elimination System (NPDES) wastewater treatment facilities permits by type within the four Coastal Habitat Protection Plan (CHPP) regions.<sup>6</sup>

CHPP Region	Number of Facilities			Permit Type					
	Minor	Major	Total	Discharging 100% Domestic < 1MGD	Industrial Process & Commercial Wastewater Discharge	Municipal Wastewater Discharge, < 1MGD	Municipal Wastewater Discharge, Large	Water Plants and Water Conditioning Discharge	Ground water Remed. Discharge
1	40	11	51	5	10	9	8	19	0
2	89	23	112	7	37	17	16	33	2
3	33	4	37	16	3	3	2	12	1
4	53	29	82	9	30	14	14	12	3
<b>Total</b>	<b>215</b>	<b>67</b>	<b>282</b>	<b>37</b>	<b>80</b>	<b>43</b>	<b>40</b>	<b>76</b>	<b>6</b>

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Table 7.2. Numbers of non-discharge permits by type within the four Coastal Habitat Protection Plan (CHPP) regions. Note: closed-loop recycle system, distribution of residual solids systems, and land application of residual solids systems pose potential for impacts to surface waters. Although such systems do not convey wastewater, they often address nutrient management needs and are referenced in the following table.<sup>6</sup>

CHPP Region	Number of Facilities			Permit Type						
	Minor	Major	Total	Waste-water Irrigation*	High-Rate Infiltration	Reclaimed Water and Distribution**	Land Application Residual Solids	Closed Loop Recycle	Distribution of Residual Solids	Other
1	15	52	67	25	18	6	11	2	2	3
2	44	46	90	41	4	16	18	3	7	1
3	13	41	54	11	30	5	5	1	2	0
4	31	53	84	32	9	11	17	7	7	1
Total	103	192	295	109	61	38	51	13	18	5

\*Combined single family and other wastewater irrigation

\*\*Combined reclaimed water and distribution

† Combined exempt and non-exempt from EPA 503 regulations for land application and disposal of residual solids

### 7.2.1 Effect on Water Quality

A major concern with SSOs that enter oceans, bays, estuaries, rivers, lakes, streams, or brackish waters is their direct impacts on water quality. Wastewater treatment plants and infrastructure are often sited in low-lying areas along the coast, since sewers are typically gravity-fed. Consequently, spills resulting from SSOs and WWTP operational complications often discharge to nearby surface waters.

Spills of untreated or partially treated sewage may convey or result in high bacteria levels to surface waters, elevated nutrient levels and loadings to surface water systems, depressed dissolved oxygen (DO) levels in surface waters, increased potential for algal blooms due to nutrient loading at chronic SSO locations, and stress or mortality of fish and other aquatic organisms. The unpredictable and random nature of SSOs makes them very difficult to monitor and study.<sup>7</sup> Prior investigations and case studies have helped characterize and quantify impacts to surface waters resulting from wastewater spills.

A study in Wilmington, NC monitored water and sediment quality following a sewer main break that discharged approximately three million gallons of raw sewage into the upper portion of Hewlett Creek<sup>8</sup>, which dispersed throughout the creek and into the Intracoastal Waterway (IWW). Sampling found very high levels of fecal coliform bacteria (270,000 Colony Forming Units (CFU)/100 ml) in the creek initially. After three days, levels dropped below 100 CFU/100 ml in the channel and lower portion of the creek. However, in two tributaries, maximum counts remained high for five days, dropped slightly, then increased one week later after a rainfall. The increase after rain was attributed to runoff carrying residual sewage and resuspension from bottom sediment. Bacteria levels slowly decreased to normal levels over several more weeks. Fecal coliform bacteria in the sediment was also highly elevated and remained elevated for over a month, longer than the water column. The study found that the sediment served as a reservoir for fecal bacteria. Rainfall and experimental prop washing verified that bottom disturbance caused resuspension and fecal coliform to increase in the water column.

The biochemical oxygen demand (BOD) of the nutrient rich sewage caused severe hypoxia and several large fish kills two to three days after the spill. Dead organisms included American eels, flounder, mullet, bait fish, and birds. Nutrient concentrations in these sewage pipes are normally very high, approximately 40.2 mg/l total Kjeldahn nitrogen (TKN), 23.3 mg/l ammonium (NH<sub>4</sub>), and 5.3 mg/l total phosphorus (TP). Once in the creek, nutrient levels declined rapidly (1-1.5 days), being taken up by phytoplankton,

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resulting in several algal blooms. The decline in nutrients was also attributed to absorption by marsh plants, sediment and the sediment microbial community, benthic microalgae, macroalgae, and tidal flushing. The authors noted that the marsh community's ability to remove and cycle nutrients demonstrated the high value of conserving wetlands to improve water quality.<sup>8</sup> In addition to nutrients and bacteria, raw sewage can contain other materials hazardous to aquatic life, such as toxic chemicals, heavy metals, and endocrine disrupting chemicals. There is growing evidence that sewage discharges contribute to increasing harmful algal blooms (HABs) and changes in biodiversity and ecosystem health. Additionally, there are many pathogens present in sewage that can impact human health, and consequently shellfish harvest and recreational swimming activities.<sup>7</sup>

Sewage spills can cause significant localized acute impacts within the affected waterbody; however, their overall contribution to water quality in NC is less certain. To assess the prevalence and magnitude of I & I in coastal NC residential wastewater treatment systems, a study analyzed flows under different rainfall and temperature conditions using 2010-2011 data.<sup>9</sup> Of the 93 WWTPs analyzed, 92 percent exhibited a statistically significant flow response to rainfall, with increased flows averaging 12 percent more than rainless flows, with a maximum of 35 percent. Most of the flow increase was attributed to infiltration rather than inflow.

The location of the systems with significant I & I occurred in both small and large municipalities throughout the coast, from Elizabeth City in the north, to Southport in the south. Central sewage treatment systems are often utilized in areas of high population density, such as cities and towns, as well as in areas where the groundwater table is too high for septic systems to function properly. Consequently, many of the wastewater collection pipes are sitting below ground, surrounded by groundwater. As pipes age and deteriorate, cracks in the pipes or joints allow groundwater to enter. Where the pipes are sitting in the groundwater, infiltration rates will be greater, particularly during wet periods. During dry periods, those same cracks can let wastewater leak out into the groundwater. Modelling predicted infiltration rates at over 40 percent where a two-inch rain event occurred after two weeks of dry weather. Modelling for a two-inch rain event occurring once a week for three weeks estimated average infiltration rates at 66 percent. Cumulative rain and lower temperatures drove significantly higher flows in the collection system suggesting that heavy rains in the cooler winter months are more likely to cause I & I problems.<sup>10</sup>

Deteriorating wastewater infrastructure plays a role in bacterial pollution, although stormwater runoff is considered the primary cause of water quality degradation.<sup>1</sup> Both SSOs and stormwater runoff occur with rainfall, complicating the ability to determine the contributing sources of fecal coliform concentrations. Similarly, where the groundwater table is low, wastewater can exfiltrate or leak out of sewer lines, and contaminate groundwater, which moves laterally to surface waters during rain events.<sup>9</sup> In urban settings, stormwater conveyances act as a conduit for sewage originating from leaking wastewater collection pipes.<sup>11, 12</sup> Studies in coastal NC comparing bacteria concentrations in septic and sewer watersheds showed both watershed types had increased bacteria counts in streams during rain events. The sewer watersheds had high increases due to leaky infrastructure or greater impervious surfaces.<sup>13, 14</sup> For a resilient system, managers must address multiple sources of pollution.

The Coastal Plain is more at risk to I & I than other regions of NC due to its low-lying geography and expansive hydrology. High groundwater levels, whether from rain or sea level rise (SLR), make wastewater infrastructure in coastal areas more at risk to infiltration, potentially resulting in more SSOs and improper treatment at the WWTPs.<sup>15</sup> The Coastal Plain is subject to higher average annual rainfall than other regions of NC and more extreme rainfall events, often associated with tropical storms. Climate change will exacerbate these conditions, and coastal wastewater collection systems may be

## Chapter 7. Wastewater Infrastructure Solutions for Water Quality Improvements

increasingly vulnerable to effects of I & I and sewer spills. For additional information, see **Chapter 3. Climate Change and Resiliency.**

Over the years, many incidents have occurred across coastal NC counties where elevated sewer system flows or other causes resulted in unpermitted discharges of wastewater or discharges of poorly treated wastewater to coastal waters and habitat.<sup>4</sup> Most of these SSOs can be traced back to the aging and failing water and sewer systems in the inner coastal region. A majority of NC's water systems are 40 years old or older, with many of them 60 to 70 years old. Some sewer lines in the towns of Columbia and Bellhaven are 90 and 100 years old, respectively. The average age of wastewater treatment plants in the state is approximately 40 years old, though many of them have undergone renovations to comply with current state and federal regulations. The NC section of the American Society of Civil Engineers gave NC a statewide grade of "C" due to its extensive wastewater infrastructure problems.<sup>16</sup>

The DWR requires that SSOs to be reported to DWR by the permittee (15A NCAC 02B .0506 - Reporting Requirements). Specifically, the permittee shall verbally report by phone to a DWR staff member at the appropriate Regional Office, as soon as possible, but in no case more than 24 hours following first knowledge of the occurrence of either 1) any SSO and/or spill over 1,000 gallons to the ground, or 2) any SSO and/or spill, regardless of volume, that reaches surface water. These SSO incidents are tracked using an internal DWR database. The permittee is required to follow up with DWR by providing a written report within five days. It should be noted that the spill volumes in the database are estimated by the reporting party, can be difficult to estimate visually, and may vary in accuracy. From 2015 through 2019, there were 501 SSO incidents reported in the twenty coastal counties (Table 7.3). The average sewer spill volume was estimated to be 50,170 gallons, median spill volume was 1,500 gallons, and maximum spill volume was 4 million gallons. In addition to estimating the volume of the spill, an estimated volume reaching surface waters is also provided. The total volume of wastewater reaching surface water was estimated to be more than 24 million gallons for this five-year period for NC's 20 twenty coastal counties. The data indicate that most of the spills reported are relatively small. The largest of the spill volumes, those that exceed approximately 33,000 gallons, represent 10 percent of the reported overflows for the five-year period. Brunswick, New Hanover, and Craven counties had the highest number of incidents during that time period (Figure 7.4). In contrast, Onslow County had the highest total volume of sewage spilled to surface waters, followed by New Hanover and Chowan counties (Figure 7.5).

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Table 7.3. Sanitary sewer overflows (SSO) incident data from NC's 20 coastal counties, 2015-2019. A dash is reflective of no information being available for the data type and may be a condition of potential reporting deficiencies in some cases.

Coastal County	No. of Reported Incidents (2015-2019)	Total Gallons of Wastewater Spilled to Surface Waters	No. of Incident Related to Storm Events	Total Gallons of Wastewater Spilled to Surface Waters Related to Storm Events
Beaufort	9	1,008,995	1	1,000,000
Bertie	22	1,549,600	2	1,000,000
Brunswick	101	883,072	4	20,650
Camden	0	0	-	0
Carteret	20	1,347,558	1	210,000
Chowan	19	2,748,141	-	0
Craven	81	791,147	4	87,300
Currituck	4	600	-	0
Dare	11	40,389	-	0
Gates	0	0	-	0
Hertford	15	109,062	4	81,122
Hyde	2	850	-	0
New Hanover	100	2,762,765	14	11,300
Onslow	47	10,299,536	-	0
Pamlico	18	130,949	3	40,149
Pasquotank	24	1,221,700	3	1,200,000
Pender	8	3,200	-	0
Perquimans	14	576,450	1	1,000,000
Tyrrell	0	0	-	0
Washington	6	11,275	1	10,000
<b>Total</b>	<b>501</b>	<b>23,485,289</b>	<b>38</b>	<b>4,660,521</b>

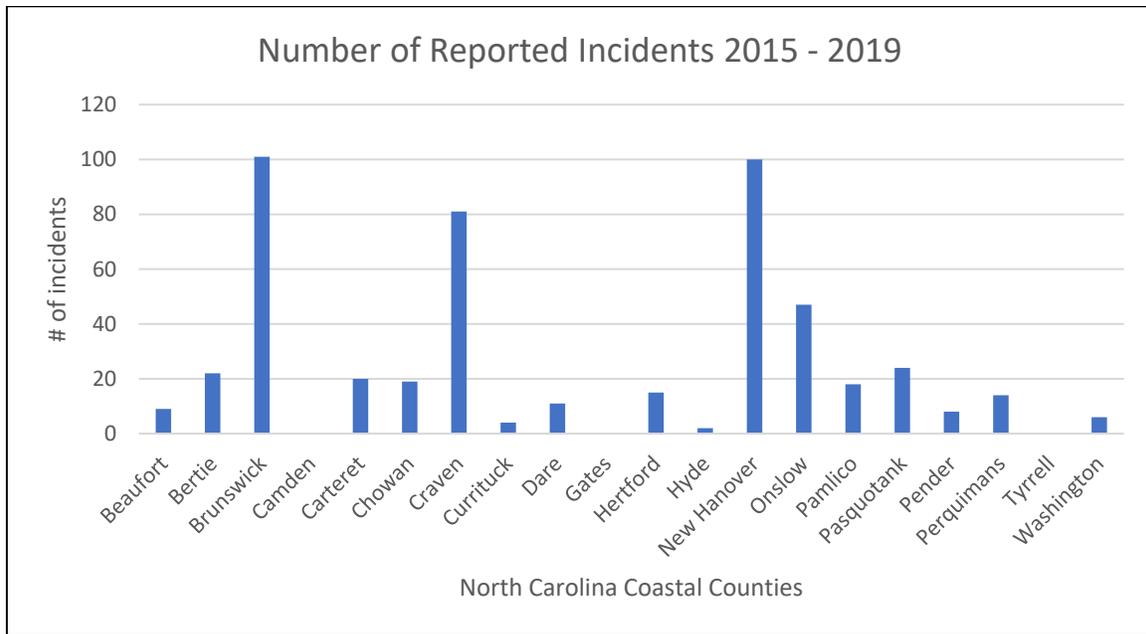


Figure 7.4. Number of reported sanitary sewer overflow (SSO) incidents by NC’s 20 coastal county, 2015-2019.

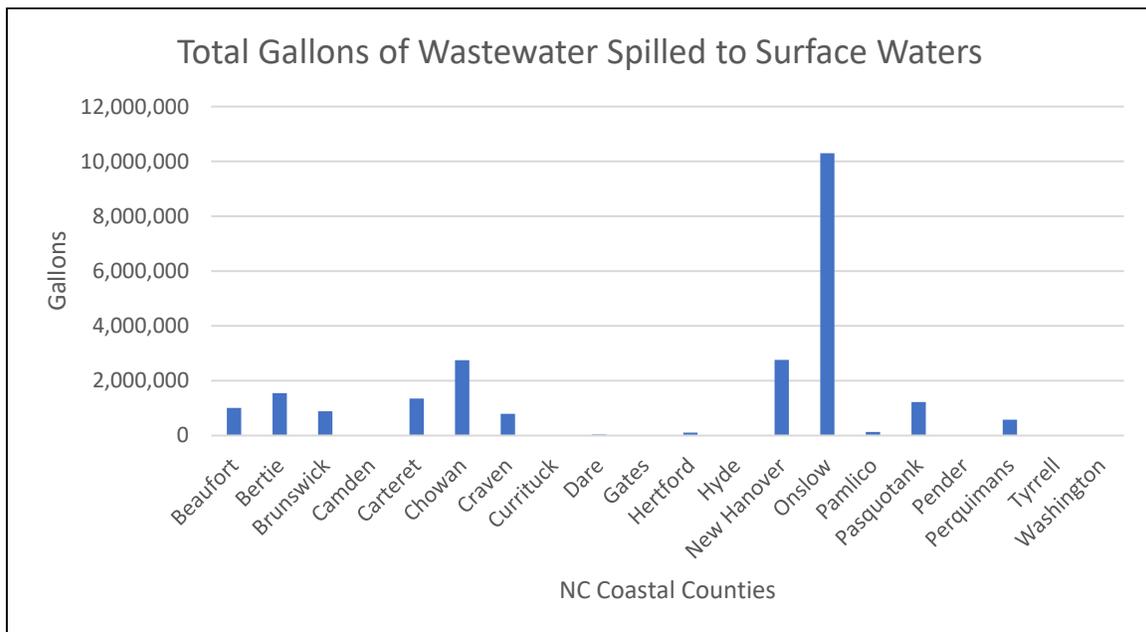


Figure 7.5. Estimated wastewater volume in gallons spilled to surface waters for NC’s 20 coastal counties, 2015-2019.

Data revealed that several coastal counties had no reports of SSOs over the five-year timeframe while other counties had what appear to be much higher instances of an SSO. Experience of DWR staff indicates that it is unlikely that no SSOs occurred in those counties reporting zero SSOs.<sup>4</sup>

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There can be many reasons a SSO is not reported or is failed to be identified; some examples include:

- Smaller collection systems may experience hydraulic loading for shorter duration and the operator is simply unaware of the occurrence.
- Problematic collection system segments can be in landscape positions where visual operations or reports from the public are infrequent due to lack of access.
- Some collection system operators actively seek out and target the identification of SSOs during severe precipitation events, other systems owners may have staffing issues that limit such proactive efforts.
- Operators and/or permittees of select systems may be unaware of the reporting requirements.

It is also the experience of DWR staff that counties with a higher population density and larger, more widely distributed collection systems tend to result in a higher likelihood of SSO incidents being reported. Both DWR and the permittee often receive notification of SSOs or a pump station alarm from adjacent homeowners and business. In addition, foot traffic along greenways having collection lines above ground results in routine and fast notification of infrastructure failures (SSOs). The identification and tracking of these events help target line cleaning and maintenance needs; Fat, Oil and Grease program implementation; and other I & I priorities.

Additional outreach, technical assistance, more intensive compliance oversight, and increased inspection frequency may result in a reduction in the number of SSO's and more accurate/robust reporting. The data provided are intended to help demonstrate the need to properly maintain, operate, and in some cases upgrade wastewater collection and treatment systems. Such action may result in fewer sewer spills to surface waters, resulting in less impact to receiving waters and coastal habitats.

Replacing leaky pipes is an expensive and disruptive process. There are several alternative methods to control leaks in collection systems. These include chemical grouting, Cured-In-Place-Pipe (CIPP) lining, fold-and-form-liner, and slip lining.<sup>17</sup> While these have the advantage of not requiring excavation, they have disadvantages, particularly they may not stop I & I, and are also relatively expensive.

Not all SSOs result in wastewater reaching surface waters. However, due to the vast hydrology of the NC Coastal Plain with numerous small creeks and ditches, it is likely that the sewage reaches surface waters directly or indirectly through runoff.<sup>18</sup> On a national scale, 10 percent of US beach/swimming closures and advisories in 2012 were attributed to sewage spills and overflows.<sup>19</sup> This category includes combined sewer overflows, SSOs, breaks or blockages in sewer lines, and faulty septic systems. Combined sewer systems, where stormwater and wastewater are transported together in the same collection lines, do not occur in NC. Stormwater runoff, including agricultural sources, was the largest known source contributing to closures and advisories. Despite not being the major contributor, the Natural Resource Defense Council (NRDC) report notes that wastewater spills are an increasing concern due to climate change and includes several strategies to improve the resiliency of wastewater infrastructure.

Sewer spills can impact swimming and shellfish harvest. From 2005 to 2019, data from Division of Marine Fisheries (DMF) Shellfish Sanitation Section indicates that there were 38 shellfish harvest closures and 19 recreational advisories reported due to SSOs (Table 7.4).<sup>20</sup> These numbers only include spills that resulted in a temporary shellfish closure or swimming advisory and are an underestimate of total sewage spills that reach coastal waters. The data does not include advisories and closures that occur in waters already closed, where the entire spill is within a restricted buffer zone around permitted WWTP discharges, or occurring during widespread closures associated with hurricane or major weather events.<sup>21</sup>

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Closures and advisories have been reported in ten counties from 2005 to 2019. Since 2012, closures and advisories have declined in part due to a concerted effort to improve wastewater infrastructure in counties or municipalities that had repeated problems in the early 2000s, such as New Hanover, Carteret, and Onslow counties. While sewer spills result in localized water quality issues, they account for less than one percent of shellfish closures and swimming advisories.<sup>21</sup>

Table 7.4. Recreational swimming advisories and shellfish harvest closures reported due to sanitary sewer overflows (SSO) in NC's 20 coastal counties, 2005-2019.<sup>20</sup>

Year	Recreational Swimming Advisories	Shellfish Harvest Closures
2005	4	5
2006	4	5
2007	4	4
2008	1	4
2009	1	4
2010	1	1
2011	3	2
2012	0	2
2013	0	2
2014	0	2
2015	0	1
2016	0	0
2017	0	2
2018	0	1
2019	1	3
Total	19	38

### 7.2.2 Economic Challenge

Problems with wastewater infrastructure contribute to a financial burden incurred by the sewer and wastewater system owner and economic impacts to the surrounding communities. Consequently, adequate funding and planning for proper maintenance and operation of wastewater infrastructure is sometimes not adequately provided. Increased flows associated with I & I result in increased volumes of wastewater to be managed and treated, translating into increased operational and system upkeep costs. In most cases, customers pay sewer fees based on the amount of water used over a time period or an established sewerage flat fee. Wastewater system owners may often be covering the added expense of managing, treating, and disposing of the additional volume of wastewater attributed to I & I while customers face increased rates. Because SSOs are not permitted, they are illegal and can result in regulatory agencies taking enforcement actions, which may include expensive fines when bodies of water cannot be used for drinking water, shellfish harvesting, fishing, or recreation, communities experience an economic loss. Remedial action may also be needed by owners in response to spills to minimize potential environmental impacts. The level of cost for such remedial response varies based on the characteristics of a spill. SSOs also impact local economies when they result in closure of beaches, impacting tourism and waterfront home values. Fishing and shellfish harvesting may be restricted or halted, in turn impacting production, supply, and distribution.

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Aging infrastructure, particularly in low income areas, reduced available federal funding, high cost of infrastructure repair and replacement, and lack of strong capital improvement plans (CIPs) or asset management plans collectively contribute to making this issue economically challenging.<sup>22</sup> Efforts to control I & I may be viewed as an ongoing continuous process, as opposed to a one-time project that will address all needs indefinitely into the future.

### 7.3 Discussion

Given the coastwide distribution of over 500 WWTPs, documented prevalence of I & I issues, and magnitude of SSOs, improvements to wastewater infrastructure are needed for long-term water quality management. This problem has been previously recognized multiple times as a priority to address. Since 2007 reducing pollution from wastewater infrastructure and treatment plants was listed as a habitat and water quality management action in five MFC Fishery Management Plans – Kingfishes (2007), Southern Flounder Amendment 1 (2013), Spotted Seatrout Revision (2014), Bay Scallop Amendment 2 (2015), and Striped Mullet Amendment 1 (2015).<sup>23, 24, 25, 26, 27</sup> The management actions were to aggressively reduce point source pollution from wastewater treatment facilities, improve maintenance of collection infrastructure, and establishment of additional incentives to local governments for wastewater treatment plant upgrading.

In 2006, the NC Rural Economic Development Center (NC Rural Center) released a series of reports, as part of a Water 2030 Initiative, with data on public infrastructure and water supply. It concluded that approximately \$17 billion in improvements were needed for water, sewer, and stormwater systems to keep pace with the growing population and repair of old infrastructure.

In 2010, a study on emerging estuarine issues was conducted by the NC Coastal Resources Law, Planning, and Policy Center, with financial support from Sea Grant and NOAA, and informational support from a steering committee.<sup>28</sup> The study was done in response to public requests following a 2009 Ocean Policy Study, thus providing a comprehensive study of emerging management and policy issues for the entire NC coast. The Estuarine Policy Steering Committee selected SSOs as one of four key emerging natural resource issues in the coastal counties. This was considered an emerging issue due to rapid development occurring on the inner coast and the expectation that infrastructure issues were likely to intensify with SLR. North Carolina is expected to be one of the top three most threatened areas from SLR in the US as more than 2,000 square miles of the coast are less than three feet in elevation.<sup>29</sup>

The report had several recommendations related to SSOs.<sup>28</sup> Two recommendations address “deemed permitted” collection systems. Deemed permitted collection systems are those with an average daily flow of less than 200,000 gallons per day (GPD) (15A NCAC 2T.0303). In the NC Department of Environmental Quality (DEQ) Washington Regional Office, approximately 50 percent of the wastewater systems were deemed permitted. One recommendation of the report was that the NC Environmental Management Commission (EMC) and DEQ revise rule 15A 02T.0403 to require that a minimum of 10 percent of a deemed permitted collection system’s lines be cleaned on an annual basis. This requirement exists for permitted systems but deemed permitted systems are exempt.

Regular cleaning of pipes can reduce SSOs. However, a better approach for these smaller systems would be to require collection lines be cleaned annually on a systematic basis (e.g., three to five years) reducing equipment mobilization cost.<sup>18</sup> Further, because a deemed permitted collection system is not covered under an individually issued collection system permit, discussion may be needed to establish a mechanism to better capture such a need and ensure that collection system owners are aware of such a requirement.

Another recommendation of the Estuarine Policy Steering Committee report was for the EMC and DEQ

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to modify rules to require municipal wastewater collection systems with 100,000 or more GPD have a certified operator as an Operator in Responsible Charge (ORC). Existing EMC rules do not require an ORC for collection systems deemed permitted. Having an ORC would ensure that a qualified operator was responsible for operating, inspecting, and maintaining the system, potentially reducing SSOs and identifying problems proactively. While more oversight by an ORC would be helpful, there is a shortage of licensed wastewater and collection system operators in coastal and other regions of the state, and therefore an expansion of facilities required to have a designated licensed wastewater collection system operator could be challenging for some operations. As such, further evaluation may be warranted to assess implications of expanding the number of sewer systems requiring oversight by licensed wastewater operators or develop appropriate criteria for deemed permitted systems where an ORC should be required. Criteria could include a maximum GPD, history of problems, vulnerability of lines, SLR and storms, and risk to high quality waters and valuable coastal habitat. During the interim evaluation period, provisions within rule 15A NCAC 2T .0403(c) provide a mechanism for the DWR to bring a deemed permitted collection system under an individual permit, in cases where it may be appropriate to do so. In cases where a deemed permitted sewer system experiences chronic compliance issues, including chronic SSOs, the operation may be required to apply for and come under an individual collection system permit. Conditions with the individual permit could provide a mechanism to require oversight of the system by a certified operator, as well as the necessity to conduct routine cleaning of sewer lines.

The report also recommended that the NC General Assembly put in place a dedicated fund for water and wastewater infrastructure maintenance and repairs. The report suggested establishment of a working group of experts to discuss and develop recommendations to address the issues associated with SSOs, as well as broader water and wastewater infrastructure issues, in NC's rural counties and municipalities. Finally, the report recommended that local governments focus on capital improvements planning and asset management planning, to aid in budgeting for improvements that will avoid and minimize the effects of wastewater collection system failures. While there is no dedicated funding for water and wastewater infrastructure operation and maintenance, some actions have since occurred to address the issues.

In 2013, the NC General Assembly, through G.S. 159G-70 created a nine-member State Water Infrastructure Authority (SWIA). Responsibilities include awarding both federal and state funding for water and wastewater infrastructure projects, establishing criteria to prioritize applications, and developing a state water infrastructure master plan. Additionally, the SWIA duties include assessing the state's water and wastewater infrastructure needs, evaluating the role of the state in funding needed infrastructure, assessing the adequacy of funding programs currently available to local governments and utilities and assessing the need for a troubled system protocol. The NC General Assembly also created the Division of Water Infrastructure (DWI) at that time to provide support to the SWIA.

Early in the SWIA work, it was realized that for the state to meet its water and wastewater infrastructure needs, it is crucial that individual utilities are, or are on a path to be, viable systems. Viability is defined as a system that functions as a long-term, self-sufficient business enterprise; establishes organizational excellence; and provides appropriate levels of infrastructure maintenance, operation, and reinvestment that allow the utility to provide reliable water services now and in the future, without reliance on grant funds. The SWIA addresses this and many other issues in its "Statewide Water and Wastewater Infrastructure Master Plan – The Road to Viability."<sup>22</sup>

The issue of I & I is more than just the physical condition and operation of a wastewater collection system. No matter how resilient and sustainable the physical infrastructure is, its ability to serve

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customers reliably for the long-term ultimately depends on decisions made by the owner – usually elected officials – about how system needs are identified and funded, and the skill level of its utility employees. For example, decisions about water and sewer rates and fees impact the amount of revenue generated by a utility and its ability to keep the system well-maintained and make needed repairs in a timely manner. Decisions made about staff training impact the operation of the infrastructure components and overall system. Decisions about communicating with customers about the critical nature of infrastructure affects customer’s understanding of and support for needed rates and fees. The organizational structure and management of a utility, from the elected officials to the operating staff, directly affects the quality of its physical infrastructure and its ability to maintain compliance.

Water and sewer utilities are intended to operate as self-sufficient business enterprises. As mentioned previously, this requires the ability to financially support the full cost of capital projects, replacement and renewal projects, as well as appropriate system operations and maintenance. Unfortunately, simply mandating utilities to fully fund infrastructure, operations and maintenance is not a realistic approach. As far as funding support, only a fraction of NC’s infrastructure needs can be met with the level of funding currently available from state and federal subsidized funding sources, and increased funds from these sources does not appear likely.

Many WWTPs and sewer systems in the state were constructed years ago either with revenue from a large manufacturing customer base or with the help of federal grant funds, both of which have diminished considerably. In 1970, over half of NC’s population lived in rural areas and supported farming and manufacturing including tobacco, furniture, and textiles. Today, the number and size of large water-using industries has declined and only one third of the state’s residents live in rural areas. Wastewater treatment plants and sewers in many rural areas, originally built for large flows from manufacturing facilities, are now oversized for the much smaller domestic flows that remain. These rural utilities are still burdened with the upkeep and operation of these large systems, but now lack the significant sources of revenue that once paid for such work. In addition to decreasing population and industrial customers, water usage overall is declining, which also reduces revenues.

Some small utilities have not raised rates in years and continue to defer needed rehabilitation of their aging infrastructure. Other small utilities have worked to replace this revenue by raising water and sewer rates, and, as a result, some of the smallest, most economically distressed communities have some of the highest water and sewer rates in the state. These rates are unaffordable and unsustainable in the long-term. The US Environmental Protection Agency (EPA) recognizes that pricing decisions involve consideration of equity as well as efficiency. Low-income households, especially those served by high-cost systems, may face affordability problems if prices are raised.<sup>30</sup> The growing issue of water and wastewater service affordability is also being elevated by the American Water Works Association and the Water Environment Federation.<sup>31</sup> Small utilities also face requirements to meet more stringent water quality regulations, especially regarding nutrient sensitive waters, which increases costs.

The SWIA recognizes that viability issues result from many different circumstances that are specific to each utility and require approaches tailored to individual needs. However, when utilities are not viable or are not on a path to become viable, other possible courses of action must be explored. The DWI administers the following two grant programs that provide funding designed to help utilities take the first steps toward viability:

- Asset Inventory and Assessment (AIA) Grants - support a utility as it examines the purpose and value of its infrastructure, and the processes it uses to determine when and how to spend infrastructure dollars. Outcomes include identifying the most critical projects and the ability to demonstrate and explain why they are critical, which will help gain support from governing

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bodies, customers, and stakeholders to make the needed investments. Funds are provided for a utility to:

- Identify the water and wastewater infrastructure components that comprise its water and wastewater systems.
- Create an asset inventory.
- Determine the condition of these assets.
- Prioritize the most critical infrastructure needs.
- Develop a capital improvement plan (CIP) to fund the projects.
- Merger/ Regionalization Feasibility Grants - investigate voluntary partnerships, such as consolidating two or more systems into one, that can result in improvements to physical infrastructure and organizational and financial management.

These options are best utilized in a proactive manner and well before a utility's infrastructure and financial situation become critical.

In addition to the above grants, permanent solutions can also be created when elected officials and utility governing boards explore potential advantages of a range of partnership solutions that might include regionalization, consolidation, shared management opportunities, contract operations, interlocal agreements, public-private partnerships, privatization, and other activities or arrangements; and Utilities reach out to other entities such as the NC Rural Water Association, Southeast Rural Community Assistance Project, regional NC Councils of Government, Department of State Treasurer, University of North Carolina at Chapel Hill School of Government Environmental Finance Center, the NC League of Municipalities, the NC Association of County Commissioners and the DWI to understand infrastructure issues and develop potential options.

The SWIA also administers other grant and loan programs to support construction of needed infrastructure repairs or modifications:

- Clean Water State Revolving Fund – provides low-interest loans to local governments to fund wastewater collection and treatment facility projects including the relocation of infrastructure outside of the 100-year and 500-year floodplains. Loans are also available for stormwater quality improvement projects, such as BMPs and stream restoration
- State Wastewater and Drinking Water Reserve Programs – provides grants and loans for wastewater treatment and collection systems as well as drinking water treatment and distribution systems
- Community Development Block Grant (Infrastructure) – provides grants to local governments to address wastewater infrastructure needs in HUD qualified low to moderate income communities

On July 1, 2020, Session Law (SL) 2020-79, "An Act to Improve the Viability of the Water and Wastewater Systems of Certain Units of Local Government..." was signed by Governor Cooper. SL 2020-79 requires review of local government units to determine if they are distressed due to issues in their water or wastewater enterprise fund and provides for a new Viable Utility Reserve (VUR) grant fund. Several units of local government in coastal areas will likely be designated as distressed due to issues with their water/wastewater systems.

The goal of SL 2020-79 is to facilitate comprehensive, permanent solutions for distressed water or wastewater utilities through a process framework and grant funding to accomplish the solutions. Both the SWIA and the Local Government Commission of the Office of State Treasurer must approve the use of VUR grant funds. However, the initial appropriation of only \$9 million for the VUR fund supports just the beginning of this process. A secure, reliable, on-going, and increased source of funding is needed for

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the long-term success of the new program. From January 2014 to September 2020, the SWIA has awarded more than 900 projects, totaling approximately \$1.9 billion to Local Government Units (LGUs). In 2019-2020, a total of \$182 million of grant and loan funding was awarded, excluding the drinking water project funding.<sup>32</sup> Funding programs included 18 projects from the Community Development Block Grant-Infrastructure, 31 projects from the Asset Inventory and Assessment grant program, 10 from the Merger/Regionalization Feasibility Grants, 31 from the Federal-State Clean Water State Revolving Fund, and four from the State Wastewater Reserve. While this is a substantial amount of assistance, the DWI continues to receive more grant and loan funding requests from throughout the state than are available.

The 2020 Resilience Plan also recognized failing infrastructure and SSOs as a growing concern to coastal water quality.<sup>33</sup> Climate change issues that can impact wastewater infrastructure include SLR, extreme heat, inundation and rainfall events, increased temperatures, flooding, storm surge, and dam failure. Flooding associated with extreme storm events can result in increases in I & I and more frequent SSO events. The frequency and magnitude of extreme storm events is expected to increase due to climate change and cause lift stations to flood and break down. Loss of power during storm events can also cause operation issues resulting in SSOs at wastewater treatment plants or lift stations.

To improve ecosystem and community resiliency, the plan suggests that state and local governments utilize policies or rules to encourage siting development, WWTPs, and other pollution sources away from riparian areas and floodplains. Also, utilities can continue to flood-proof assets such as WWTPs and upgrade sewer infrastructure to reduce the risk of I & I and SSO. The plan notes that improving wastewater management and maintaining wastewater infrastructure can help reduce the loading rates of nutrients and sediments into estuaries, resulting in more resilient conditions for submerged aquatic vegetation (SAV), other fish habitats, and coastal communities. When WWTPs are inundated and infrastructure is damaged, available federal funding could be utilized as much as possible to repair and reduce future flood risks. The plan sites a near-term priority as identifying and voluntarily moving WWTPs out of the floodplains.

The plan recommends that immediate focus is needed to develop strategic priorities for public and natural infrastructure improvements. Future climate conditions and resiliency should be integrated into current public investment decisions in local and regional water and transportation infrastructure improvements and other critical assets. By building resilience into infrastructure, risks for small businesses and communities are lowered.

As part of the EPA's Creating Resilient Water Utilities (CRWU) initiative, APNEP conducted the Climate Resilience Evaluation and Awareness Tool Exercise with the towns of Manteo and Columbia. Potential impacts of rising sea levels on wastewater infrastructure were examined using the EPA Climate Risk Evaluation and Assessment Tool (CREAT). The report provides engineering and financial recommendations for realistic measures the towns might take to improve their resiliency to coastal hazards and flooding to consider for integration into their capital improvement planning processes.<sup>34</sup>

For many years, NRDC has provided an annual analysis of water quality by state. To deter increasing SSOs due to increasing SLR, extreme rain events, and flooding, NRDC recommended that wastewater utilities immediately implement climate-smart strategies, similar to what was recommended in the 2020 Resilience Plan.<sup>19,33</sup> In addition to flood-proofing and relocating high-risk facilities where possible, other strategies included:

- Update water and wastewater emergency response and maintenance procedures to prepare for more common and more extensive coastal flooding of vulnerable infrastructure.

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- Plan for alternative power supplies to support operations in case of loss of power.
- Install effluent pumping systems for wastewater treatment plants affected by SLR and ensure the adequacy of emergency generator systems.
- Until vulnerable facilities can be relocated, build berms as a short-term protective measure.

The DWR emphasizes to utility owners the need for proper operation and maintenance of sewer lines to prevent many SSOs, but this also requires funding. Maintenance includes routinely inspecting sewer lines and cleaning them at a frequency sufficient to address blockages from grease and fat, roots, and pipe deflections. Smoke testing, dye testing, and using cameras are examples of tools that can be used to detect sources of broken lines, obstructions, and illicit connections.

In 2017, as an incentive to correct illicit discharges from wastewater infrastructure, DWR approved a new nutrient reduction practice, “Design Specifications and Nutrient Accounting for Remedying Illicit Discharges to Surface Waters or Stormwater Systems”.<sup>35</sup> Illicit discharges were defined to include SSOs caused by I & I during wet weather, sewage leakage out of the pipe (exfiltration) during dry periods, and sanitary direct connections. Nutrient credits can be received for remedying such problems for compliance with applicable Nutrient Management Strategy Rules. This would only be applicable in NSW watersheds. Further information regarding Nutrient Practices and Crediting, as well as topics including Stormwater Nutrient Accounting Tools, Approved Nutrient Reduction Practices, and Nutrient Offset and Trading information maintained by DWR can be found [here](#).<sup>36</sup>

### 7.4 Recommended Actions

Charging and assessing fees to customers at rates necessary to cover costs, including long-term expenses that may require extensive re-investment in the system when components have reached or exceeded their life cycle expectancies, seems like a commonsense approach. However, as discussed previously, many communities cannot afford the increase that would be required to do this. The State Water and Wastewater Infrastructure Master Plan includes increasing regional planning, incentives for regionalization, consolidation of failing systems, and increasing customer assistance programs.<sup>22</sup> The CHPP supports these approaches are supported to address this challenging issue.

In 2020, the NCDWI annual report therefore included the following recommendations:<sup>32</sup>

- Request adequate and recurring state appropriated funds needed for the viable utility reserve.
- Request the NC General Assembly modify legislation to allow SWIA flexibility in establishing grant conditions for programs under their authority, to ensure grant funds are used to help systems achieve long-term viability.

Other studies have also recognized the significance of this issue and provided recommendations. Most recently, the 2020 NC Climate Risk Assessment and Resilience Plan (2020 Resilience Plan) recommended wastewater infrastructure improvements be addressed for coastal resiliency.<sup>33</sup> Expanding funding ability from current state level resources is clearly needed to protect water quality and increase coastal community resiliency. The CHPP Steering Committee strongly supports the NCDWI and 2020 Resilience Plan recommendations, as well as the following recommendations.<sup>32</sup>

#### 7.4.1 Policy

- 7.1 By 2024, DEQ will request that funding programs under the purview of the SWIA give additional priority for projects with a direct benefit to sensitive estuarine waters, including SA waters, fish nursery areas, and impaired waters, particularly those adversely impacting estuarine fish and their habitat.
- 7.2 By 2025, DWR will develop additional incentives to encourage improved maintenance of the

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collection system (e.g., incentivize owners and operators of wastewater lines for both existing systems and potential new systems to adopt construction designs that minimize the potential for sewer spills over the long-term).

- 7.3 By 2025, DCM and DWR will work with NC Office of Recovery and Resiliency (NCORR) and local governments in the coastal counties to develop strategies regarding flood-proofing wastewater infrastructure; siting new and relocating existing infrastructure away from sensitive estuarine waters and floodplains; upgrading sewer infrastructure; and develop strategic priorities for public and natural infrastructure improvements.

### 7.4.2 Potential Rulemaking

- 7.4 By 2023, DWR will evaluate modifications of EMC rules to require deemed permitted collection systems under select criteria (e.g., 100,000 or more GPD) to have a certified operator as an Operator in Responsible Charge (ORC). DWR shall provide an update on this evaluation effort to the Water Quality Committee in approximately one year.
- 7.5 By 2023, DWR will investigate modification of EMC rules to require deemed permitted collection systems to be cleaned annually on a systematic basis (e.g., 3 to 5 years). The DWR shall provide an update on this evaluation effort to the Water Quality Committee in approximately one year.

### 7.4.3 Research

- 7.6 Prioritize research on alternative wastewater collection system designs that may be better suited for coastal conditions (i.e., alternative sewer systems, composting toilets).
- 7.7 Evaluate the feasibility of re-designing and re-engineering existing systems that are inadequately protecting ground and surface water quality.

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- <sup>22</sup> NCDWI (North Carolina Division of Water Infrastructure). 2017. *NC's statewide water and wastewater infrastructure master plan. The road to viability*. North Carolina Department of Environmental Quality. Raleigh, NC. 104 p. [https://files.nc.gov/ncdeq/WI/Authority/Statewide Water and Wastewater Infrastructure Master Plan 2017.pdf](https://files.nc.gov/ncdeq/WI/Authority/Statewide%20Water%20and%20Wastewater%20Infrastructure%20Master%20Plan%202017.pdf)
- <sup>23</sup> NCDMF (North Carolina Division of Marine Fisheries). 2007. *North Carolina kingfish fishery management plan*. North Carolina Department of Environment and Natural Resources. Division of Marine Fisheries. Morehead City, NC. 243 p.
- <sup>24</sup> NCDMF (North Carolina Division of Marine Fisheries). 2013. *Amendment 1 to the North Carolina southern flounder fishery management plan*. North Carolina Department of Environment and Natural Resources. Division of Marine Fisheries. 380 p.
- <sup>25</sup> NCDMF (North Carolina Division of Marine Fisheries). 2014. *North Carolina spotted seatrout fishery management plan*. North Carolina Department of Environment and Natural Resources. Division of Marine Fisheries. Morehead City, NC. 360 p.
- <sup>26</sup> NCDMF (North Carolina Division of Marine Fisheries). 2015. *Amendment 2 to the North Carolina bay scallop fishery management plan*. North Carolina Department of Environment and Natural Resources. Division of Marine Fisheries. Morehead City, NC. 193 p.
- <sup>27</sup> NCDMF (North Carolina Division of Marine Fisheries) 2015. *Amendment 1 to the North Carolina striped mullet fishery management plan*. North Carolina Department of Environment and Natural Resources. Division of Marine Fisheries. Morehead City, NC. 388 p. <https://files.nc.gov/ncdeq/Coastal%20Management/documents/PDF/opscreport.pdf>
- <sup>28</sup> Albemarle-Pamlico Conservation and Communities Collaborative. 2009. *Public listening sessions report: sea level rise and population growth in NC*. Report 29. 62 p. <https://digital.ncdcr.gov/digital/collection/p249901coll22/id/639601>
- <sup>29</sup> <https://www.epa.gov/sustainable-water-infrastructure/pricing-and-affordability-water-services#affordability>
- <sup>30</sup> <https://www.awwa.org/Resources-Tools/Resource-Topics/Affordability>
- <sup>31</sup> NCDWI (North Carolina Division of Water Infrastructure). 2020. *Report on the water infrastructure fund and state water infrastructure authority. Fiscal year 2020*. North Carolina Department of Environmental Quality. Raleigh, NC. 183 p.
- <sup>32</sup> NCDEQ (NC Department of Environmental Quality). 2020. *NC Climate Risk Assessment and Resilience Plan. Impacts, vulnerability, risks, and preliminary actions. A comprehensive strategy for reducing North Carolina's vulnerability to climate change*. Raleigh, NC.
- <sup>33</sup> USEPA (United States Environmental Protection Agency) 2013. *Climate Resilience Evaluation and Awareness Tool Exercise with Manteo and Columbia, North Carolina and the Albemarle-Pamlico National Estuary Partnership*. EPA 817-B-13-002.E PA Office of Water (4608-T). 32 p.
- <sup>34</sup> NCDWR (North Carolina Division of Water Resources). 2017. *Memorandum on the Approval of Remedying illicit discharges nutrient reduction practice*. Department of Environmental Quality Raleigh, NC. <https://files.nc.gov/ncdeq/Water%20Quality/Planning/NPU/Nutrient%20Offset%20Rule/Remedying%20Illicit%20Discharges%20Practice%20Signed%2004%2005%202017.pdf>
- <sup>35</sup> <https://deq.nc.gov/about/divisions/water-resources/planning/nonpoint-source-management/nutrient-offset-information#about-nutrient-offsets-and-trading>

### 8. COASTAL HABITAT MAPPING AND MONITORING TO ASSESS STATUS AND TRENDS

#### 8.1 Issue

An understanding of the status and trends of NC's six coastal habitats, and the ability to monitor them over time, is needed to assess both the long-term changes to the habitats and the causative effects. Comprehensive mapping and monitoring of all of NC's coastal habitats is needed to quantifiably measure the necessity and success of management actions and restoration efforts. Adequate spatial coverage and resolution can inform protection and restoration efforts and can provide indicators of larger changes in the system that may need to be investigated in the future.<sup>1</sup> Various levels of mapping and monitoring of the six coastal habitats occur in NC. However, more unified, robust, and standardized approaches would increase the ability to report on the health of NC's coastal ecosystem including detecting change and potential causation. This approach will better inform protection and restoration efforts and support current or potential management actions. The need for rapid habitat assessment to facilitate habitat restoration and protection has been recognized by the Coastal Habitat Protection Plan (CHPP) since its inception.<sup>2</sup> Building from this, generating metrics for assessing habitat trends was a priority issue in the 2016 CHPP.<sup>3</sup> While some progress was made, the purpose of this paper is to advance standardized and regular monitoring of NC's coastal habitats.

#### 8.2 Background

The Fisheries Reform Act of 1997 (G.S. 143B-279.8) specifies that the CHPP identify threats and recommend management actions to protect and restore habitats critical to NC's coastal fishery resources. The legislative goal of the CHPP is *"...the long-term enhancement of coastal fisheries associated with coastal habitats."* The statute specifies the plan must include evaluation of the status and trends of fish habitat. A species' use of specific areas can depend on various factors, including life stage, time of day, and tidal stage. Together, these habitat areas form a functional and connected system that supports the fish from spawning until death. Because of the interconnectedness and functions that each habitat provides, the status of one habitat can affect others. Within NC's coastal ecosystem, six habitat types were distinguished: water column, shell bottom, submerged aquatic vegetation (SAV), wetlands, soft bottom, and hard bottom.

Recognizing the problems caused by degradation and destruction of the environment and identifying the causes, both natural and human induced, is essential in raising public awareness. Yet, this is only the starting point for environmental management.<sup>4</sup> Coastal resource managers have to consider the complex interactions between and within the coastal habitats, the estuarine ecosystems as a whole, and the human population creating the need for standardized monitoring and assessments of these habitats. The primary purpose of monitoring is to collect information that can be used for development of policy, examine the outcomes of management actions, and guide management decisions (Kull et al. 2008).<sup>5</sup> Habitat monitoring at local to regional scales is essential given their vulnerability to human pressures and those associated with climatic fluctuation.<sup>6</sup>

To quantifiably achieve the main goal of the CHPP, the status and trends of these six coastal habitat types must be monitored over time to assess long-term changes. This information can then be used, not only to educate the public on the condition of the coastal habitats, but also to inform protection and restoration decisions and evaluate and adapt management actions and strategies (Figure 8.1).

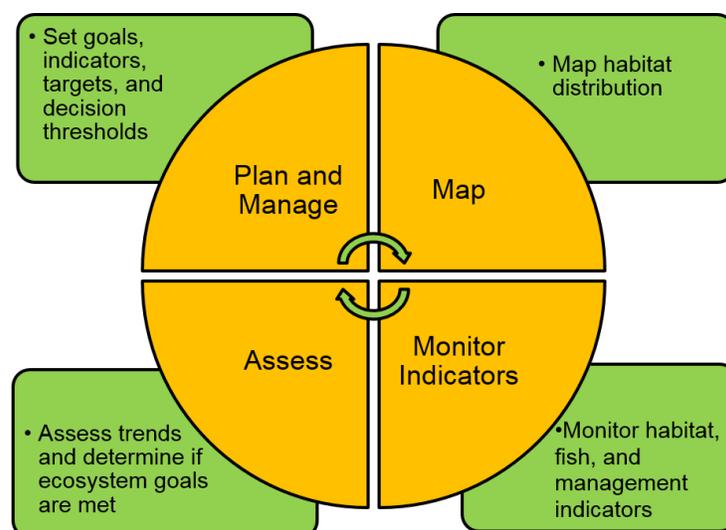


Figure 8.1. The role of monitoring in successful habitat management.<sup>7</sup>

The integration of social and ecological information relevant to stakeholders and managers is an essential component when trying to reach management goals and remediate environmental impacts.<sup>8</sup> The 2016 CHPP recognized this and the need to incorporate ecosystem-based management (EBM) into coastal resource conservation strategies.<sup>3</sup> The following management options were proposed:

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

Ecosystem based management is a shift away from a limited or partial consideration of the interactions of the natural systems and society. The emphasis of EBM is: 1) factoring in complex linkages in social-ecological systems; 2) dealing with adequate scales (both spatially and temporally); 3) promoting adaptive management of complex and dynamic systems; and 4) adopting integrated assessment and management frameworks.<sup>9</sup> While the concept of EBM has been widely accepted and research into social-ecological systems has provided a very promising direction for improved environmental management, to date there has been limited progress in incorporating such practice into large scale policy.<sup>4</sup> This is evident in the implementation of the above proposed management options. Although notable implementation progress has been made in developing indicators for assessing fish use of strategic habitat areas (for additional information, see **Chapter 2. Implementation Progress 2016-2020**), substantial work is still needed on the proposed management options to develop indicator metrics and performance criteria. Therefore, a first step in understanding ecosystem level trends is to assess individual habitat status and trends.

While there are permanently funded programs for monitoring fish and water quality, programs for continuous monitoring and assessment of the coastal habitats are very limited or absent due to lack of funding for long-term data collection not directly related to agency mission statements and regulatory compliance. The description, distribution, ecological role, and functions of the six coastal habitats can be

## Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends

found in the 2016 CHPP source document. The following details the most up to date status and trends for each of the six coastal habitats using the most current and available monitoring data. For additional information on SAV and wetlands, see **Chapter 4. Submerged Aquatic Vegetation Protection and Restoration Through Water Quality Improvements** and **Chapter 5. Wetland Protection and Restoration through Nature-Based Solutions** issue papers.

### **8.2.1 North Carolina's Coastal Habitats Mapping and Monitoring**

#### Water Column

The water column habitat is defined as “water covering a submerged surface and its physical, chemical, and biological characteristics”.<sup>2</sup> The chemical and physical properties of the water affect the biological components of the water column - including fish distribution. The water column is the medium through which all aquatic habitats are connected and is therefore critical to the overall health of the ecosystem.

Water quality describes the condition of waters based on selected physical, chemical, and biological characteristics, usually with respect to its suitability for a particular purpose such as drinking, recreation, or supporting aquatic life. Fish species and other organisms, such as SAV and oyster that also provide fish habitat, exhibit threshold tolerances. Conditions of the water column that are outside the threshold tolerance are considered impaired, polluted, or otherwise not supporting aquatic life. Basic parameters of water impairment include: pH, temperature, dissolved oxygen (DO), turbidity, bacteria, and chlorophyll *a*. Additional parameters impacting water quality include nutrients, such as nitrogen and phosphorous. However, currently there are no nutrient standards used to assess for water quality impairment. Excessive nutrient-rich sediment from land-based activities can exacerbate eutrophication, decreasing DO and water clarity and increasing toxic contamination. Therefore, flow and movement play a vital role in distributing the drivers of eutrophication and chemical pollution.

#### 2010 National Coastal Condition Assessment (NCCA)

A national assessment, the United States Environmental Protection Agency (EPA) 2010 National Coastal Condition Assessment (NCCA) found in the Southeast Coastal region (NC to FL), 21 percent of the coastal area is in good condition based on the water quality index, 69 percent is in fair condition, and nine percent is in poor condition (Figure 8.2).<sup>10</sup> Ratings for chlorophyll *a* and phosphorus contribute most to the region's fair and poor water quality scores. Between the 1999 to 2001 and the 2005 to 2006 reporting periods, the Southeast coastal region that was rated good based on the water quality index declined significantly by 27 percent (Figure 8.3). Dissolved oxygen and water clarity seem to be primary drivers for this decrease in quality. Between the 2005 to 2006 and the 2010 reporting periods, there was a modest increase in the percent area rated good based on the water quality index. A significant rise in the percent area rated good for dissolved oxygen and water clarity conditions and a small but significant change in nitrogen conditions contributed to the improvement in 2010.

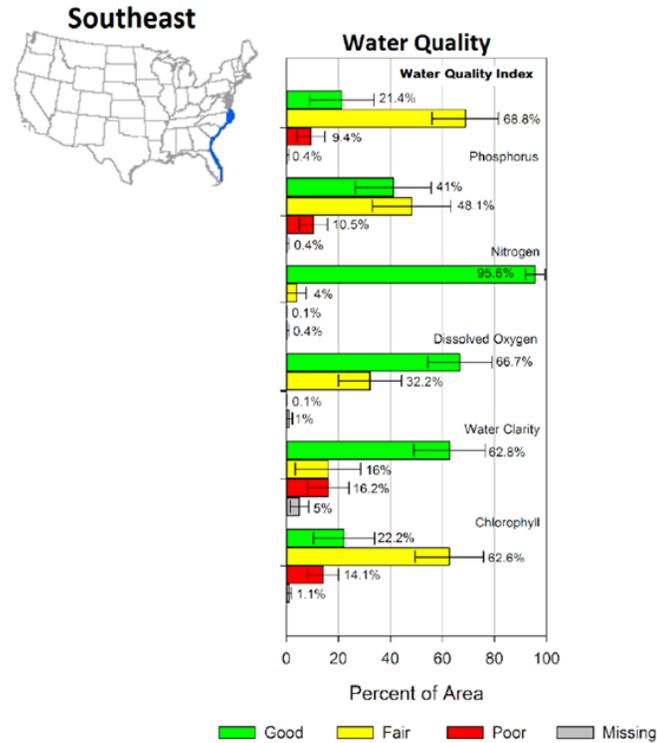


Figure 8.2. The United States Environmental Protection Agency (EPA) National Coastal Condition Assessment (NCCA) 2010 water quality index results for the Southeast Coastal region. Bars show the percent of coastal area within a condition category for specific indicators. Error bars represent 95 percent confidence intervals. Note: The sum of percent of area for each indicator may not add up to 100 percent due to rounding.<sup>10</sup>

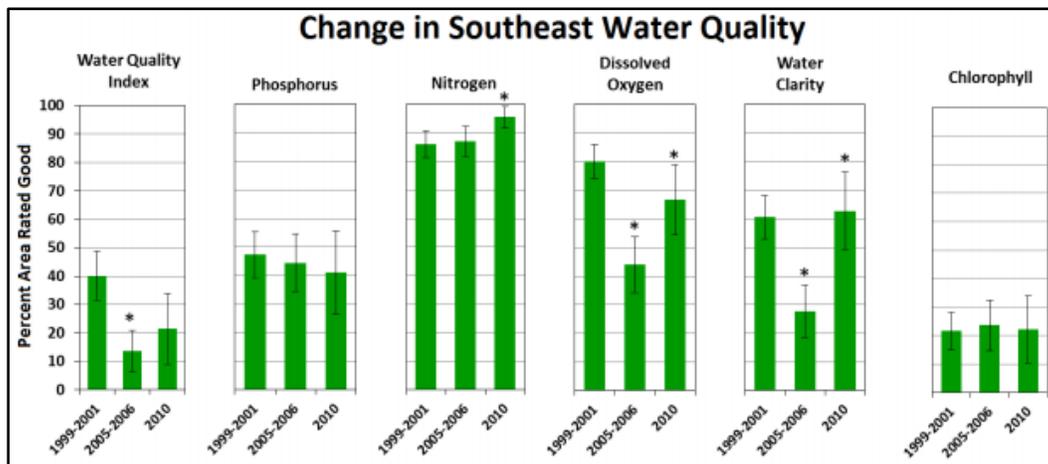


Figure 8.3. The United States Environmental Protection Agency (EPA) National Coastal Condition Assessment (NCCA) 2010 comparison of the percent area rated good for water quality indicators over three periods in the Southeast Coast. Note: Asterisks (\*) indicates statistically significant change between periods.<sup>10</sup>

## Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends

### *North Carolina Division of Water Resources (DWR) Ambient Monitoring System (AMS)*

The DWR is the primary water quality monitoring agency in NC. Surface waters in NC are assigned a classification reflecting the uses of that waterbody (e.g., water supply, shellfish harvest, primary recreation, aquatic life, agriculture). To determine how well waterbodies are meeting their best-intended uses, chemical, physical, and biological parameters are regularly assessed by DWR. The assessment of water quality in NC, known as the Integrated Report (IR) is required under Sections 303(d) and 305(b) of the Clean Water Act and is completed biennially.<sup>11</sup> This assessment indicates the general condition of NC's waters and identifies waters that are not meeting water quality standards where sufficient data exists. The impaired waters (acres and miles) listed in the 2018 IR are shown in Table 8.1 by region and for the overall coast.

Table 8.1. The impaired waters (acres and miles) listed in the 2018 Integrated Report by Coastal Habitat Protection Plan (CHPP) regions. Percent of waters assessed in parentheses.

	2018 Integrated Report Impaired Waters				
	Region 1	Region 2	Region 3	Region 4	Overall
Freshwater (ac)	15,600 (42%)	0.0 (0.0%)	0.0 (0.0%)	289 (67%)	15,889 (34%)
Freshwater (mi)	43 (5%)	304 (18%)	12.4 (14%)	123 (9%)	482 (12%)
Saltwater (ac)	349,699 (43%)	204,534 (15%)	47,597 (6%)	16,470 (42%)	618,300 (20%)
Atlantic Coast (mi)	0.0 (0.0%)	0.0 (0.0%)	0.6 (0.4%)	0.0 (0.0%)	0.6 (0.2%)

Several of DWR's water quality management activities use data produced by the Ambient Monitoring System (AMS). The AMS consists of a network of stations established to provide site-specific, long-term water quality information on significant waterbodies throughout the state (Figure 8.4). The program has been active for over forty years and is used in development of the IR, Basinwide Water Resources Plans, Total Maximum Daily Loads (TMDLs), and National Pollutant Discharge Elimination System (NPDES) permit limits. Active stations are visited at least quarterly for the collection of a variety of physical, chemical, and bacterial pathogen samples and measurements. Stations monitoring water quality are concentrated in riverine and upper estuarine waters. Currently there are 329 active stations, 149 of which are within the coastal boundaries of the CHPP regions. Water quality data (e.g., chlorophyll *a*, nutrients, pH, dissolved oxygen (DO), and turbidity) from a representative 18 DWR AMS stations throughout the CHPP regions are shown in Figure 8.4 and summarized graphically by year in Figures 8.5-8.8. The graphs are not statistical trends or meant to show standard exceedance, but are generated to show general trends over the years. These sites were also summarized in the 2016 CHPP.<sup>3</sup>

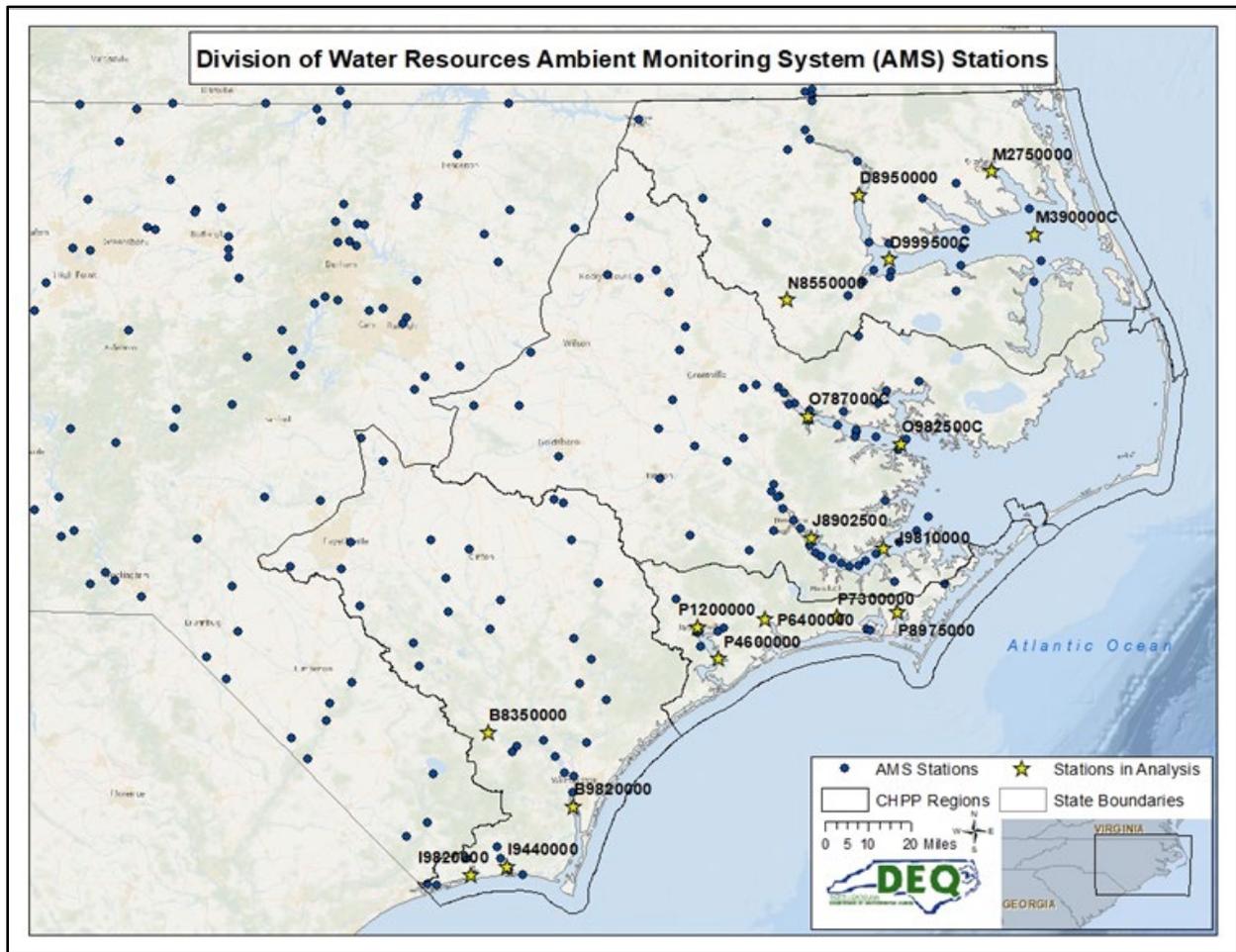


Figure 8.4. The NC Division of Water Resources (DWR) Ambient Monitoring System (AMS) Stations. Stars indicate stations used in analysis.

#### *Ambient Monitoring System (AMS) Coastal Habitat Protection Plan (CHPP) Region 1*

The five selected stations in CHPP Region 1 include:

- Roanoke River near Williamston (N8550000)
- Chowan River near Colerain (D8950000)
- Albemarle Sound near Edenton (D9995000)
- Albemarle Sound near Frog Island (M3900000)
- Pasquotank River near Elizabeth City (M2750000; Figure 8.4)

Annual mean water quality data indicate:

- Total phosphorus (TP) levels are higher in the rivers versus Albemarle Sound.
- Total nitrogen (TN) is increasing in all the stations, the Pasquotank River showed higher concentrations especially during the wetter years.
- Turbidity data show peaks during wetter years and higher concentrations in the Roanoke River.
- High and low DO levels may indicate the growth and crash of algal production within these waterbodies. The low DO in the Roanoke and Pasquotank is due to excess swamp drainage during wet years.

## Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends

- Median pH levels fluctuate at each station with the levels not indicating any extended periods of standard exceedance. The Roanoke and Pasquotank are influenced by swamp water draining into these systems which can result in naturally low DO and pH levels.
- Chlorophyll *a* concentrations indicate that the mean concentration is increasing throughout this region. A dramatic increase was identified in the Chowan River at the Colerain station (D8950000) from 2010 to 2015 where summer nuisance algal blooms were documented during this time. The Albemarle Sound near Frog Island station (M390000C) has been variable but steadily increasing since the early 2000s (Figure 8.5).



Photo Credit: NCWetlands.org



Figure 8.5. Annual median total phosphorus (mg/L), total nitrogen (mg/L), turbidity (NTU), DO (mg/L) concentrations, and pH values, and mean chlorophyll *a* (µg/L) concentrations for representative Ambient Monitoring System (AMS) stations in Coastal Habitat Protection Plan (CHPP) Region 1.

*Ambient Monitoring System (AMS) Coastal Habitat Protection Plan (CHPP) Region 2*

The four selected stations in CHPP Region 2 include:

- Pamlico River mid-channel at the mouth of Brad Creek near Bunyon (O787000C)
- Pamlico River mid-channel between the mouths of the Pungo River and Goose Creek (O982500C)
- Neuse River near Thurman (J8902500)
- Neuse River near Oriental (J9810000; Figure 8.4)

## Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends

Annual mean water quality data indicate:

- Data from the two upper and lower estuary stations show similar patterns over the years.
- The graphs clearly show higher nutrient levels in the upper estuary, whereas dilution and biological uptake has occurred resulting in lower concentrations of TP and TN at the lower estuarine stations.
- The median TN concentrations are clearly increasing over the 21-year period.
- Chlorophyll *a* concentration has remained fairly consistent over this time period with elevated concentrations at the upstream station and a significant spike in the 2014 annual mean concentration of 117 µg/L at the Neuse River J8902500 station. A prolonged period of elevated biological productivity occurred between July and December 2014. The chlorophyll *a* concentration ranged between 55-780 µg/L, with a mean concentration of 206 µg/L (Figure 8.6).



Photo Credit: Joe Facendola

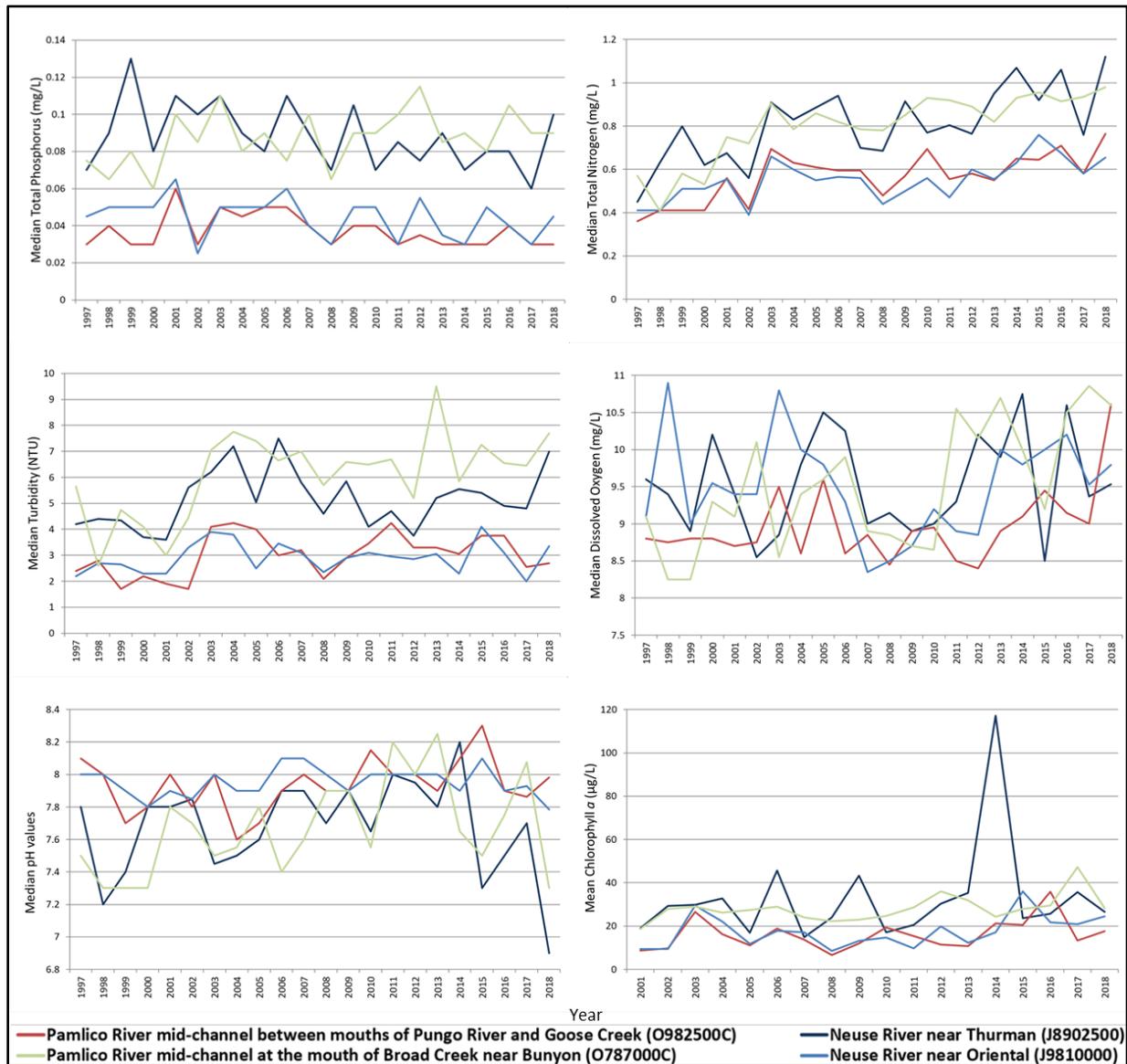


Figure 8.6. Annual median total phosphorus (mg/L), total nitrogen (mg/L), turbidity (NTU), DO (mg/L) concentrations, and pH values, and mean chlorophyll  $a$  ( $\mu\text{g/L}$ ) concentrations for representative Ambient Monitoring System (AMS) stations in Coastal Habitat Protection Plan (CHPP) Region 2.

*Ambient Monitoring System (AMS) Coastal Habitat Protection Plan (CHPP) Region 3*

The five selected stations in CHPP Region 3 include:

- North River near Bettie (P8975000)
- Newport River near Newport (P7300000)
- White Oak River near Stella (P6400000)
- New River near Jacksonville (P1200000)
- New River upstream of French Creek (P4600000; Figure 8.4)

## Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends

Annual mean water quality data indicate:

- Nutrient data were only collected at the New River stations; these data show much higher concentrations near Jacksonville than downstream in the New River estuary.
- This is generally reflected in the chlorophyll *a* biological response with higher mean concentrations at the New River near Jacksonville station (P1200000). Higher concentrations can occur downstream when flows are high enough to limit the productivity upstream due to stream flows limiting for algal bloom development.
- Turbidity data show much higher concentrations in the North River near Bettie station (P8975000) than in other coastal rivers.
- DO and pH levels are much lower at the Newport River near Newport station (P7300000) than other coastal stations (Figure 8.7).



Photo Credit: Nolen Vinay

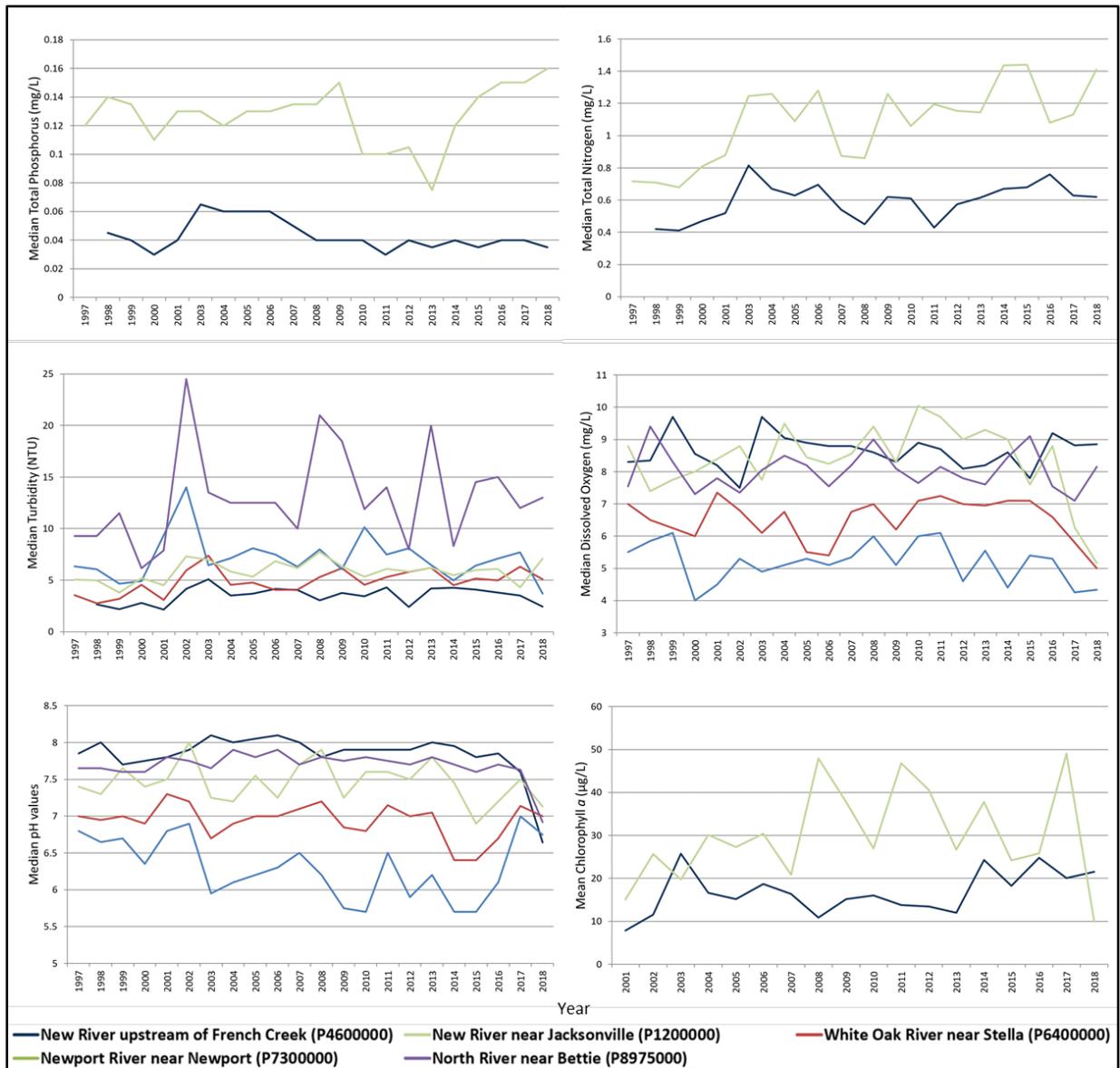


Figure 8.7. Annual median Total Phosphorus (mg/L), total Nitrogen (mg/L), Turbidity (NTU), DO (mg/L) concentrations, and pH values, and mean chlorophyll *a* (µg/L) concentrations for representative Ambient Monitoring System (AMS) stations in Coastal Habitat Protection Plan (CHPP) Region 3.

*Ambient Monitoring System (AMS) Coastal Habitat Protection Plan (CHPP) Region 4*

The four selected stations in region 4 include:

- Cape Fear River near Kelly (B8350000, below lock and dam #1)
- Cape Fear River near Wilmington (B9820000)
- Lockwood Folly near Varnum (I9440000)
- Shallotte River near Shallotte (I9820000; Figure 8.4)

## Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends

Annual mean water quality data indicate:

- Nutrient data were only collected at the Cape Fear River stations with the higher concentration data indicated in the upstream station.
- The upstream Cape Fear River station (B8350000) also shows a larger range of turbidity concentrations.
- Lower pH conditions in the Cape Fear River stations are likely the result of swamp drainage influence (Figure 8.8).

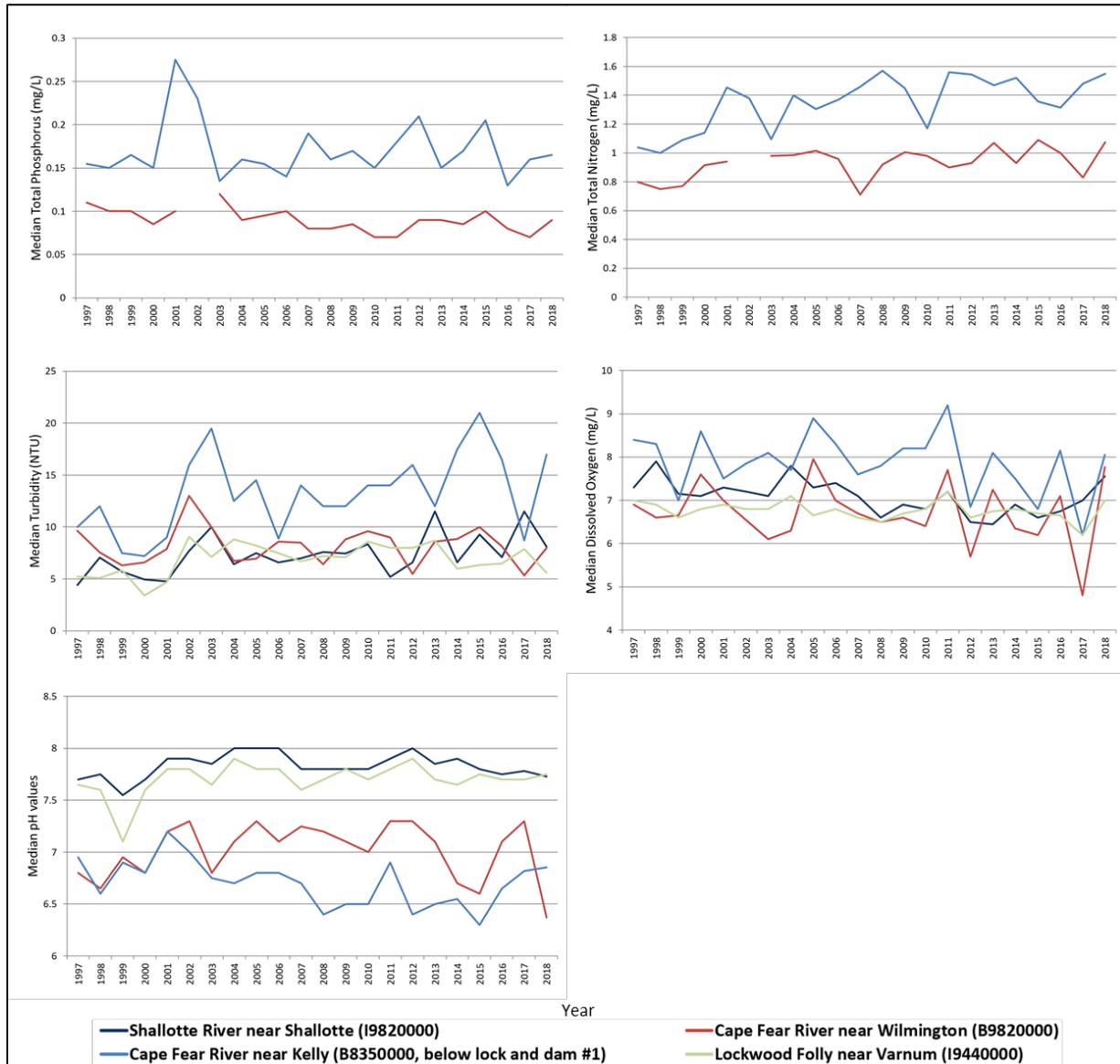


Figure 8.8. Annual median total phosphorus (mg/L), total nitrogen (mg/L), turbidity (NTU), DO (mg/L), and pH values, and mean chlorophyll *a* ( $\mu\text{g/L}$ ) concentrations for five representative Ambient Monitoring System (AMS) stations in Coastal Habitat Protection Plan (CHPP) Region 4.

## Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends

There is a general trend of increasing nutrients and chlorophyll *a* coastwide, in almost every CHPP region. This is especially evident in the upstream AMS stations. Increases in turbidity, especially during wet years, are also being observed. Eutrophication and decreased water clarity due to increased turbidity, not only degrade water quality, but can lead to algal blooms and fish kills, as well as having detrimental effects on other coastal habitats such as SAV and oysters.

Toxic chemical contamination is not evaluated by DWR in estuarine and nearshore ocean waters. The current standards do not completely eliminate risk from toxins because: (1) values are not established for many toxic chemicals, (2) mixtures and breakdown products are not considered, (3) effects of seasonal exposure to high concentrations have not been evaluated, and (4) some potential effects, such as endocrine disruption and unique responses of sensitive species, have not yet been assessed.

### Nutrient Sensitive Waters

Nutrient Sensitive Waters (NSW) is a supplemental classification intended for waters needing additional nutrient management due to excessive growth of microscopic or macroscopic vegetation. Currently, there are no water quality standards for nutrients, except 10mg/L nitrate for drinking water; nutrient enrichment is presently measured by chlorophyll *a* response in the water column. Four basins carry the supplemental classification of NSW, including all waterbodies in the Tar-Pamlico, Neuse, and Chowan river basins, and the New River in the White Oak Basin (i.e., Onslow Bay Basin). Nutrient Sensitive Waters are subject to nutrient reduction strategies for wastewater discharge limitations (T15A NCAC 2B .0223), and different nutrient management strategies, including stormwater and agriculture, as well as riparian buffer protection (15A NCAC 02B .0700 - .0715) are in place to help reduce nutrient loads in these waterbodies.

### *Chowan Nutrient Sensitive Waters Strategy*

Algal blooms and subsequent fish kills in the Chowan River led to its NSW classification in 1979, with a nutrient control plan in 1982 calling for a basinwide reduction of 35 percent TP and 20 percent TN. Implementation to reduce nutrient loads by point sources included limits of 1 mg/L TP and 3 mg/L TN, and the conversion of many municipal point source discharges to land application non-discharge systems resulted in improved water quality. The basin was a priority for implementation of agriculture BMPs, reducing nutrient runoff. Data through 2012 did not indicate chlorophyll *a* levels exceeding standards in the Chowan River. The nutrient measures taken did result in water quality improvements for almost 30 years. During that time period, an increase in SAV occurred, an indicator of improved water quality.

However, since about 2015, the Chowan River has experienced a resurgence in recurrent summer algal blooms and harmful algal bloom (HAB) activity. Harmful algal blooms are those that produce toxic or harmful effects on people, aquatic organisms, or birds. These HABs have occurred mainly south of Harrellsville (near AMS station D8356200) down to the Edenhouse Bridge (near AMS station D9490000). Many of the blue-green algal bloom species detected have been identified as potentially harmful, such as *Dilochospermum* and *Microcystis*. The blooms evaluated in 2019 were widespread throughout the Chowan River system but were most intense from Indian Creek (Dillard Millpond) downstream to Rockyhock Creek. These intense blooms were associated with elevated microcystin cyanotoxin concentrations. In response, DEQ has issued press releases “urging the public to avoid contact with the green or blue water in the Chowan River due to algal blooms that have lingered in the area”.

The central Chowan River near Colerain is tracked by DWR as a coarse gauge of productivity trends for the basin. For the current draft Chowan River Basinwide Plan, DWR compiled biannually tabulated five year statistics for this station beginning in 2016; the results are provided in Table 8.2.<sup>12</sup>

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Table 8.2. Chowan River near Colerain, chlorophyll *a* (chl *a*) Integrated Report (IR) Summaries for IR 2016, 2018, IR 2020 (Draft) and IR 2022 (Partial; Missing Year 2020).

	Integrated Report Period			
	2016	2018	2020 (Draft)	2022* (Partial)
Mean chl <i>a</i> conc. ( $\mu\text{g/L}$ )	7.6	9.2	18.6	24.9
Number of samples	50	45	45	33
Number > 40 $\mu\text{g/L}$ chl <i>a</i>	1	2	4	5
% > 40 $\mu\text{g/L}$	2	4.4	8.9	15.2
Integrated Report date window	2010-2014	2012-2016	2014-2018	2016-2020

\*The data as of June 2020 for the partial 2022 IR is for 2016-2019. It is missing data for 2020. Final 2022 IR values will be different than what is presented here.

The DWR also analyzed longer-term temporal trends in nutrient loading for the current draft Chowan Basinwide Plan. While most nutrient parameters were generally unremarkable, a pronounced upswing was evident in total kjeldahl nitrogen (TKN) concentrations, which is total concentration of organic nitrogen and ammonia, and loads since about 2000 across most watersheds. The Chowan River Colerain station results are provided in Figure 8.9 as illustrative of this TKN phenomenon, which is attributed to the organic nitrogen fraction.

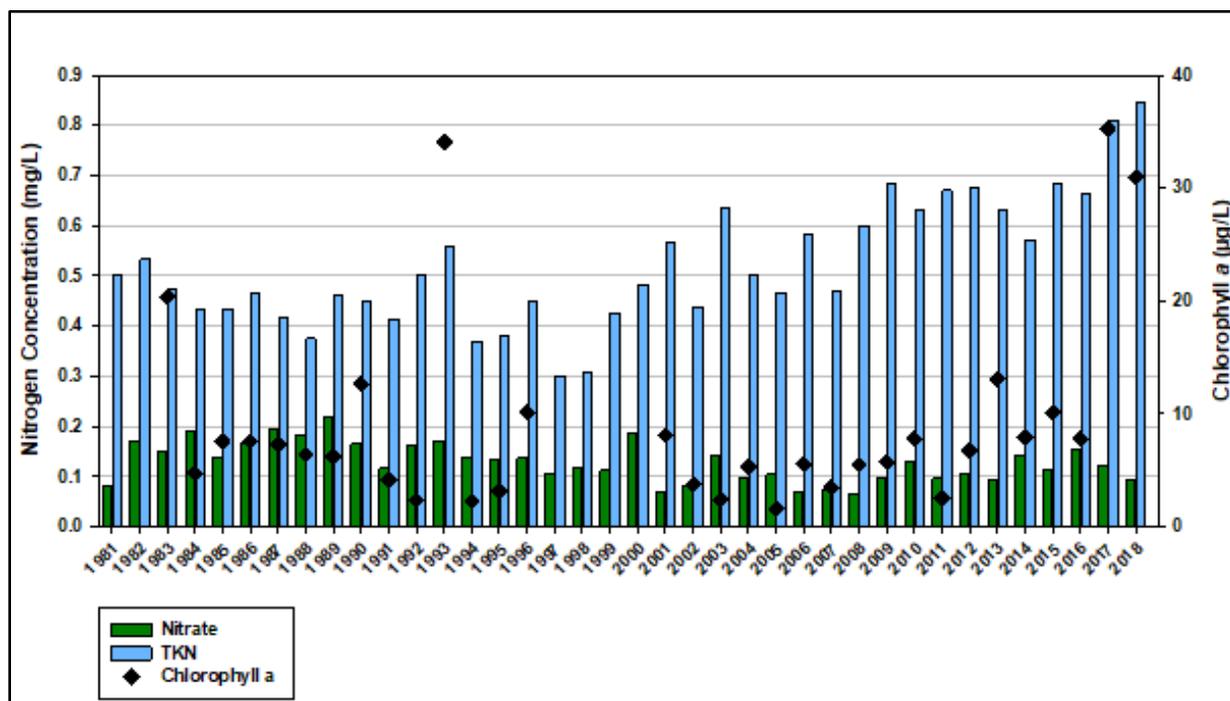


Figure 8.9. Annual mean total kjeldahl nitrogen (TKN), nitrate and chlorophyll *a* concentrations at the Chowan River near Colerain Ambient Monitoring System (AMS) Station (D8950000).

### Tar-Pamlico Nutrient Sensitive Waters Strategy

The Tar-Pamlico Basin was classified as NSW in 1989. The basin has a TMDL goal to help meet chlorophyll *a* standards in the Pamlico estuary. Water quality data are assessed at Grimesland (O65600000) along the Tar River to determine whether or not nutrient levels in the Tar-Pam Basin are meeting standards, including reductions of 30 percent TN and not increasing TP from the 1991 baseline

## Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends

data. Trend analysis of the nutrient parameters data from 1991 to 2016 at Grimesland indicate an increase in TKN and TN flow-normalized loads (Figure 8.10). The organic nitrogen increase wholly offsets earlier decreases in nitrate loading. Interestingly, the flow-normalized TP loads showed a pronounced and unexplained rise and fall since 2010 (Figure 8.11).

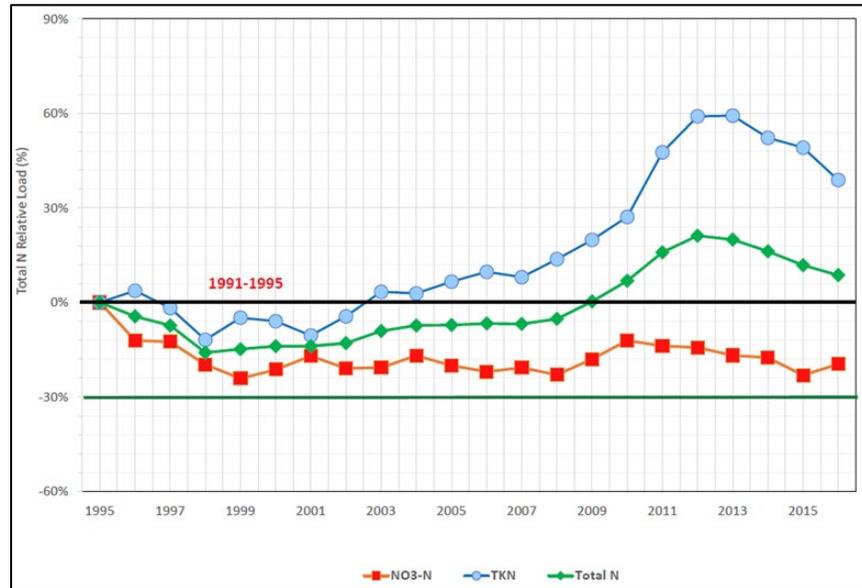


Figure 8.10. Flow-normalized nitrogen loads, at the Tar River at Grimesland Ambient Monitoring System (AMS) Station (O65600000; Percent Change vs. 1991 to 1995).



Figure 8.11. Flow-normalized total phosphorus loads, at the Tar River at Grimesland Ambient Monitoring System (AMS) Station (O65600000; Percent Change vs. 1991 to 1995).

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Nutrient loading is flow dependent, with levels falling below baseline only during extreme low flows. The Tar-Pamlico and Neuse river basins indicate a rise in TKN, specifically organic nitrogen. The USGS LOAD ESTimator (LOADEST) tool was used to estimate TN and TP annual load time series at the compliance point in the Tar-Pamlico basin (NCDWR unpublished). Load assessments are impacted by precipitation as seen in 1996 (Hurricane Fran), 1999 (Hurricane Floyd) and 2003 (unusually wet year). The annual load time series of the Tar-Pamlico River at Grimesland shows that the load fell below the targeted TMDL goal of 3,000,491 lbs/yr in 2007, 2008, 2011. The LOADEST TP annual load time series at the same station fell below the targeted TP load of not-to-exceed 396,832 lbs/yr in 2007, 2008, 2010 and 2011. These were drought years as seen by the low flow at the USGS gage station.

### *Neuse Nutrient Sensitive Waters Strategy*

The Neuse River Basin was classified as NSW in 1988. Data for the Neuse River TMDL requiring a 30 percent decrease in TN load from the 1991-1995 baseline is assessed at Ft. Barnwell. Data from 1991-2011 indicate decreasing trends in TN, TP, NH<sub>3</sub> and NO<sub>x</sub> concentrations, and an increase in concentrations of TKN. Portions of the Neuse River Estuary remain impaired due to nutrient enrichment.

Like the Tar-Pamlico, the Neuse river basins indicate a rise in TKN, specifically organic nitrogen, and the LOADEST tool was used to estimate TN at the Neuse River compliance point. Load assessments are impacted by precipitation as seen in 1996 (Hurricane Fran), 1999 (Hurricane Floyd) and 2003 (unusually wet year). The annual load time series for the Neuse River at Fort Barnwell indicates that only during the low flow years of 2001, 2002, 2005, 2007, 2008, 2011 and 2012 does the TN load at the compliance point fall below the TMDL target of <6,750,000 lbs/yr of TN.

The DWR's longer-term trend analysis, normalizing for the effects of flow, shows an upswing in organic nitrogen loading very similar to the other coastal watersheds since around 2000, as captured in TKN values. Figure 8.12 illustrates this trend above the estuary near Fort Barnwell. Again, organic nitrogen loading increases wholly offset early nitrate decreases.

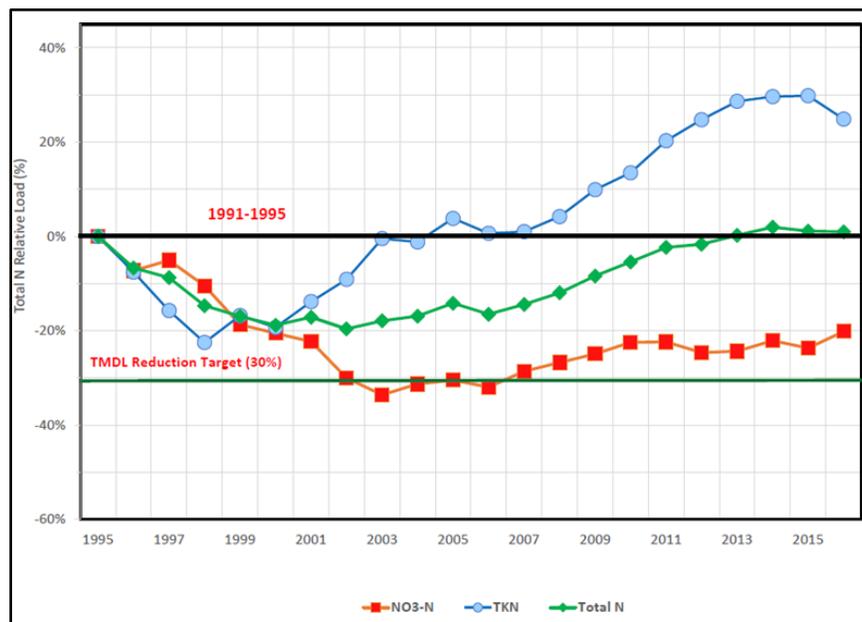


Figure 8.12. Flow-normalized nitrogen loads, Neuse River at Fort Barnwell Ambient Monitoring System (AMS) Station (Percent Change vs. 1991 to 1995).

### *New River Nutrient Sensitive Waters Strategy*

The New River was classified NSW in 1991. The strategy to reduce point source nutrients to the upper estuary include: TP and TN limits on existing discharges, and monitoring for TN and TP for facilities without limits. It was recommended that no new discharges be permitted, and expansions of existing facilities only be allowed if there is no increase in loading of oxygen-consuming waste. Ambient water quality data through 2018 indicate nutrient enrichment is still a problem in the upper New River Estuary resulting in continued excursions of the chlorophyll *a* standard (Figure 8.13). The DWR White Oak River Basin Plan will be completed in 2021 and will include additional water quality assessments and possible recommendations to address nutrient contributions to the New River Estuary. The point source reduction only strategy has not resulted in sufficient nutrient reductions in the estuary. There is a need to understand the overall load reductions achieved from point sources and to initiate nutrient reductions from all nonpoint sources in the watershed.

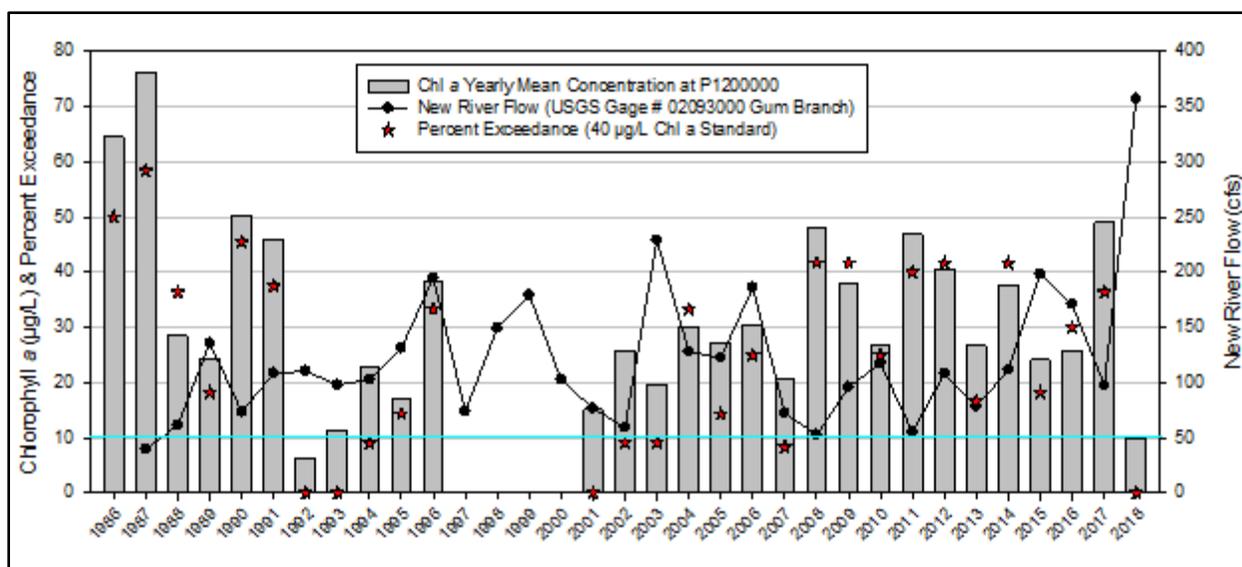


Figure 8.13. Annual mean chlorophyll *a* concentrations at the New River at Jacksonville US 17 Bridge Ambient Monitoring System (AMS) Station (P1200000) with corresponding percent exceedance of the 40 µg/L chlorophyll *a* standard and annual mean New River flow (blue line denotes the 10% excursion level).

### *Nutrient Criteria Development Plan*

The DWR is currently revisiting nutrient-related water quality criteria statewide in accordance with the Nutrient Criteria Development Plan (NCDP).<sup>13</sup> The plan was adopted in 2014 and last revised in 2019. The goal is to develop scientifically defensible criteria based on the linkage between nutrient inputs and the protection of designated uses. The first priority is to evaluate nutrient criteria for one specific water body within each of the three water body types. The development of these site-specific criteria will occur for the following water bodies in this order: 1) Reservoir/Lake - High Rock Lake, 2) Estuary – Chowan River/Albemarle Sound, and 3) River/Stream - Middle Cape Fear River.

Evaluation of nutrient-related criteria for the Chowan River and Albemarle Sound is currently underway. An initial evaluation process and identification of research needs were coordinated by the Albemarle-Pamlico National Estuary Partnership (APNEP) with a phase I report documenting those interim findings

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in 2018. The DWR, Scientific Advisory Council (SAC) members, and academic partners are currently filling those research gaps and continuing with the evaluation of nutrient criteria in this region. Both the APNEP phase I report and more recent input from the SAC have identified linkages between potential nutrient-related criteria and the protection of water column and submerged aquatic vegetation habitats. For additional information, see **Chapter 4. Submerged Aquatic Vegetation Protection and Restoration through Water Quality Improvements.**

### *Fish Kills and Algal Blooms*

Algal blooms occur when specific environmental conditions are met, such as increased nutrient (nitrogen and phosphorus) concentrations, increased water temperature, prolonged solar radiation, and stagnant water flows. These conditions can cause algae to grow rapidly (“bloom”), thus creating negative effects in the system, including decreased DO, increased pH levels, and fish kills. They are aesthetically unappealing and if comprised of HABs, can impact health of humans and aquatic organisms. Not all algal blooms result in fish kills, and they are not the only cause of hypoxic conditions, however they are often related.

The number of reported algal bloom events along the NC coast varied annually from 2015 through 2019. During this time, the number of reported blooms reached a maximum in 2015 with 50 events and a minimum in 2017 with 25 events. Blooms are either reported by concerned citizens through the algal bloom reporting app or by DWR staff during routine monitoring. As with fish kills, investigations of bloom reports depend on the availability of field and laboratory staff to collect and analyze the samples. Even when an investigation does not occur, suspected bloom reports are recorded to help analyze overall trends in algal activity across the state.

Certain types of algae are also known to produce various taste and odor compounds as well as toxins, which can harm aquatic organisms, humans, and terrestrial animals that interact with the contaminated water (e.g., dog drinking, bird feeding). DWR has the capabilities to test for Microcystin, a common toxin produced by bloom-forming algae known as cyanobacteria. In particular, the Chowan River and portions of the Pasquotank River basin including the Albemarle Sound have experienced algal blooms since the 1970s. Blooms in these systems have increased in recent years, prompting DWR to begin evaluation of numeric nutrient criteria for the systems.

In 2019, DWR investigated 13 fish kill events across NC and provided reports under its investigation protocols (Figure 8.14).<sup>14</sup> In addition, 64 sightings of fish kills or algal blooms were reported by the public to DWR via its online app. Some public sightings were accounted for in DWR reports, but much of the public information remained unconfirmed by DWR staff members. Confirmed and unconfirmed activity was reported during the year in 12 of the state’s 17 major river basins and in 35 counties. Fish kill information for the current year is posted weekly from June to November on the DWR fish kill [website](#).<sup>15</sup>



Figure 8.14. Fish kill activity reported to NC Division of Water Resources (DWR) in 2019.

During 2019, DWR received 65 reports of fish kill or algal bloom activity from the public often via the mobile app (Figure 8.14).<sup>14</sup> Developed in 2016, the app has proven useful in notifying regional staff of possible fish kill activity and as a means for initial contact with regards to dead fish and related algal bloom sightings. Public reports were reviewed and forwarded as soon as possible to the appropriate regional office staff for further investigation. Less available oxygenated waters, termed habitat compression, has resulted in increased fish mortality in NC, due to algal bloom events as well as hurricanes, potentially pushing fish into less suitable habitat conditions or making them more vulnerable to predation. Habitat compression may be associated with a 10-50 percent worldwide decline of pelagic predator diversity.<sup>16</sup> Increasing occurrence of hypoxic or anoxic waters is problematic for the coastal habitats and the organisms that call them home. Fish kill and algal bloom activity can be reported through the [website](#) or the Hotline #: (800) 858-0368.<sup>17</sup>

### *Shellfish Sanitation and Recreational Water Quality (SSRWQ)*

Various sections of DMF, including Fisheries Management, Habitat Enhancement, and Shellfish Sanitation and Recreational Water Quality (SSRWQ), also collect water quality data within the CHPP regions. The SSRWQ is responsible for monitoring and classifying coastal waters as to their suitability for shellfish harvesting and monitoring and issuing advisories for coastal recreational swimming areas. The Shellfish Sanitation Program is conducted in accordance with the guidelines set by the Interstate Shellfish Sanitation Conference (ISSC) contained in the National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish Model Ordinance. The NSSP is administered by the US Food and Drug Administration and is based on public health principles to prevent human illness associated with the consumption of molluscan shellfish. To fulfill this purpose, the SSRWQ section performs water sampling at 968 shellfish growing area (SGA) stations.

All SGAs are surveyed every three years to document all existing or potential pollution sources, to assess the bacteriological quality of the water, and to determine the hydrographic and meteorological factors that could affect water quality. Water samples are collected at least six times a year from each SGA and are tested for fecal coliform bacteria, which are an indicator that human or animal wastes are present in the water. In addition, reviews of SGA bacteriological data and pollution sources are conducted annually. This information is then used to classify each SGA as either approved, conditionally approved open/closed, restricted or prohibited. Approved areas are consistently open to shellfish harvest while

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prohibited areas are permanently closed (Table 8.3). Conditionally approved areas can be open to shellfish harvest under certain conditions. An area's status can change quickly due to temporary closures after significant rainfall resulting in runoff, high results during routine bacteriological sampling, or an unexpected pollution event (ex. sanitary sewer overflow). For additional information, see **Chapter 7. Wastewater Infrastructure Solutions for Water Quality Improvement Issue Paper**. The area remains closed until water sampling indicates a return to acceptable bacteria levels. Restricted waters can be used for harvest at certain times as long as the shellfish are subjected to further cleansing before they are made available for consumption. For the most up to date closures, refer to the Shellfish Sanitation Temporary Closure [Public Viewer](#).<sup>18</sup>

Table 8.3. Classification of shellfish growing areas (SGAs) in acreage from 2007-2020 from the NC Division of Marine Fisheries' (DMFs') Shellfish Sanitation and Recreational Water Quality Section (SSRWQ).

Year	Open Area		Closed Area		
	Approved	Conditionally Approved Open	Conditionally Approved Closed	Prohibited	Restricted
2007	1,732,069	45,699	11,775	429,475	NA
2008	1,734,339	43,184	12,793	428,685	NA
2009	1,734,192	43,281	12,788	428,739	NA
2010	1,734,938	43,054	12,552	428,414	NA
2011	1,734,938	43,054	12,552	428,414	NA
2012	1,732,888	44,599	12,708	428,835	NA
2013	1,733,069	44,649	11,834	429,531	NA
2014	1,733,155	44,261	11,827	429,796	NA
2015*	1,418,373	43,849	11,739	745,169	NA
2016	1,416,960	44,785	12,008	745,597	NA
2017	1,414,709	44,425	12,209	747,759	NA
2018**	1,414,525	44,122	11,859	729,761	18,933
2019	1,414,877	43,217	12,721	730,550	20,260
2020	1,416,179	42,857	10,138	735,791	18,658

\*314,710 acres administratively closed on 2/4/15 due to budget cuts and office closures.

\*\*First year of use for Restricted classification. Previously these waters were included in our Prohibited classification.

While changes in acreage closed to shellfish harvest is one useful indicator of water quality trends, the number and duration of temporary harvest closures due to contamination associated with rainfall and stormwater runoff is another useful metric to examine (Table 8.4). These temporary closures can have a significant impact on the shellfish industry due to their unpredictability and length, and the number of closure days has been trending upwards in recent years due to increasing annual rainfall and coastal development. For example, research on the upper Newport River, which is home to several popular natural shellfish reefs as well as a number of shellfish aquaculture leases, has found that bacteria levels in this portion of the river often exceed the standards for safe shellfish harvesting following rain events totaling one inch or more within a 24-hour period. The current management plan for this area dictates that this portion of the river be closed following these rain events, and it remains closed until sampling indicates that bacteria levels have once again fallen to below safe harvest standards. Over the last five years (2016-2020), this portion of the river has been closed for an average of 168 days per year, although in 2016, 2018, and 2020, the Newport River watershed received well above average annual rainfall, and in these three years, portions of the harvesting area were closed for 198, 232, and 194 days,

respectively.

Table 8.4. Temporary Shellfish Growing Area (SGA) closures due to rainfall in the upper Newport River based on estimated annual rainfall in Morehead City (MHC), NC.

Year	Est. Annual Rainfall - MHC	Number of Closures	Total Days Closed	Avg. Closure Duration (Days)
2010	55.74	6	75	13
2011	48.34	6	58	10
2012	56.41	10	91	9
2013	54.69	10	141	14
2014	71.65	12	136	11
2015	82.47	11	163	15
2016	70.13	11	198	18
2017	52.47	12	109	9
2018	85.97	14	232	17
2019	51.99	12	107	9
2020	68.65	11	194	18

The NC Recreational Water Quality Program began testing coastal waters in 1997 with the mission to protect the public health by monitoring the quality of NC’s coastal recreational waters and notify the public when bacteriological standards for safe bodily contact are exceeded. The coastal waters monitored include the ocean beaches, sounds, bays, and estuarine rivers. The program tests water at 204 swimming sites approximately weekly during the swimming season from April through September. Similar to the Shellfish Sanitation Program these samples are tested for bacteria; general water quality parameters are also recorded. Instead of fecal coliforms, these samples are tested for *Enterococcus* bacteria, an indicator organism found in the intestines of warm-blooded animals. While it will not cause illness, its presence is correlated with organisms that can and it survives better in the higher salinities associated with the ocean beaches.

Additional monitoring for water quality and swimming advisories are collected by NGOs and academics along the coast. For example, Sound Rivers publishes weekly water alerts (<https://soundrivers.org/swimguide/>) and the Lower Cape Fear River program publishes yearly reports on the water quality of the Lower Cape Fear Watersheds (<https://uncw.edu/cms/aelab/lcfrp/>).

### Other Water Quality Monitoring

The DMF has over 20 different sampling programs with coastwide spatial cover. Most DMF programs were already collecting abiotic environmental variables, such as temperature, salinity, DO, depth, sediment and bottom composition. In 2009, DMF modified monitoring programs to ensure those parameters were being accurately recorded, and to collect additional habitat metrics such as secchi depth, and shoreline alteration. While these are point in time measurements, they can be useful for looking at long-term averages. For example, DMF program data, along with the AMS data and data provided by Wildlife Resources Commission (WRC), were used to make interpolated salinity maps for high, mean, and low flow years from 1988 to 2017 (Figures 8.15-8.24). High and low flow years were determined if the yearly mean was +/- two standard deviations from the time period mean.<sup>19</sup>

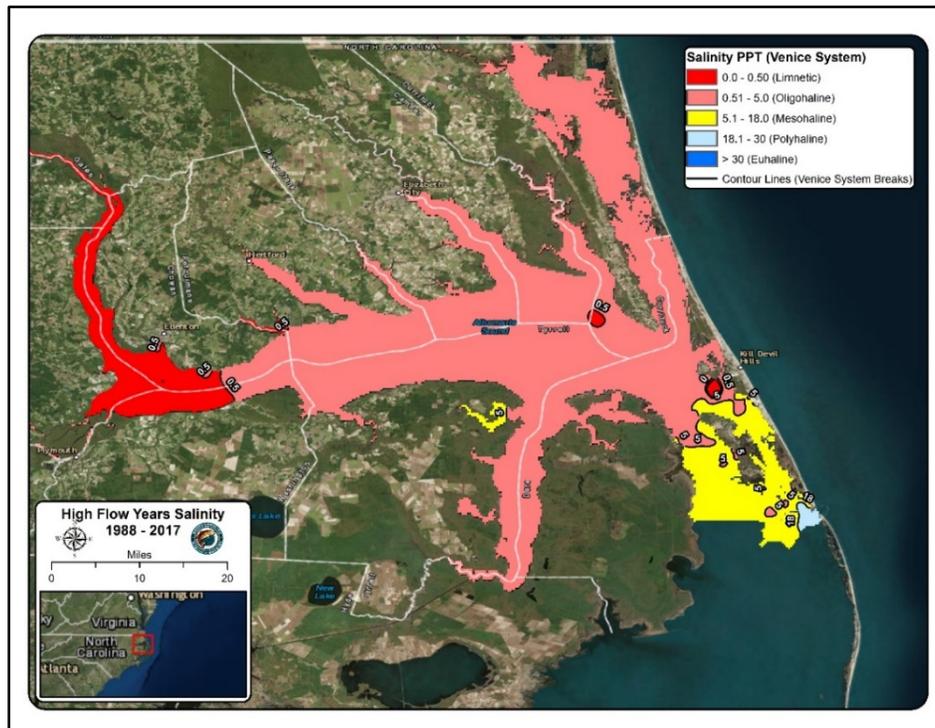


Figure 8.15. Interpolated salinity maps for high flow years for Coastal Habitat Protection Plan (CHPP) Region 1, 1988-2017.

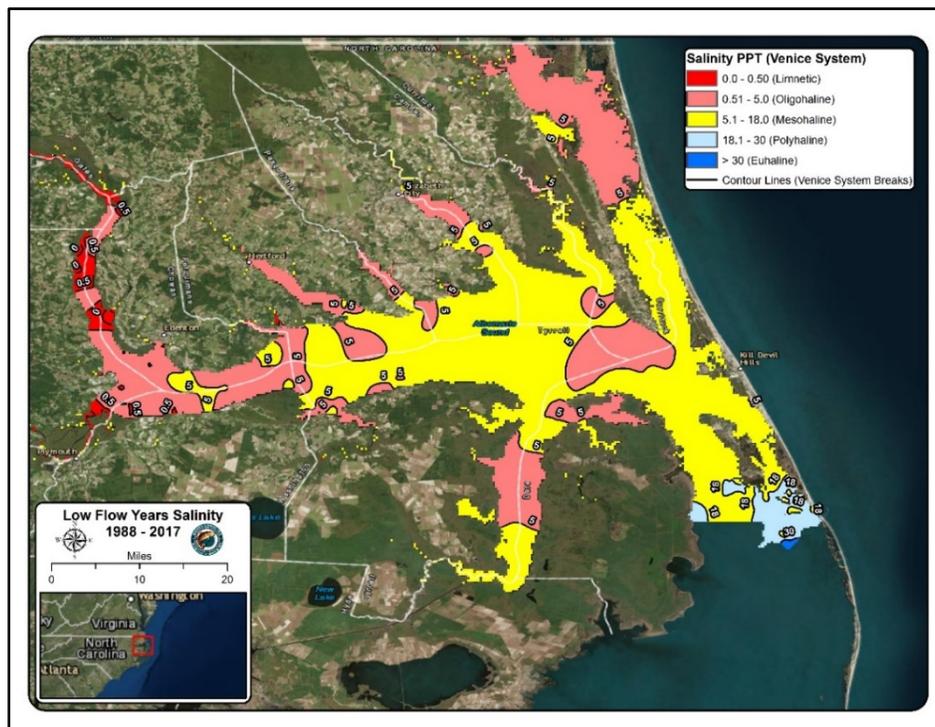


Figure 8.16. Interpolated salinity maps for low flow years for Coastal Habitat Protection Plan (CHPP) Region 1, 1988-2017.

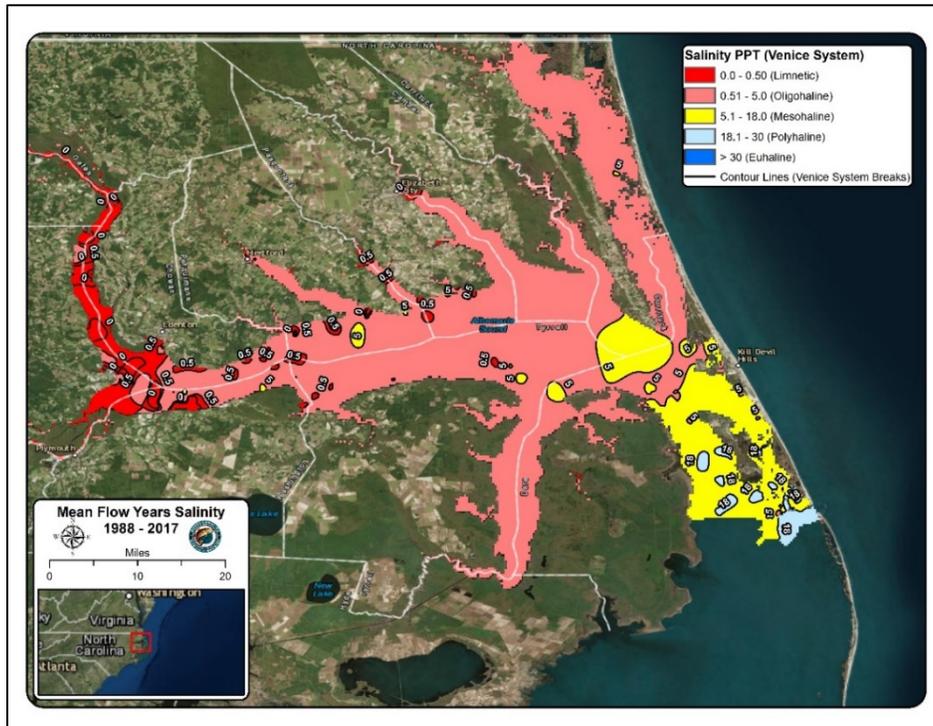


Figure 8.17. Interpolated salinity maps for mean flow years for Coastal Habitat Protection Plan (CHPP) Region 1, 1988-2017.

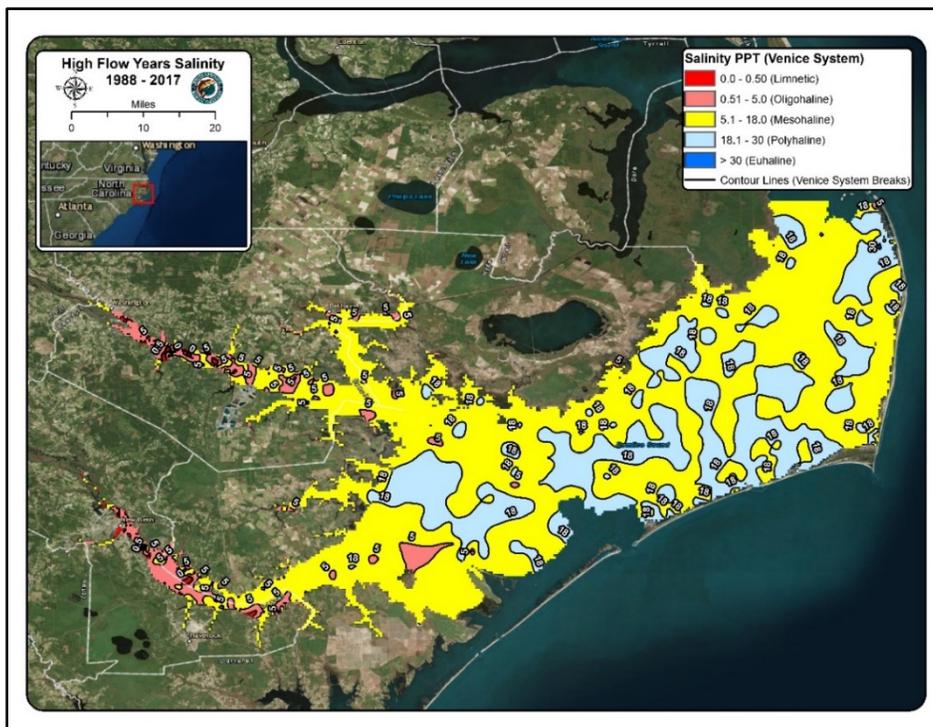


Figure 8.18. Interpolated salinity maps for high flow years for Coastal Habitat Protection Plan (CHPP) Region 2, 1988-2017.

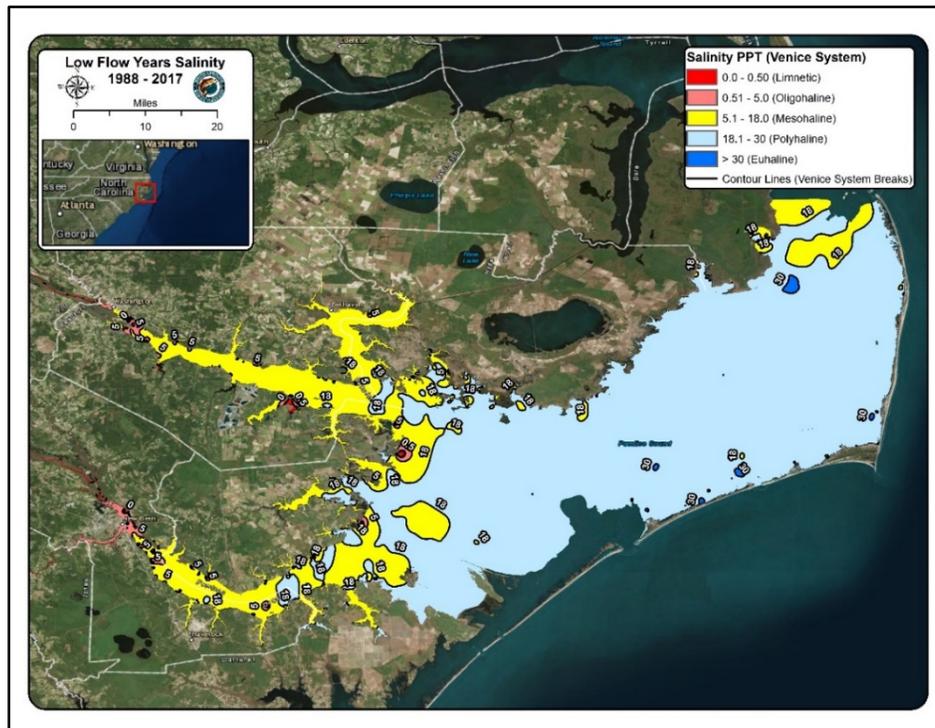


Figure 8.19. Interpolated salinity maps for low flow years for Coastal Habitat Protection Plan (CHPP) Region 2, 1988-2017.

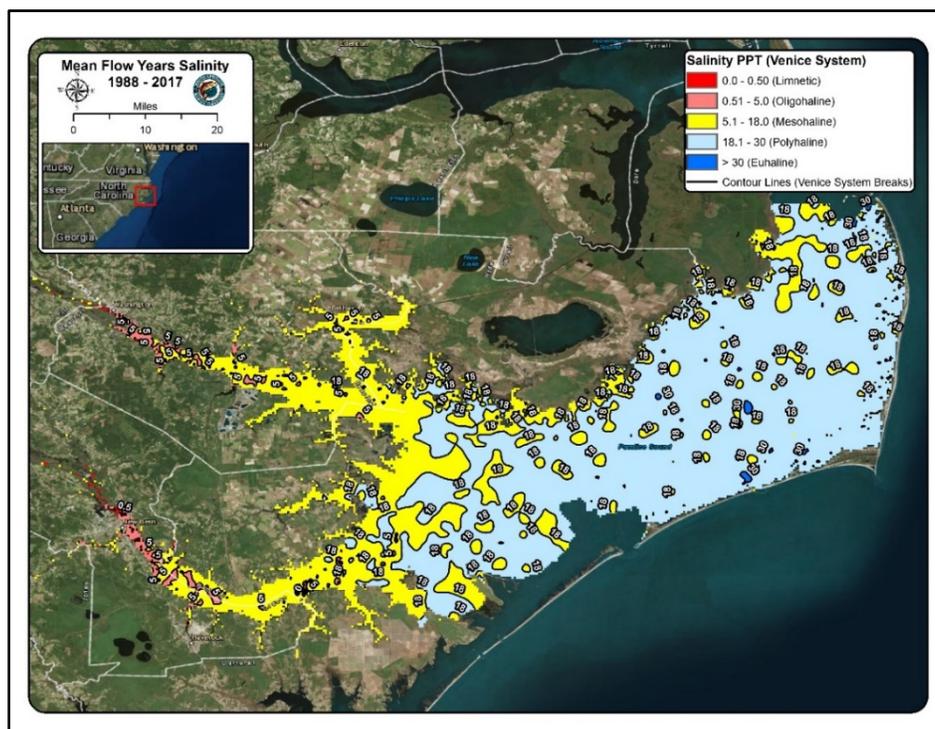


Figure 8.20. Interpolated salinity maps for mean flow years for Coastal Habitat Protection Plan (CHPP) Region 2, 1988-2017.

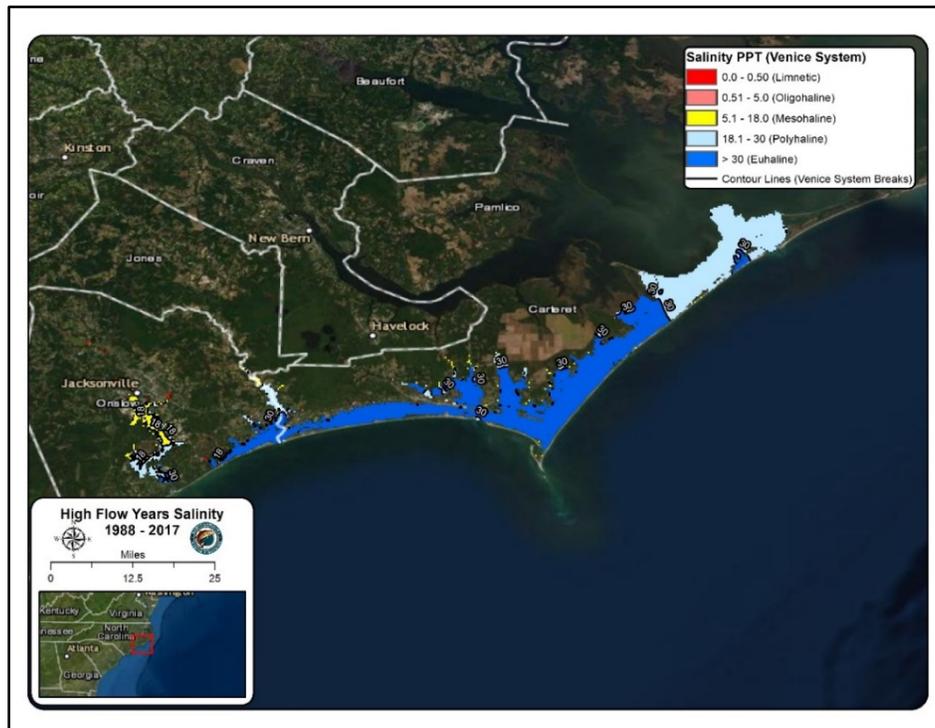


Figure 8.21. Interpolated salinity maps for high flow years for Coastal Habitat Protection Plan (CHPP) Region 3, 1988-2017.

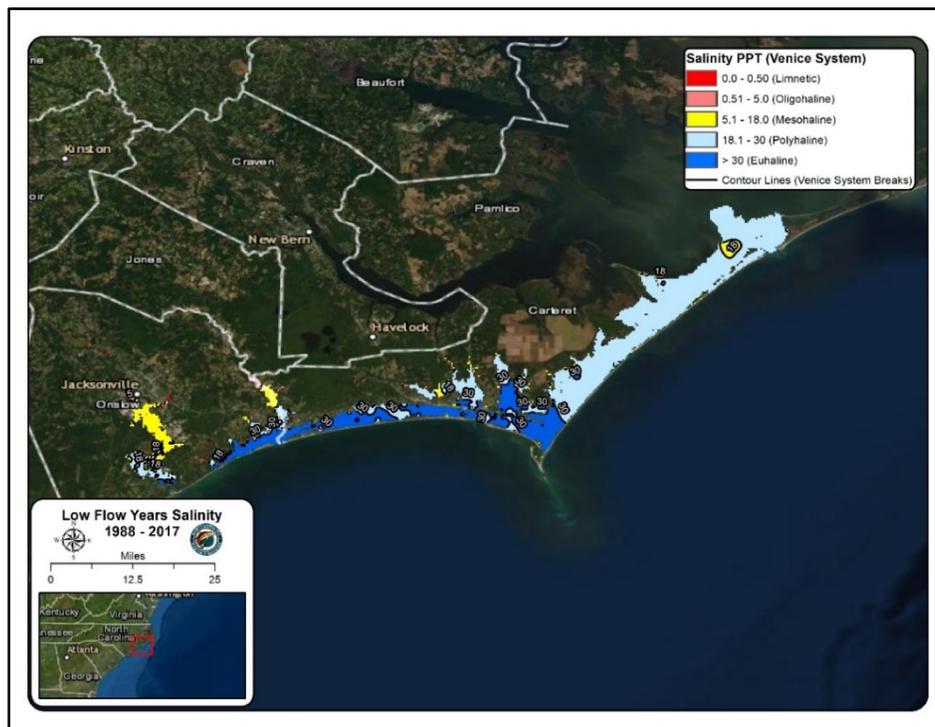


Figure 8.22. Interpolated salinity maps for low flow years for Coastal Habitat Protection Plan (CHPP) Region 3, 1988-2017.

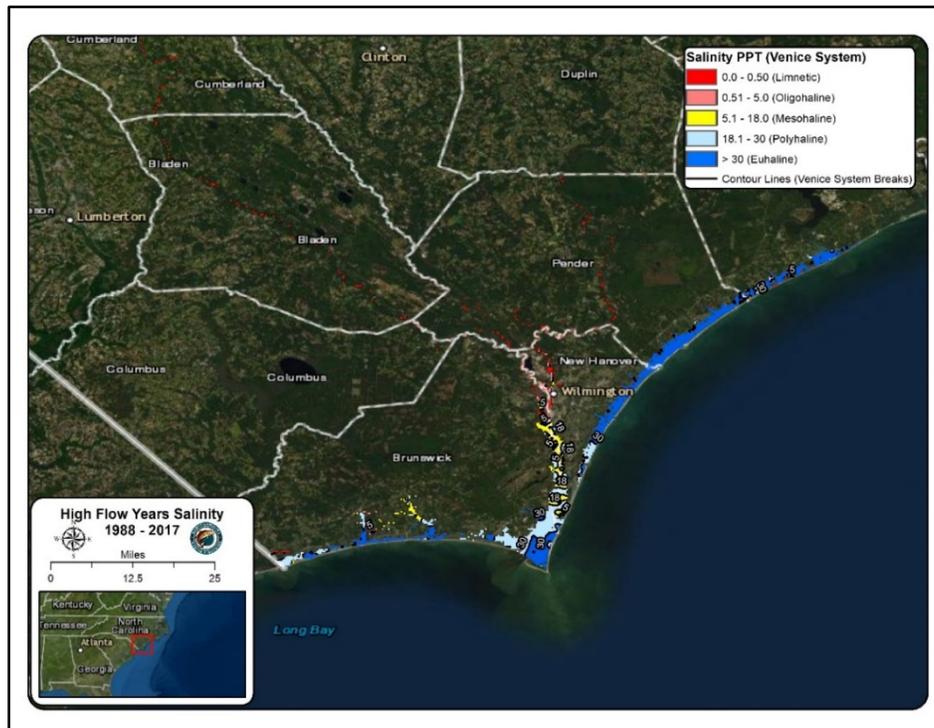


Figure 8.23. Interpolated salinity maps for high flow years for Coastal Habitat Protection Plan (CHPP) Region 4, 1988-2017.

Figure 8.24. Interpolated salinity maps for low flow years for Coastal Habitat Protection Plan (CHPP) Region 4, 1988-2017.

The DMF has used continuous water quality data sondes for the management of several programs. The Spotted Seatrout Cold Stun Monitoring Program, beginning in October 2015, deploys a coastwide array of 80 Onset HOB0 Water Temperature Pro V2 loggers to collect water temperature data. The objective of this array is to monitor water temperatures that trigger cold stun events for spotted seatrout. Data loggers are deployed at 52 stations throughout the coastal rivers and creeks of NC to detect changes in water temperature throughout the year. If water temperatures in at least two spotted seatrout cold stun management areas met the triggers of 3°C for 24 hours and/or 5°C for eight consecutive days, and the DMF director closed the spotted seatrout commercial and recreational fishery temporarily. Data sondes that record additional parameters, including DO, have been used for river herring management and to assist with site selection and monitoring of oyster sanctuaries. These sondes require extensive maintenance however, and were discontinued in 2021 due to insufficient staff time and funds.

### Shell Bottom

Shell bottom in NC has seen dramatic changes since colonial times when oyster reefs were so extensive along the coast they were a hazard to navigation.<sup>20</sup> For the purposes of the CHPP, shell bottom is defined as estuarine intertidal or subtidal bottom composed of surface shell concentrations of living or dead oysters (*Crassostrea virginica*), hard clams (*Merceneria merceneria*), and other shellfish and is limited to estuarine waters.<sup>2,3</sup> Healthy oyster reefs are vital to the estuarine ecosystem, providing three dimensional structure for fish and important ecological services such as particulate and nutrient filtration, shoreline stabilization, and benthic habitat for fish, shrimp, and other invertebrates.<sup>3,21,22,23,24</sup>

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While oysters provide the major fish habitat from shellfish, hard clams and bay scallops contribute shell material to shell hash.

The eastern oyster occupies a unique position in the estuaries of NC because its colonization of estuarine bottom creates a productive habitat and the animal itself is harvested as a food item. Due to the combined effects of habitat destruction, overfishing, disease, and deteriorated water quality, eastern oyster populations have experienced tremendous declines world-wide, particularly within subtidal oyster reefs that occur along the mid-Atlantic coastline of the United States.<sup>25, 26, 27, 28</sup> A 2011 study that examined the condition of oyster reefs across 144 bays and 44 ecoregions estimated that 85 percent of oyster reefs have been lost globally.<sup>29</sup> Additionally, this study found that most of the world's remaining wild capture of native oysters (> 75 percent) comes from just five ecoregions in North America, yet the condition of reefs in these ecoregions is poor at best, except in the Gulf of Mexico. The historical losses of oyster reefs in NC, primarily in the Pamlico Sound region, has been summarized and historical distributions have been documented.<sup>2, 3, 28, 30, 31, 32, 33, 34</sup>

### Commercial Harvest

The need for extensive shellfish management in NC has been recognized since the 1947 NC General Assembly authorized the Division of Commercial Fisheries to conduct a rehabilitation program to restore the declining oyster fishery. Although the Fisheries Management Section of DMF has been actively managing these shellfish resources since 1964, it has done so with limited resource base information. In NC, commercial oyster landings from public bottom have been variable, but have been in general decline for most of the past century.<sup>34</sup> The decline in the oyster stock was likely initiated by poor harvesting practices resulting in overharvest and low spawning stock biomass, but compounded by habitat disturbance, pollution, and biological and environmental stressors including disease and storm damage. In the past decade, landings from private bottom aquaculture have increased significantly due to more interest in shellfish aquaculture industry with oyster aquaculture landings eclipsing wild harvest landings for the first time in 2017. Yet, there are insufficient data to conduct a traditional stock assessment for the eastern oyster in NC;<sup>35</sup> therefore, population size and rate of removals from the wild oyster population are not known.

### Management Monitoring

Shellfish management by DMF includes monitoring and managing natural harvest (cultch planting program), enhancing oyster habitat to increase larval recruitment (oyster sanctuary program), shellfish habitat mapping, and shellfish leasing. Monitoring is conducted in association with management activities. Supplement A to the Oyster FMP Amendment 2 established the trigger for closing areas to mechanical harvest to protect the resource and habitat, which was approved to continue under Amendment 4 of the Oyster FMP.<sup>32, 34</sup> Sampling efforts targets areas and oyster rocks that are fished by commercial oystermen, directly before the opening of and throughout the mechanical harvest oyster season. Only areas where commercial oystermen are working are sampled to determine localized depletion and address habitat protection.

Sampling began in September 2009 with pre-season oyster sampling using mechanical harvest methods. Sampling has consistently continued with a target of 10 sites per management area, throughout the four management areas. More intensive sampling is conducted if samples are near the trigger percentage. Sampling continues after an area is closed to assess the possibility of reopening. Sampling is discontinued when it is apparent that reopening is not likely to occur. This sampling is not intended for use as a species abundance index, but instead to reflect the conditions of the habitat during the open oyster mechanical harvest season to determine closure of an area as a protection measure. The 2012 to

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2019 mechanical harvest season trigger sampling revealed low abundance and percent legal in all mechanical harvest management areas.

### *Oyster Sanctuaries and Cultch Planting Programs*

To combat the generally declining trends of shellfish, shellfish habitat restoration efforts have been occurring throughout NC's estuarine waterbodies for over half a century. The Shellfish Rehabilitation Program, which began in 1947, has contributed to the restoration of depleted oyster grounds through the planting of cultch material and seed oysters.<sup>36, 37, 38</sup> State-sponsored cultch plantings began in 1915. The primary purpose of DMF cultch planting (Program 610) and oyster sanctuary (Program 611) programs is oyster fishery enhancement, which provides temporary habitat value as well as fishery benefits. These efforts also increase the co-benefits of the ecosystem services oysters provide, including water filtration and shoreline protection against waves and storms. As of 2020, DMF has constructed 15 oyster sanctuaries in the Pamlico Sound, totaling 396 permitted acres, and annually deploys several thousand bushels of cultch rock strategically throughout the estuaries of NC (Figure 8.25). Since standard record keeping began in 1980, the Habitat Enhancement section of DMF has planted over 12 million bushels of cultch.

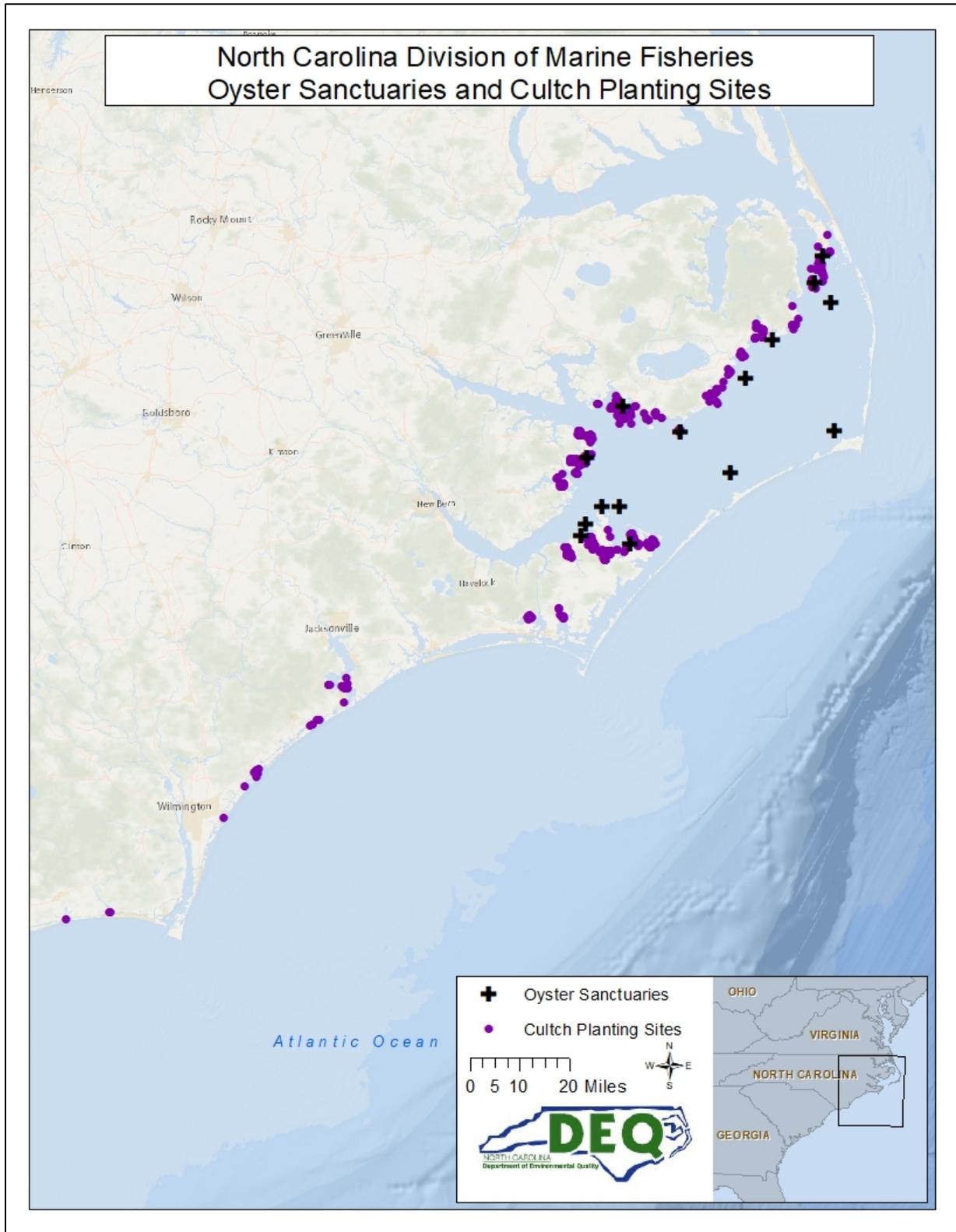


Figure 8.25. The NC Division of Marine Fisheries (DMF) Oyster Sanctuaries and Cultch Planting Sites.

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Monitoring occurs at both oyster sanctuaries and cultch reefs to evaluate reef performance and potential for contribution to the state's fishery and benthic oyster habitat. Generally, oyster sanctuaries are evaluated annually for oyster densities, size frequencies, and population demographics via quadrat material extraction and subsequent oyster measurements (Figure 8.26). Cultch sites are sampled annually for three years, post-construction, using a mechanical dredge survey to track oyster settlement and growth towards suitable densities of harvestable oysters (figure 8.27). Both reef types are additionally evaluated opportunistically via side scan to provide a metric of material persistence and reef rugosity through time. However, monitoring and site selection methods are currently evolving.

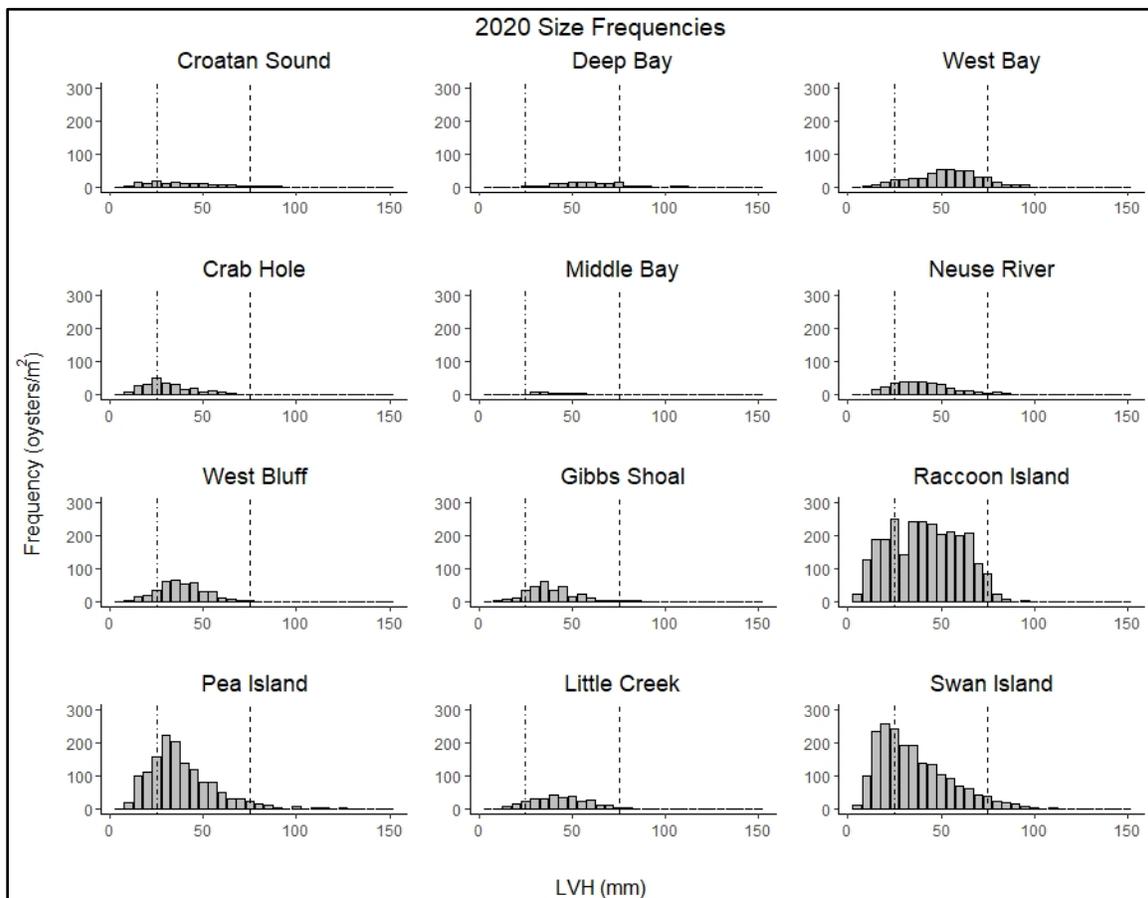


Figure 8.26. The NC Division of Marine Fisheries (DMF) 2020 Oyster Sanctuary sampling length frequency data. Data has consolidated into 5mm bins. Dashed and dotted vertical lines indicate recruit maximum (25mm) and legal minimum (75mm) oyster size class, respectively.

North Carolina oyster sanctuaries have demonstrated the capacity to maintain higher population density and greater abundance of large, fecund oysters in comparison to non-protected oyster reefs. Based on data collected from 2011-2014, oyster sanctuaries generally become “established” as oyster recruitment densities start high (~200 oysters/m<sup>2</sup>), then generally settling around a density that can be supported within the body of water the reef is located. Many of the sanctuaries within the network are considered stable, with annual fluctuations reflecting recruitment and survival year to year. Newer oyster sanctuaries like Raccoon Island and Swan Island are still exhibiting larger densities of live spat, sublegal, and legal oysters (Figure 8.26). When comparing no-take to unprotected oyster reefs, there is a striking

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decrease in densities. Oyster Sanctuary mean density is approximately 72 oysters/m<sup>2</sup> which is eight times higher mean oyster recruitment in natural reefs and approximately 12 times higher in cultch-planted reefs. The average reproductive potential per square meter of oyster sanctuaries can also be up to 30 times greater than unprotected reefs.<sup>39, 40, 41, 42</sup> Integrating total reef area and reproductive potential per square meter, oyster sanctuaries potentially provide 26.2 percent of all larvae to the system while accounting for 1 percent of reef area. The most recent sampling of the state's oyster sanctuary network indicated a wide distribution of oyster sizes were present on each reef sampled in 2020, with densities well above the 10 oysters/m<sup>2</sup> established by researchers as successful.<sup>43</sup> Variability between sanctuaries results from a variety of factors including location, proximity to both major freshwater and saltwater sources, and age of the reef among other drivers of oyster survival and persistence.

Oyster recruitment (spatfall) on newly deployed cultch can be an indicator of potential larval availability and recruitment potential. The spatfall data (Program 610) from cultch planting sites over the past 31 years indicate a decline in maximum spatfall relative to similar surveys in the 1950s.<sup>33, 36</sup> During the 1990s, average oyster spat per shell (spatfall) in Pamlico Sound declined considerably, representing less than half the number of spat per shell recorded during the 1980s.<sup>31</sup> From the late 1990s to the mid-2010s, spatfall showed a pronounced increase, surpassing 1980s spat densities. However, for the past five years there has been an overall declining trend, with the 2018 and 2019 indices being the lowest, falling below the 10-year average (annual average number of spat across all sampling sites).<sup>44</sup>

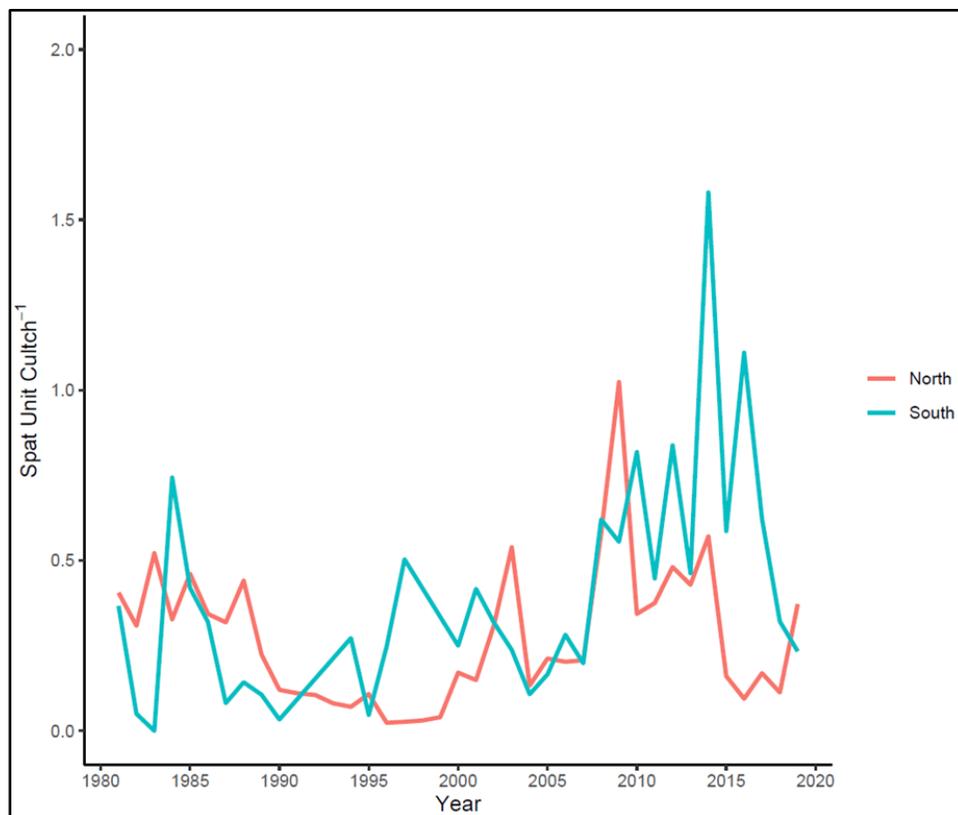


Figure 8.27. The NC Division of Marine Fisheries (DMF) Cultch Sampling Program 610 annual spatfall (average # of oyster spat/cultch unit) in northern and southern coastal waters (southern district includes from Newport River to South Carolina), 1980-2020.

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From 1980 to 2000, annual spatfall from north and south of Newport River has been somewhat variable from year to year, but generally stable overall (Figure 8.27). In the early 2000s, both regions saw increases in spatfall densities. The southern region continued to see increased spatfall densities through the mid-2010s and has been declining since. The northern region densities peaked around 2010 and have also been declining, but has since seen a slight increase in the last few years. Some researchers suspect that subtidal oysters in Pamlico Sound are becoming spawner-limited, while others attribute the decline to stress and mortality from infectious diseases and poor water quality, including hypoxia due to nutrient rich runoff following intense rain and storm events, or physical damage from fishing activities.<sup>31, 45, 46</sup>

### *Extent in North Carolina*

#### *Estuarine Bottom Mapping Program*

The first large scale shellfish bottom survey in NC waters was done by the US Navy in the late 1880s, but was limited to the larger estuaries.<sup>30</sup> This survey was targeted solely toward oysters and potential oyster producing grounds and found that nearly 700,000 acres of potentially productive oyster bottom existed in NC. Although it was quite an extensive survey, it is now outdated. In the early 2000s, a study revisiting this surveyed oyster bottom found many once-productive high profile reefs consisted of low profile shell rubble, low density reefs, or buried reef.<sup>47</sup> It was also reported that the larger solid reefs had less live oysters, attributed to the ease of locating the reefs by fishermen. Anecdotal information and DMF sampling have noted that sediment has buried oysters in some locations that were once abundant, including the northeast side of the Neuse River, and Newport and North rivers.

In 1978, DMF began a shellfish bottom survey of the commercial shellfish-producing waters in the coastal area. The purpose of the survey is to locate and map shellfish-producing areas and to delineate potentially productive benthic shellfish habitats. The objectives include: 1) summarizing existing shellfish information and evaluate shellfish producing habitat based on environmental and utilization criteria; 2) surveying shellfish habitats to obtain baseline data and production potential information; 3) defining and delineating existing and potential shellfish habitat through a series of resource maps; and 4) providing for better utilization of the estuarine resources through improved information for management and increased public awareness.

A preliminary survey of the Newport River system was conducted from November 1980 to April 1981. Newport River was selected as a testing ground for survey techniques because of its close proximity to sampling headquarters, its diverse fisheries and environmental characteristics, and the pressing need for resource base data in that system. From this survey it was deemed that the mapping techniques and survey methods proved acceptable, and in 1987 the estuarine waters were divided into areas based on shellfish habitat suitability criteria. In 1989, based off the pilot study data, the Shellfish Resource Mapping Proposal was introduced which led to the creation of the Estuarine Bottom Mapping Program 635 in 1990. From 1990 to 2019, this program mapped the shellfish habitat of the coast of NC from Roanoke Sound to the South Carolina line. Along with the delineation of bottom types, gross determinations of shellfish concentrations within productive bottom types were determined through a stratified random sampling program. In 2019, the mapping of 567,691 acres of the intended 589,071 acres of coastal waters delineated into 24 bottom type strata was completed (Tables 8.5 and 8.6 and Figures 8.28-8.31).

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Table 8.5. The NC Division of Marine Fisheries (DMF) Estuarine Bottom Mapping Program 635 acreage and percentages of estuarine bottom habitat mapped, 1990-2019.

CHPP Regions*	Area Intended for Mapping		Percent Mapped	Total Mapped Shell Bottom		Mapped Subtidal Shell bottom		Mapped Intertidal Shell Bottom	
	Acres	Mapped**		Acres	Percent	Acres	Percent	Acres	Percent
Albemarle Sound to Northeastern Coastal Ocean (1)	64,810	64,918	101% <sup>†</sup>	615	2.79%	571	3.42%	44	0.82%
Pamlico Sound System (2)	278,477	286,890	103% <sup>†</sup>	4,290	19.45%	4,213	25.21%	77	1.44%
White Oak River Basin (3)	200,697	170,973	85%	10,543	47.79%	9,123	54.60%	1,420	26.53%
Cape Fear River Basin (4)	45,088	44,820	99%	6,612	29.97%	2,801	16.76%	3811	71.21%
<b>Total</b>	<b>589,071</b>	<b>567,601</b>	<b>96%</b>	<b>22,060</b>		<b>16,709</b>	<b>75.74%</b>	<b>5,351</b>	<b>24.26%</b>

\*Oregon Inlet acres included in Albemarle Region; Ocracoke Inlet acres included in White Oak River Basin Region.

\*\*Excludes areas that cannot be mapped due to military prohibitions, leases, bridge restrictions, depths, hazards.

<sup>†</sup> More than intended was mapped.

Table 8.6. The NC Division of Marine Fisheries (DMF) Estuarine Bottom Mapping Program 635 mapped estuarine bottom habitat acreage by strata, coastwide and by Coastal Habitat Protection Plan (CHPP) regions, 1990-2019.

Strata Description	Acreage				
	Coastwide	Region 1	Region 2	Region 3	Region 4
Subtidal Soft Vegetated Shell (A)	0	0	0	0	0
Subtidal Soft Vegetated w/o Shell (B)	1,290	1	1,142	147	0
Subtidal Soft Non-vegetated Shell (C)	1,134	2	570	551	11
Subtidal Soft Non-vegetated w/o Shell (D)	62,806	1,248	43,462	14,748	3,347
Subtidal Firm Vegetated Shell (E)	333	0	1	331	0
Subtidal Firm Vegetated w/o Shell (F)	2,228	63	548	1,617	0
Subtidal Firm Non-vegetated Shell (G)	10,046	144	3,044	4,898	1,960
Subtidal Firm Non-vegetated w/o Shell (H)	68,807	7,131	26,925	26,336	8,415
Subtidal Hard Vegetated Shell (I)	128	4	9	115	0
Subtidal Hard Vegetated w/o Shell (J)	89,064	1,142	72,520	15,402	0
Subtidal Hard Non-vegetated Shell (K)	5,067	421	588	3,228	830
Subtidal Hard Non-vegetated w/o Shell (L)	281,907	53,637	136,180	86,002	6,088
Intertidal Soft Vegetated Shell (M)	12	0	0	0	12
Intertidal Soft Vegetated w/o Shell (N)	42	0	0	25	16
Intertidal Soft Non-vegetated Shell (O)	65	0	0	22	43
Intertidal Soft Non-vegetated w/o Shell (P)	750	0	0	146	604
Intertidal Firm Vegetated Shell (Q)	459	0	4	388	67
Intertidal Firm Vegetated w/o Shell (R)	27,191	76	97	13,606	13,413
Intertidal Firm Non-vegetated Shell (S)	2,905	0	1	402	2,502
Intertidal Firm Non-vegetated w/o Shell (T)	4,386	2	6	209	4,170
Intertidal Hard Vegetated Shell (U)	220	5	3	137	74
Intertidal Hard Vegetated w/o Shell (V)	2,647	779	1,276	418	174
Intertidal Hard Non-vegetated Shell (W)	1,617	39	69	471	1,038
Intertidal Hard Non-vegetated w/o Shell (X)	4,496	225	444	1,772	2,055
<b>Total</b>	<b>567,601</b>	<b>64,918</b>	<b>286,890</b>	<b>170,973</b>	<b>44,820</b>

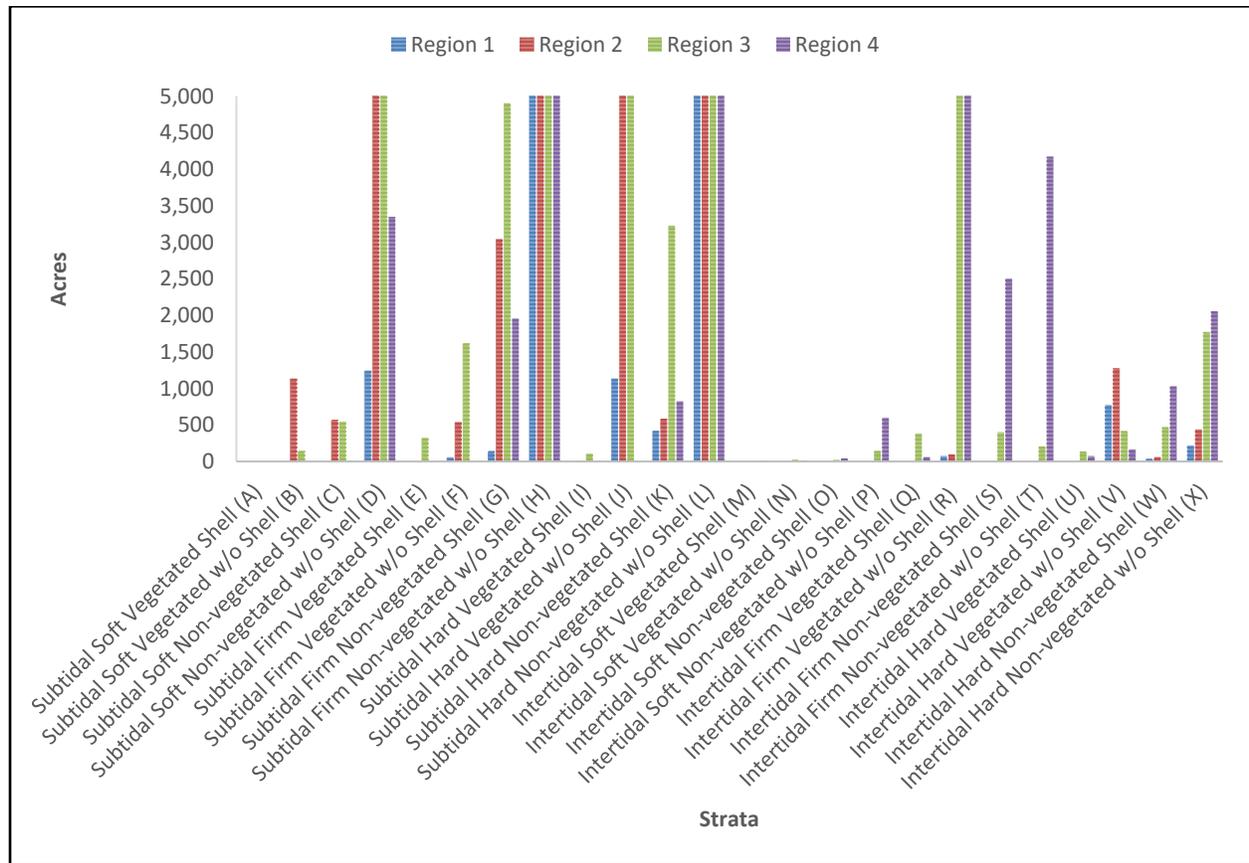


Figure 8.28. The NC Division of Marine Fisheries (DMF) Estuarine Bottom Mapping Program 635 mapped estuarine bottom habitat acreage by with shell strata and Coastal Habitat Protection Plan (CHPP) regions, 1990-2019.

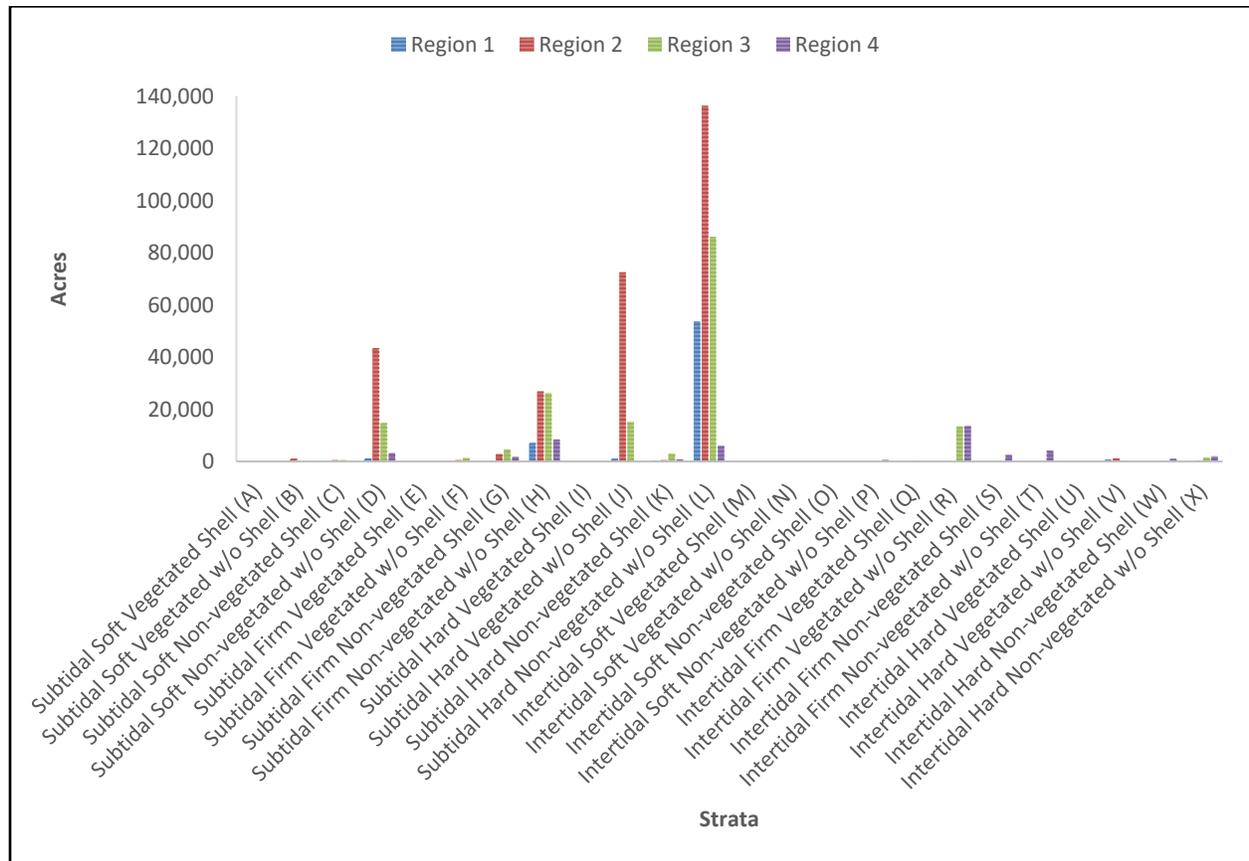


Figure 8.29. The NC Division of Marine Fisheries (DMF) Estuarine Bottom Mapping Program 635 mapped estuarine bottom habitat acreage by without shell strata and Coastal Habitat Protection Plan (CHPP) regions, 1990-2019.



Photo Credit: Nolen Vinay

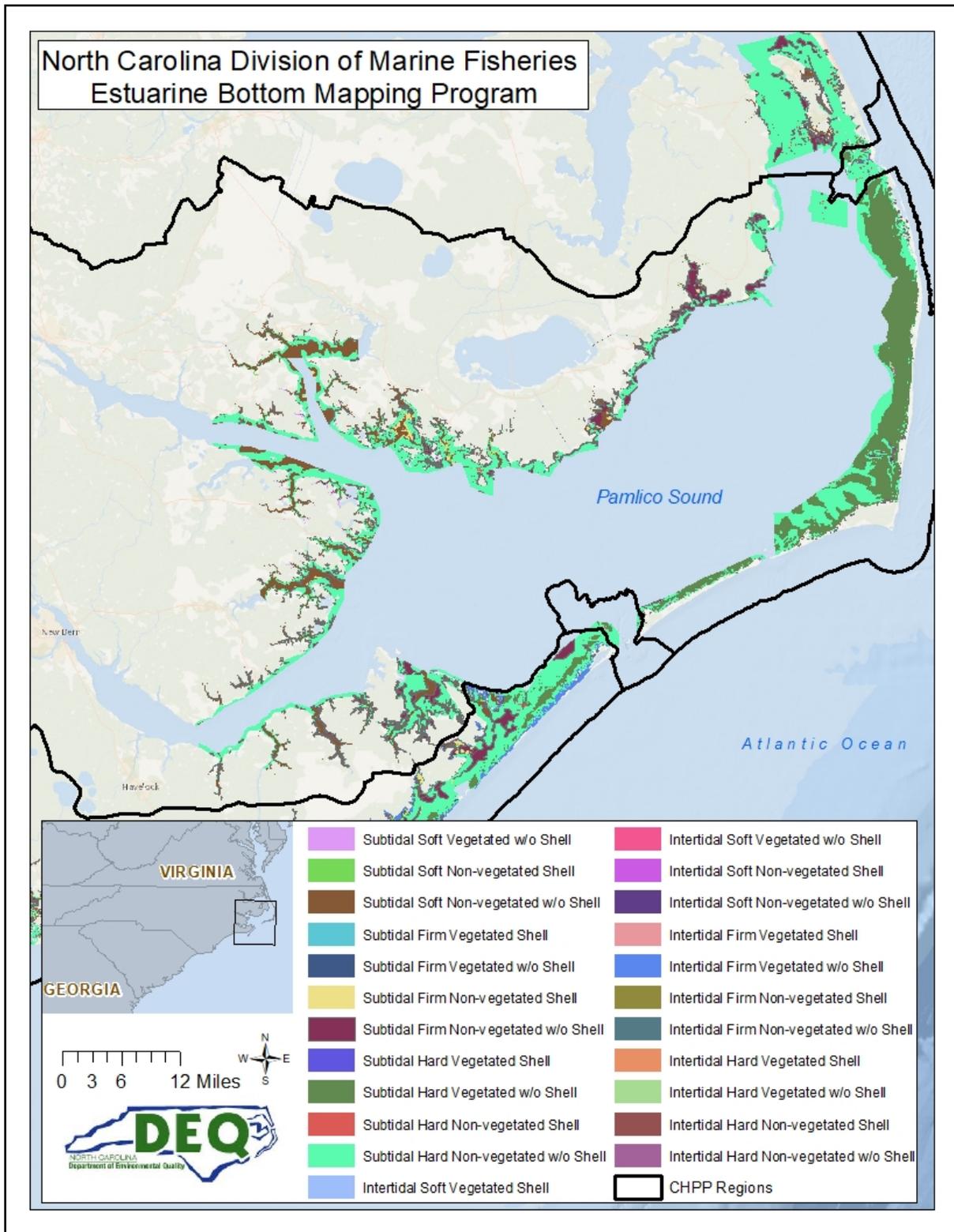


Figure 8.30. The NC Division of Marine Fisheries (DMF) Estuarine Bottom Mapping Program 635 strata for the northern Coastal Habitat Protection Plan (CHPP) regions 1, 1/2, and 2, 1990-2019.

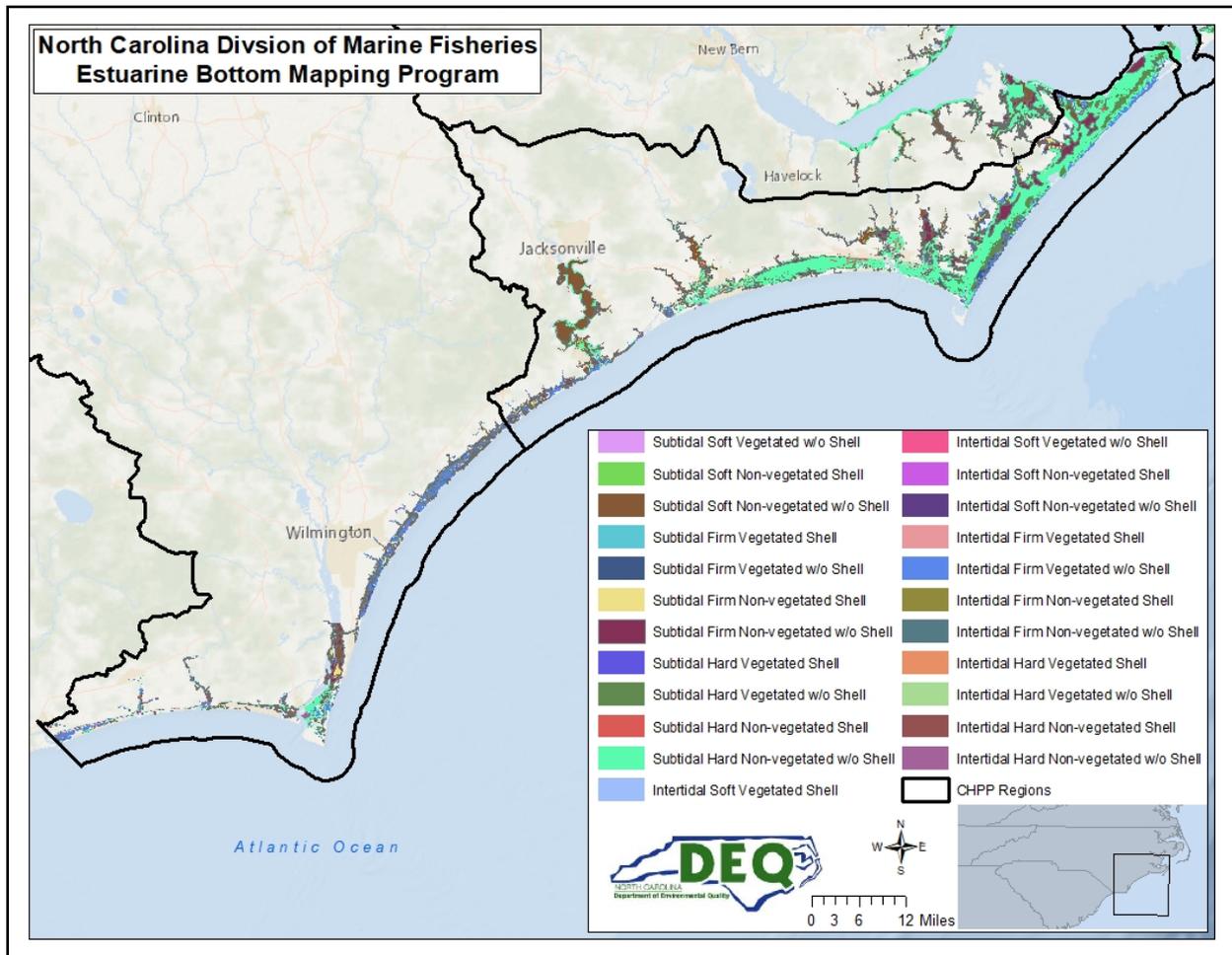


Figure 8.31. The NC Division of Marine Fisheries (DMF) Estuarine Bottom Mapping Program 635 strata for the southern Coastal Habitat Protection Plan (CHPP) regions 3, 3/4, and 4, 1990-2019.

After the strata were mapped, sampling was done to quantify the number of eastern oysters, hard clams, and bay scallops present. Since mapping and sampling took place over a long time series, data should be interpreted only as general trends of the density and distribution of shellfish resources across the coast of NC over the last 30 yrs. Comparing shellfish densities across CHPP regions, the White Oak (Region 3) and Cape Fear River (Region 4) river basins had the highest densities for oysters (20.11 oysters/m<sup>2</sup> and 38.95 oysters/m<sup>2</sup>, respectively) and clams (0.63 clams/m<sup>2</sup> and 1.21/m<sup>2</sup>, respectively) with the White Oak (Region 3) having the highest density for scallops (0.09 scallops/m<sup>2</sup>).

The rest of the data presented will focus on eastern oysters since they comprise the majority of shell bottom. To determine the highest density of oyster strata coastwide and across CHPP regions, weighted means (oysters/m<sup>2</sup>) were examined (Table 8.7 and Figure 8.32). The Subtidal Soft Vegetated Shell (A) strata does not exist anywhere along the coast due to photosynthetic restraints of vegetation. Across the coast and in every region, subtidal firm non-vegetated shell (G), subtidal hard non-vegetated shell (K), intertidal firm non-vegetated shell (S), and intertidal hard non-vegetated shell (W) strata were significantly different, with the exception of intertidal firm non-vegetated shell (S) which did not occur in the Albemarle Sound to northeastern coastal ocean (Region 1; p<0.05).

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Table 8.7. The NC Division of Marine Fisheries (DMF) Estuarine Bottom Mapping Program 635 eastern oyster weighted means (oysters/m<sup>2</sup>) by strata, coastwide and by Coastal Habitat Protection Plan (CHPP) region, 1990-2019.

Strata Description	Weighted Mean of Oysters (per m <sup>2</sup> )				
	Coastwide	Region 1	Region 2	Region 3	Region 4
Subtidal Soft Vegetated Shell (A)	-	-	-	-	-
Subtidal Soft Vegetated w/o Shell (B)	0.09	1.40	0.00	0.00	-
Subtidal Soft Non-vegetated Shell (C)	4.75	19.74	3.28	3.21	5.94
Subtidal Soft Non-vegetated w/o Shell (D)	0.08	0.20	<0.01	0.12	0.00
Subtidal Firm Vegetated Shell (E)	7.49	3.45	0.72	12.81	-
Subtidal Firm Vegetated w/o Shell (F)	1.01	0.17	<0.01	1.93	-
Subtidal Firm Non-vegetated Shell (G)	*9.56	*11.26	*6.85	*11.82	*8.05
Subtidal Firm Non-vegetated w/o Shell (H)	0.21	*0.38	0.07	0.22	0.18
Subtidal Hard Vegetated Shell (I)	4.04	12.97	3.33	1.80	-
Subtidal Hard Vegetated w/o Shell (J)	0.05	0.06	0.08	0.04	-
Subtidal Hard Non-vegetated Shell (K)	*16.11	*9.53	*11.60	*19.00	*33.53
Subtidal Hard Non-vegetated w/o Shell (L)	0.04	0.02	0.02	0.02	0.23
Intertidal Soft Vegetated Shell (M)	16.51	-	-	-	23.44
Intertidal Soft Vegetated w/o Shell (N)	4.49	-	-	0.00	4.15
Intertidal Soft Non-vegetated Shell (O)	*41.33	-	-	*55.79	19.50
Intertidal Soft Non-vegetated w/o Shell (P)	0.01	-	-	0.00	0.01
Intertidal Firm Vegetated Shell (Q)	*37.84	3.25	1.53	*34.68	*51.10
Intertidal Firm Vegetated w/o Shell (R)	*2.29	*4.11	0.00	*0.98	*4.69
Intertidal Firm Non-vegetated Shell (S)	*43.23	-	*5.15	*35.74	*46.81
Intertidal Firm Non-vegetated w/o Shell (T)	0.51	0.00	0.00	0.45	0.57
Intertidal Hard Vegetated Shell (U)	*50.23	7.76	4.95	*50.12	*59.41
Intertidal Hard Vegetated w/o Shell (V)	1.29	0.34	<0.01	2.63	0.00
Intertidal Hard Non-vegetated Shell (W)	*91.23	*2.32	*12.89	*101.27	*108.46
Intertidal Hard Non-vegetated w/o Shell (X)	0.01	0.04	<0.01	<0.01	0.00

\*significantly different from overall weight mean  $p < 0.05$

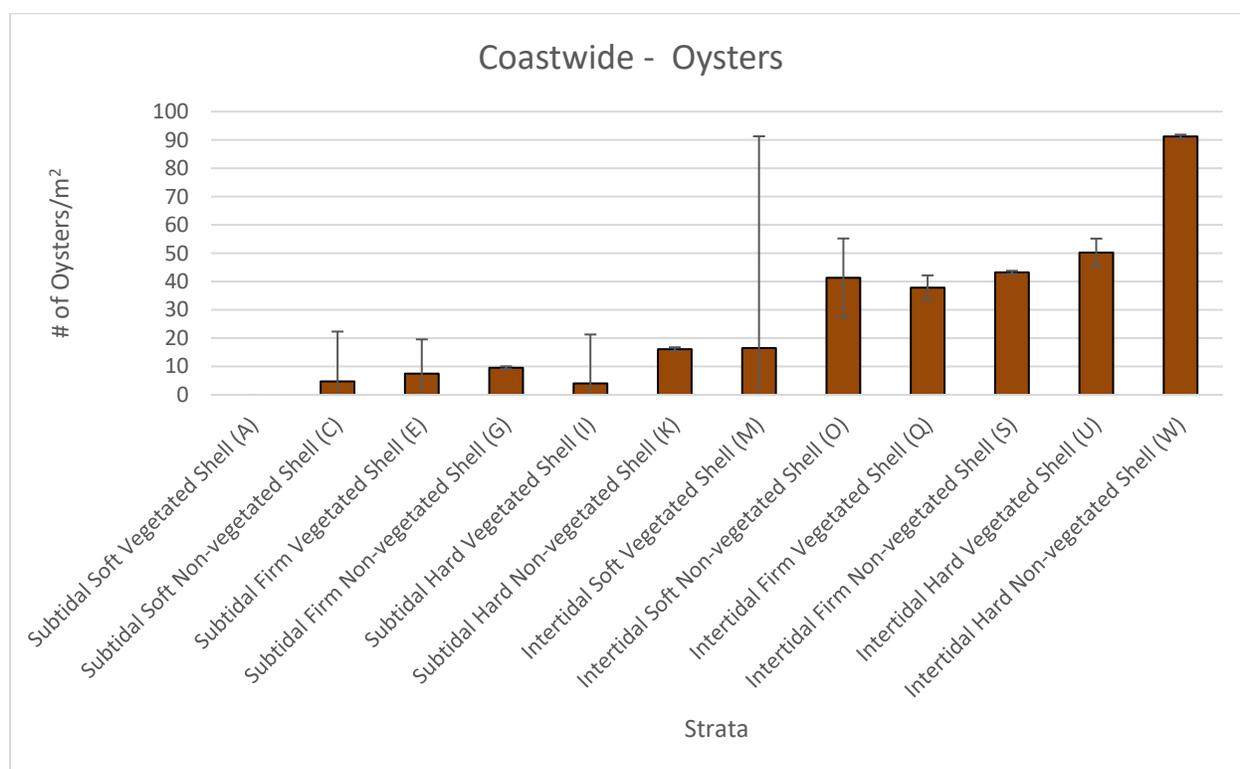


Figure 8.32. The NC Division of Marine Fisheries (DMF) Estuarine Bottom Mapping Program 635 coastwide eastern oyster weighted mean densities (# oysters/m<sup>2</sup>) by with shell strata, 1990-2019.

Across the NC coast, the top five highest density strata were: intertidal hard non-vegetated shell (W;  $91.23 \pm 0.64$  oysters/m<sup>2</sup>), intertidal hard vegetated shell (U;  $50.23 \pm 4.93$  oysters/m<sup>2</sup>), intertidal firm non-vegetated shell (S;  $43.23 \pm 0.56$  oysters/m<sup>2</sup>), intertidal soft non-vegetated shell (O;  $41.33 \pm 13.88$  oysters/m<sup>2</sup>), and intertidal firm vegetated shell (Q;  $37.84 \pm 4.34$  oysters/m<sup>2</sup>). These five strata were significantly different ( $p < 0.05$ ; Table 8.7 and Figures 8.32). The majority of the oyster resource across the coast, within the mapped study area, were intertidal. The intertidal hard non-vegetated Shell (W) and intertidal firm non-vegetated shell (S) strata represent the typical intertidal oyster reef or bar, while the intertidal hard vegetated shell (U) and intertidal firm vegetated shell (Q) strata are typical of fringing oyster reef adjacent to marsh. Subtidal firm non-vegetated shell (G;  $9.56 \pm 0.50$  oysters/m<sup>2</sup>), subtidal hard non-vegetated shell (K;  $16.11 \pm 0.68$  oysters/m<sup>2</sup>), and intertidal firm vegetated without shell (R;  $2.29 \pm 0.30$  oysters/m<sup>2</sup>) were also significantly different for oysters coastwide. The subtidal firm non-vegetated shell (G) and subtidal hard non-vegetated shell (K) strata are the most common subtidal oyster concentrations. Two strata, intertidal soft vegetated shell (M) and intertidal soft vegetated without shell (N), were not significantly different from any other strata for oysters coastwide. Most of NC's shell bottom can be found in the Southern CHPP Regions 3 and 4, the White Oak and Cape Fear River Basins. The White Oak Region 3 is dominated by subtidal shell while intertidal shell is dominant in the Cape Fear region 4. These regions also had the highest density of mapped shell strata.

### Submerged Aquatic Vegetation (SAV)

#### Background

Currently, NC is steward to one of the most productive and biodiverse SAV resources on the Atlantic seaboard, including the largest in-tact polyhaline and mesohaline seagrass meadows in the temperate

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western Atlantic.<sup>3, 48, 49, 50, 51, 52</sup> There are two distinctive groups of SAV ecosystems in NC distributed according to estuarine salinity. One group, referred to as low salinity SAV or underwater grasses, thrives in fresh and low salinity riverine waters ( $\leq 10$  ppt), and includes species such as Redhead grass (*Potamogeton perfoliatus*), Wild celery (*Vallisneria Americana*), and Sago pondweed (*Stuckenia pectinate*). The second group, referred to as high salinity SAV or seagrass, occurs in moderate to high ( $>10$  ppt) salinity estuarine waters of the bays, sounds, and tidal creeks, and includes three species, temperate eelgrass (*Zostera marina*), tropical shoal grass (*Halodule wrightii*), and cosmopolitan widgeon grass (*Ruppia maritima*). Collectively, they are referred to as SAV.

When SAV beds are subjected to human-induced impacts, such as physical damage and water quality degradation, in addition to natural stressors, such as storm damage and climate change, large-scale losses may occur. Globally, SAV abundance is declining. Of the 72 known species of seagrass, 10 are at an elevated risk for extinction and three are endangered.<sup>53</sup> A summary of status and trends information of SAV at a global scale found reports of large-scale SAV losses in the European Mediterranean, Japan, and Australia.<sup>54</sup> Reports of SAV recovery were very low by comparison. A summary based on over 215 studies and 1,800 observations dating back to 1879 showed seagrasses disappearing at rates similar to coral reefs and tropical rainforests.<sup>55</sup> The compilation of studies shows a 29 percent decline in known SAV extent since 1879. The study also indicated an acceleration of loss since 1940. In North America, losses of seagrass beds have been as high as 50 percent in Tampa Bay, 43 percent in northern Biscayne Bay, 30 percent in the northern portion of Indian River Lagoon, and as much as 90 percent in Galveston Bay, Texas, and Chesapeake Bay.<sup>56, 57, 58, 59</sup> For more information, see **Chapter 4. Submerged Aquatic Vegetation Protection and Restoration Through Water Quality Improvements.**

### Mapping and Monitoring

Quantitative information on SAV status and trends comes in three forms: 1) station monitoring, 2) transect monitoring, and 3) areal coverage monitoring. In NC, some of the earliest data comes from a 70+ year history of station and transect monitoring in Currituck Sound.<sup>60, 61</sup> Studies have documented the status of SAV in Currituck Sound since 1909. Major declines occurred in 1918, which were mostly caused by increased turbidity from dredging for the locks of the Albemarle and Chesapeake Canal. In 1932, operation of the canal locks was modified and SAV began to recover; fully recovering by 1951. During 1954 and 1955, four hurricanes along NC's coast increased turbidities and resulted in widespread destruction of SAV beds.<sup>62</sup> The community recovered rapidly, as growth was considered good by 1957 (Davis and Brinson 1983, 1990).<sup>60, 61</sup> After a severe nor'easter in 1962, saltwater intrusion in Currituck Sound raised the average salinity by 4.4 ppt, causing major reductions in freshwater SAV biomass. As SAV beds recovered in Currituck Sound after 1962, non-native Eurasian watermilfoil (*Myriophyllum spicatum*) began to spread across the sound, possibly encouraged by improved water clarity that resulted from dry conditions and higher post-1962 salinities. This caused a major change in composition of the native SAV.

Since the 1980s, various other mapping and monitoring projects have been conducted by universities and state and federal agencies across the coast of NC in both high and low salinity areas. Each of these mapping events produced individual GIS files, that when compiled together, make up the historically known presence and suitable habitat of SAV along NC's coast, suggesting a historic extent of approximately 191,155 acres of SAV in the public trust waters of coastal NC (Tables 8.8; Figure 8.33). The data sources, mapping years, methodology, and extent of each individual mapping event and individual maps by regions can be found in **Chapter 4. Submerged Aquatic Vegetation Protection and Restoration through Water Quality Improvements.** Additional mapping and monitoring of fresh and brackish SAV has occurred through hydroacoustic surveys, the recent establishment of sentinel sites in recent years in

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the Neuse and Pamlico rivers and Albemarle Sound and a coastwide aerial photography mapping event that occurred in 2019 and 2020 with funding from DEQ and APNEP.<sup>63, 64, 65, 66</sup> As these more current data layers become available they will be incorporated into this mosaic of SAV mapping events to better inform the known historic and current extent of SAV and SAV habitat in NC.

Table 8.8. The known historical extent of mapped submerged aquatic vegetation (SAV) in NC, 1981-2015.

Salinity Zone	SAV Region #	SAV Region Name	Historic Extent* (ac)	Percent of Historical Extent* (%)
Low	1	Currituck and Back Bay	21,613	11.3
Low	2	Albemarle Sound	12,872	6.7
Low	3	Tar-Pamlico & Neuse rivers	4,581	2.4
High	4	Pamlico Sound	712	0.4
High	5	Roanoke Sound to Ocracoke Inlet	101,739	53.2
High	6	Core Sound	36,862	19.3
High	7	Bogue Sound	10,826	5.7
High	8	Bear Inlet to Snow's Cut	1,950	1.0
High/Low	9	Cape Fear River to SC line	0	0.0
Total			191,155	100.0

\*SAV Mosaic 1981 to 2015 (as of 6/3/2020)



Photo Credit: Anne Deaton

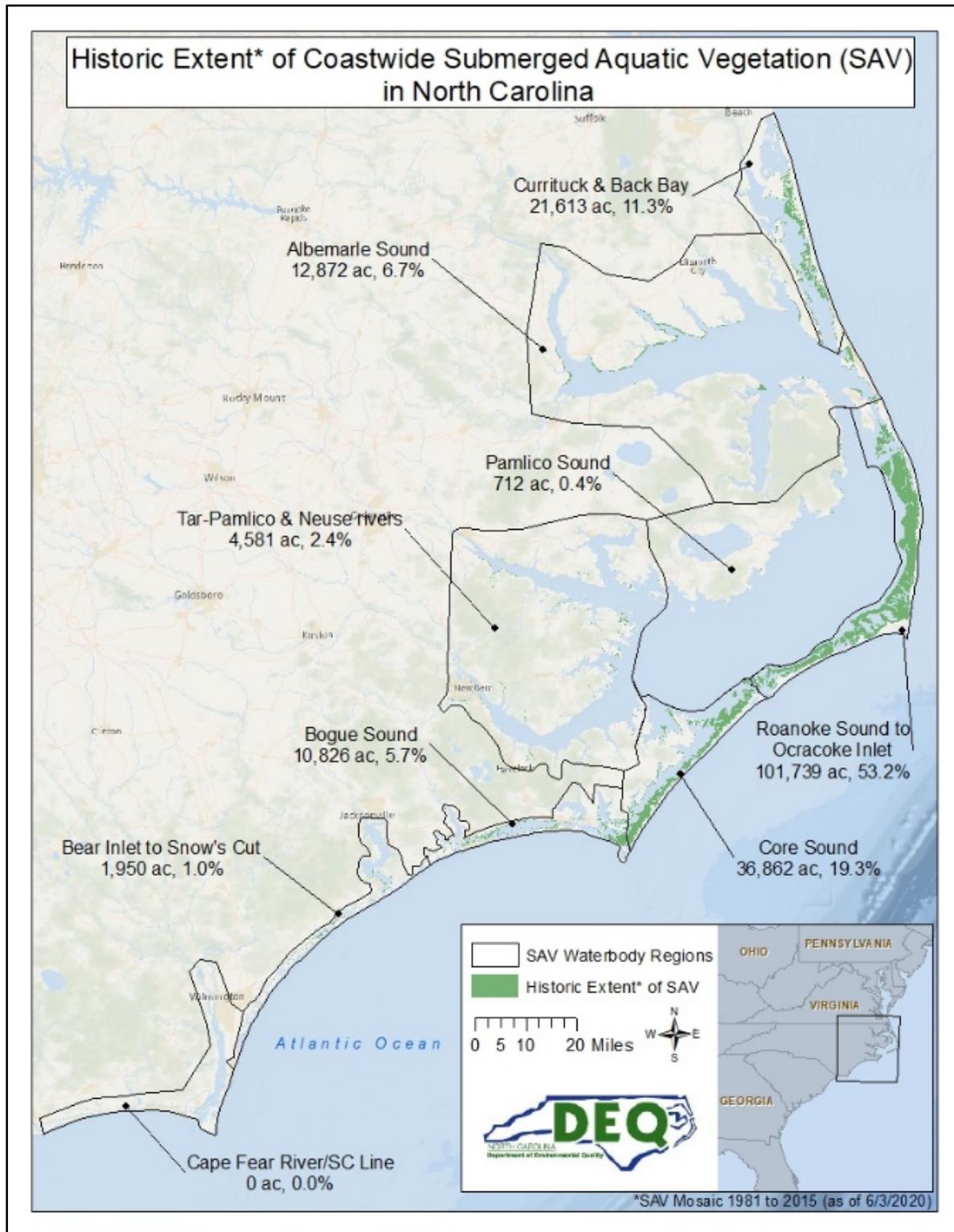


Figure 8.33. Known historic extent of submerged aquatic vegetation (SAV) and SAV habitat mapped in NC, 1981 to 2015. Absence of SAV does not suggest actual absence, as surveys have not been conducted in all areas. Presence of SAV does not reflect current state, as data dates to 1981.

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### Extent and Loss in North Carolina

The extent of SAV loss has not been well quantified in NC, but anecdotal reports indicate SAV beds may be reduced by as much as 50 percent, especially on the mainland side of the coastal sounds.<sup>3, 67</sup>

However, more recent efforts have been made to quantify these losses in both high and low salinity SAV habitats.<sup>66, 68</sup> Mapping and monitoring low salinity SAV is more difficult due to low water clarity compared to high salinity SAV areas of the estuary. However, despite the limited availability of historical baseline data of low salinity SAV habitat, fluctuations in SAV abundance have been observed through hydroacoustic surveys and other sentinel site observations. Based on the most recent hydroacoustic surveys of linear SAV extent along the 1-m isobath in the Neuse, Pamlico and Albemarle river sub-estuaries, there has been an estimated 33 percent decline from the historical extent of low salinity SAVs (Table 8.9).

Table 8.9. Net change from known historical extent of submerged aquatic vegetation (SAV) to 2014-2017 linear extent (LE) along 1-meter isobaths line for low salinity SAV based on recent hydroacoustic surveys in NC.<sup>66, 68</sup>

Estuary	Known Historical* SAV LE (m)	2014-2017 SAV LE (m)	No change in SAV from historical (m)	Change in SAV LE (gain)	Change in SAV LE (loss)	Percent change in SAV LE (loss)
Albemarle Sound	117,778	90,565	56,457	+34,108	-61,321	-23.10
Tar - Pamlico River	29,223	6,036	756	+5,280	-28,467	-79.33
Neuse River	10,512	9,519	2,821	+6,692	-7,685	-9.42
Total	157,513	106,120	60,034	+46,080	-97,473	-32.62

\*From 1981-2015 SAV Mosaic

Although there is less known about low salinity SAV, there are some recurring themes. These include fluctuations in abundance, changes in species composition, a proliferation of non-native, persistent SAV species, high turbidity, extreme weather events and large amounts of precipitation, increases in harmful algal blooms, and fluctuations in salinity. This all represents an important and needed effort to develop numeric nutrient criteria, so that progress on water quality improvements can be made for the benefits of SAV.<sup>68</sup> The high salinity seagrasses appear to be in slightly better health than the low salinity SAVs. There is a good baseline of data on distribution and abundance for most of the high salinity SAV resource, along with a good understanding of species composition, persistence, and resilience. However, little water quality data are collected in this part of the estuary and represents a crucial data gap.

The APNEP metric report: *Extent of Submerged Aquatic Vegetation, High-Salinity Estuarine Waters*, provides an analysis of SAV change based on spatial coverage detected from aircraft during two survey periods: 2006-2007 (Survey 1) and 2013 (Survey 2). Survey 1 represents late spring aerial surveys of Bogue and Back Sounds and fall aerial surveys between Roanoke Island and Barden's Inlet. Survey 2 represents late spring aerial surveys between Roanoke Island and Bogue Inlet.<sup>69</sup> Due to weather conditions during the second survey, extent and location measurements for SAV in much of Core Sound were not included in this report. For the analysis, the coastal areas were broken down into three geographic regions: 1) the "North Zone" from the US Highway 64 Bridge at Roanoke Island to Hatteras Inlet, 2) the "Central Zone" from Hatteras Inlet to Ophelia Inlet and, 3) the "South Zone" from Barden's Inlet at Cape Lookout to Bogue Inlet. The data were also subdivided into the categories showing all possible categorical changes in SAV: continuous to none, patchy to none, continuous to patchy, patchy

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both years of analysis, none to patchy, continuous both years of analysis, patchy to continuous, and none to continuous.

All three regional zones showed declines in SAV acreage (Table 8.10).<sup>69</sup> However, the southern zone, where there is more development and higher population densities, declined by over 10 percent at a rate of 1.7 percent loss per year (Table 8.11). The northern and central regions are less developed, receive less direct riverine input, and therefore had a lower estimated SAV acreage loss. SAV can grow at depths generally up to  $\leq 2.0$  m, yet much of the available benthic habitat within this depth range was not occupied by SAV. An additional concern is the amount of continuous beds that were converted to patchy beds. The biggest component of the overall change in the northern region was the conversion of 15,327 acres (6,202.8 ha) of continuous seagrass in Survey 1 to patchy seagrass in Survey 2.

Table 8.10. Net change in high salinity submerged aquatic vegetation (SAV) extent in NC from Survey 1 (2006/2007) to Survey 2 (2013) in three regional zones 1) the “North Zone” from the US Highway 64 Bridge at Roanoke Island to Hatteras Inlet, 2) the “Central Zone” from Hatteras Inlet to Ophelia Inlet and, 3) the “South Zone” from Barden’s Inlet at Cape Lookout to Bogue Inlet and overall (acres, hectares in parentheses).<sup>69</sup>

Regional Zones	Survey 1	Survey 2	Change	% Change
North	70,861 (28,676)	66,445 (26,889)	-4,416 (-1,787)	-6.2
Central	24,132 (9,766)	23,477 (9,501)	-655 (-265)	-2.7
South	5,850 (2,367)	5,235 (2,119)	-615 (-249)	-10.5
Overall	100,843 (40,810)	95,157 (38,509)	-5,686 (-2,301)	-5.6

Table 8.11. From-to calculations for the net change in high salinity submerged aquatic vegetation (SAV) extent in the three NC zones 1) the “North Zone” from the US Highway 64 Bridge at Roanoke Island to Hatteras Inlet, 2) the “Central Zone” from Hatteras Inlet to Ophelia Inlet and, 3) the “South Zone” from Barden’s Inlet at Cape Lookout to Bogue Inlet and overall (acres, hectares in parentheses).<sup>69</sup>

Conversion		Zone		
From	To	North	Central	South
No SAV	Patchy SAV	4,462 (1,810)	4,386 (1,775)	638 (258)
No SAV	Continuous SAV	203 (82)	150 (601)	60 (24)
Gain		4,665 (1,888)	4,537 (1,836)	698 (283)
Continuous	None	1,895 (766)	401 (162)	88.4 (36)
Patchy	None	7,009 (2,837)	4,782 (1,935)	1,218 (493)
Loss		8,904 (3,603)	5,184 (2,098)	1,306 (528)
Net Loss (Loss – Gain)		4,239 (1,715)	647 (262)	607 (246)
Total		70,861 (28,676)	24,132 (9,766)	5,850 (2,367)
% Change		-6.2	-2.7	-10.5
% Change yr-1		-1.1	-0.5	-1.7

A global assessment of 215 studies found that seagrasses around the world have been disappearing at a rate of 110 km<sup>2</sup> per year since 1980 with an overall global average rate of decline of 1.5 percent per year.<sup>55</sup> Although rates of decline within the northern and central regions of NC are lower than this global average, the higher rate of decline in Back and Bogue sounds (1.7 percent per year) is comparable.<sup>69</sup> Bogue and Back Sounds may be especially vulnerable to the impairment of water quality associated with shoreline development and other anthropomorphic impacts (boat wakes, dredging, fishing gears, etc.).

## Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends

### Wetlands

There are multiple classification systems used to differentiate classes of wetlands, but for the purposes of this paper, we will be using a simplified Cowardin System which splits wetlands into two broad classes: palustrine and estuarine.<sup>70</sup> Palustrine wetlands include all non-tidal wetlands that are dominated by trees, shrubs, or emergent vegetation, as well as any tidal wetlands where ocean-derived salinities are less than 0.5 parts per thousand (ppt). Wetlands with ocean-derived salinities greater than 0.5 ppt are categorized as estuarine wetlands, which can be further divided by vegetation type into forested, scrub/shrub, and emergent estuarine wetlands.

Wetland resources in the United States have declined considerably (>50 percent) since the colonial period.<sup>71</sup> It is estimated nearly half of NC's 11 million historical acres of wetlands were lost (physically or functional) between pre-colonial times and the 1980s.<sup>72</sup> These alterations were not evenly distributed between wetland types, with 52.4 percent of coastal palustrine wetlands having been altered, in contrast with 12.2 percent of estuarine wetlands.<sup>73</sup> The loss of NC's wetlands has continued into the 21st century. Approximately 40 percent of total documented wetland losses occurred between 1950 and 2000. For additional information, see **Chapter 5. Wetland Protection and Restoration through Nature-Based Solutions.**

### Extent in North Carolina

Approximately 95 percent of NC's wetland resources are in the state's Coastal Plain.<sup>74</sup> According to the most recent NOAA Coastal Change Analysis Program (C-CAP) data, NC has 4.35 million acres of palustrine (freshwater) wetlands, of which 71 percent are forested wetlands, 23 percent are scrub/shrub wetlands, and 6 percent are emergent wetlands, as well as 235,425 acres of estuarine wetlands, of which 97 percent are emergent wetlands (Table 8.12 and Figure 8.34).<sup>75</sup>

Table 8.12. Acres of palustrine (freshwater) and estuarine wetlands in NC's Coastal Plain.<sup>75</sup>

Wetland Class	Acres
Palustrine Forested Wetland	3,069,690
Palustrine Scrub/Shrub Wetland	1,008,552
Palustrine Emergent Wetland	272,932
Estuarine Forested Wetland	166
Estuarine Scrub/Shrub Wetland	7,747
Estuarine Emergent Marsh	235,425
Total	4,594,513

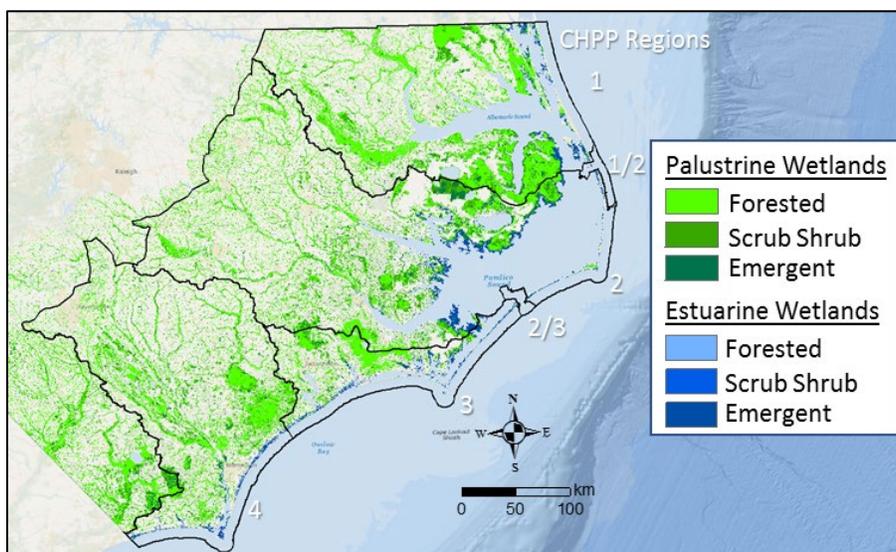


Figure 8.34. Distribution of palustrine and estuarine wetlands with the Coastal Habitat Protection Plan (CHPP) regions.<sup>75</sup>

Calculating wetland change over five year periods beginning in 1996, the recent C-CAP publication of 2011-2016 data provides 20 years of wetland change data for NC’s Coastal Plain.<sup>75</sup> Documented within the 20-year period from 1996-2016, 135,000 acres of palustrine wetland were lost in NC’s Coastal Plain (Table 8.13). Roughly 72 percent of all coastal freshwater wetland losses documented occurred in the first five-year period from 1996 to 2001. A net loss of coastal freshwater wetland was observed 1996 to 2011, with the conversion of freshwater wetlands to upland habitat accounting for the majority of losses (54 to 80 percent). From 1996 to 2011, the rate of net coastal freshwater wetland loss decreased with 2011 to 2016 reporting a net increase. The conversion from upland habitat resulted in a net gain in freshwater wetlands, while conversion to development accounted for 90 percent of all observed palustrine wetland losses.

Table 8.13. Net loss or gain of NC’s coastal palustrine wetland acreage to other land cover classes, by conversion type. Negative values represent a loss of coastal palustrine wetlands to the specified land cover class and positive values represent a gain. Net change represents net change from all land conversions during that time period.<sup>75</sup>

Palustrine Wetland Conversion To:	Time Period				
	1996-2001	2001-2006	2006-2011	2011-2016	20-Yr Total
Development	-6,450	-2,172	-3,001	-1,317	-12,940
Agriculture	-9,218	-2,476	127	0	-11,567
Upland	-77,636	-13,493	-9,748	637	-100,240
Estuarine Wetlands	0	0	0	0	0
Unconsolidated Shore	46	16	-39	-144	-121
Open Water	-3,255	-6,840	-3,973	3,952	-10,116
Net Change	-96,513	-24,965	-16,633	3,128	-134,983

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While the magnitude of cumulative losses to coastal palustrine wetlands from 1996 to 2011, the proportion of loss was not evenly distributed among palustrine subclasses. Palustrine forested wetlands, which account for 71 percent of all coastal palustrine wetland acreage, accounted for 99 percent of overall net losses incurred across all three classes over the 20-years of NOAA C-CAP data (Table 8.14).

Table 8.14. Net loss or gain of NC's coastal palustrine (freshwater) wetland acreage by type palustrine wetland classes. Negative values represent a net loss of coastal palustrine wetlands and positive values represent a net gain of coastal palustrine wetlands.<sup>75</sup>

Time Period	Palustrine Wetland Type		
	Forested	Scrub/Shrub	Emergent
1996-2001	-279,324	147,607	35,204
2001-2006	-150,287	89,661	35,664
2006-2011	-115,836	99,574	-265
2011-2016	-42,969	40,277	5,816
20-Yr Total	-588,416	377,119	76,419

These losses, totaling 588,523 acres of forested palustrine wetlands between 1996 and 2016, were offset by gains of 377,119 acres and 76,684 acres of coastal palustrine scrub/shrub and emergent wetlands, respectively, over the same period.<sup>75</sup> Between 1996 and 2016, conversion to palustrine scrub/shrub wetland accounted for 42 percent of cumulative palustrine forested wetlands losses, conversion to palustrine emergent wetland accounted for 37 percent of cumulative losses, and conversion to upland accounted for 16 percent of losses (Table 8.15). Palustrine scrub/shrub wetlands were the only palustrine wetland class in which net gains in acreage were observed across all four five-year periods between 1996 and 2016. Of 381,426 acres of palustrine scrub/shrub wetland gained between 1996 and 2016, conversion from palustrine forested wetland accounted for 64 percent of gains and palustrine emergent wetland accounted for 35 percent. Conversion of palustrine scrub/shrub to development, which totaled 1,592 acres over the 20-year period, accounted for the largest percentage (42 percent) of cumulative losses. Conversion from palustrine forested wetland was also the major contributor (>99 percent) to palustrine emergent wetland acreage gains between 1996 and 2016. Of the 219,520 acres of palustrine emergent wetland gained through conversion of palustrine forested wetland, the leading contributor to palustrine emergent wetland losses, conversion to palustrine scrub/shrub wetland, negated 62 percent of those potential gains. Indeed, recent analysis of palustrine wetland losses in coastal counties of the conterminous US found that 80 percent of palustrine wetland losses occurring between 1996 and 2010 occurred in five states, with NC ranking fifth and accounting for 8 percent of all losses incurred nationally over the period.<sup>76</sup>

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Table 8.15. Net loss or gain of NC's coastal palustrine forested, scrub/shrub, and emergent wetland acreage by type of conversion to other land cover classes. Negative values represent a net loss of the coastal palustrine wetland class and positive values represent a net gain of the coastal palustrine wetland class.<sup>75</sup>

Conversion Type	Time Period				
	1996-2001	2001-2006	2006-2011	2011-2016	20-year period
<b><i>Palustrine Forested Wetland To:</i></b>					
Development	-6,027	-1,281	-1,530	-870	-9,708
Agriculture	-7,784	-1,783	227	0	-9,340
Upland	-77,143	-10,993	-7,755	367	-95,524
Palustrine Scrub/Shrub Wetland	-122,149	-54,957	-57,626	-10,816	-245,548
Palustrine Emergent Wetland	-63,038	-77,125	-45,049	-34,308	-219,520
Estuarine	0	0	0	0	0
Unconsolidated Shore	11	-2	-2	-66	-59
Open Water	-3,193	-4,149	-4,206	2,724	-8,824
Net Change	-279,324	-150,290	-115,941	-42,969	-588,524
<b><i>Palustrine Scrub/Shrub Wetland To:</i></b>					
Development	-296	-719	-280	-297	-1,592
Agriculture	-704	-159	-33	0	-896
Upland	-37	-197	-783	-3	-1,020
Palustrine Forested Wetland	122,149	54,957	57,626	10,816	245,548
Palustrine Emergent Wetland	26,295	36,153	42,727	30,185	135,360
Estuarine	0	0	0	0	0
Unconsolidated Shore	4	1	7	-16	-4
Open Water	197	-376	310	-407	-276
Net Change	147,607	89,661	99,574	40,277	377,119
<b><i>Palustrine Emergent Wetland To:</i></b>					
Development	-127	-172	-1,190	-150	-1,639
Agriculture	-729	-534	-67	0	-1,330
Upland	-455	-2,303	-1,210	272	-3,696
Palustrine Forested Wetland	63,038	77,125	45,409	34,308	219,880
Palustrine Scrub/Shrub Wetland	-26,295	-36,153	-42,727	-30,185	-135,360
Estuarine	0	0	0	0	0
Unconsolidated Shore	31	16	-44	-62	-59
Open Water	-258	-2,315	-77	1,634	-1,016
Net Change	35,204	35,664	-265	5,816	76,419

In contrast to coastal palustrine wetlands, net change in estuarine wetland acreage exhibited an inverse temporal pattern (Table 8.16).<sup>75</sup> Specifically, net gains of estuarine wetlands were observed between 1996 and 2006, while net losses were observed from 2006 to 2016. The type of land conversion that accounted for the majority of loss shifted considerably through time. Conversion of estuarine wetlands to agriculture and upland land accounted for 48 percent and 42 percent of losses from 1996 to 2001,

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respectively. Conversion to agriculture land accounted for 80 percent of estuarine wetland losses between 2001 and 2006, while conversion to development and upland accounted for 37 percent of losses each between 2006 and 2011. From 2011 to 2016, conversion to unconsolidated shore and open water were the leading sources of estuarine wetland losses, accounting for 38 percent and 32 percent, respectively.

Table 8.16. Net loss or gain of NC's estuarine wetland acreage by type of conversion between estuarine wetlands and other land cover classes. Positive values represent a net gain of estuarine wetlands to the specified land cover class and negative values represent a loss gain of the estuarine wetlands from the specific land class cover.<sup>75</sup>

Estuarine Wetland Conversion To:	Time Period				
	1996-2001	2001-2006	2006-2011	2011-2016	20-yr period
Development	-6	-16	-77	-15	-114
Agriculture	-30	-62	-1	0	-93
Upland	-26	4	-77	-9	-108
Palustrine	0	0	0	0	0
Unconsolidated Shore	252	1	-54	-31	168
Open Water	400	75	146	-26	595
Net Change	590	2	-63	-81	448

### Permitting and Impacts

In NC, EMC has wetland standards (15A NCAC 02B.0231) that provide protection of wetland functions. Projects can impact wetlands if below the allowed threshold. If unavoidable, and a project meets other EMC rule criteria, a project may be permitted, but mitigation is required (15A NCAC 02H.1305). Impact thresholds not requiring a permit are less than or equal to one acre in the coastal region, and less than or equal to 0.5 acres in the piedmont region. The DWR tracks wetland, stream, and buffer impacts that are permitted through the 401 Wetland Program. According to DEQ's Basinwide Information Management System (BIMS), 17,984 acres of wetland impacts were permitted statewide through 12,386 issued 401 certifications and Isolated Wetlands and Waters permits between January 1, 1990 and December 31, 2019 (Figure 8.35).<sup>77</sup> The areas of the most impacted acres can be found in some of the coastal counties. The DWR permit data for the 20 coastal counties indicate that in the 1990s, most impacts were attributable to water dependent structures (marinas, docks, bulkheads), followed by dredging. From 2000 to 2010, there was a large increase in mining impacts. Since 2010, most impacts were associated with transportation (Figure 8.36). Some of the impacts are offset by mitigation.

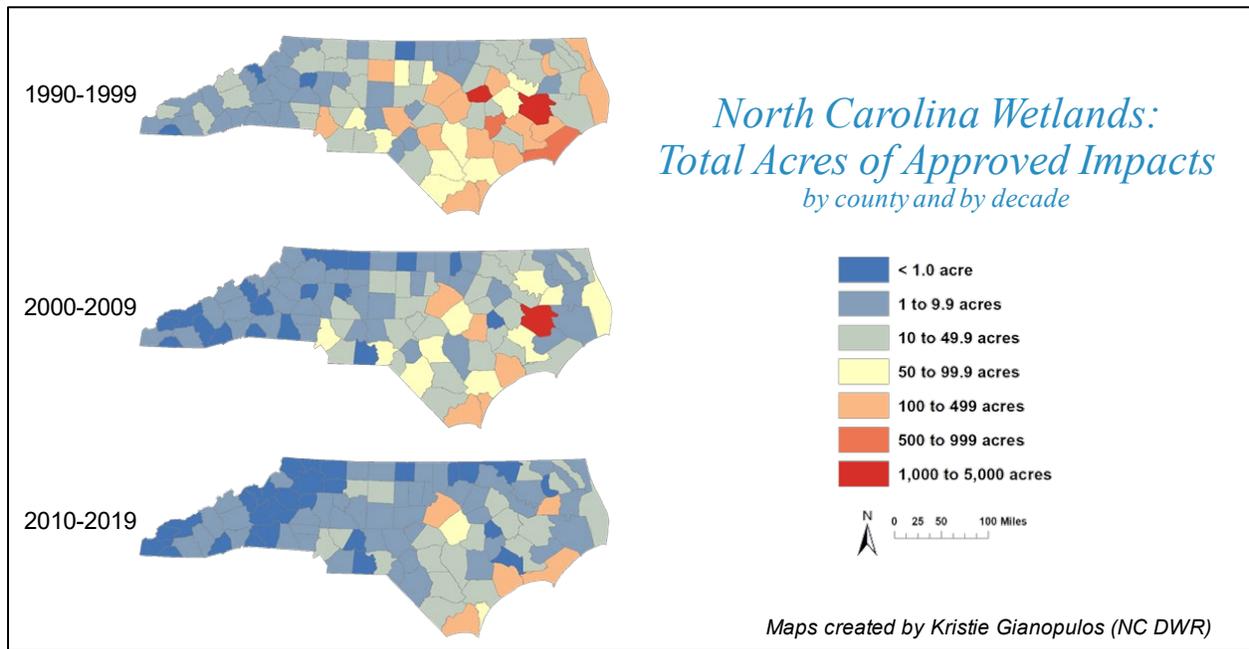


Figure 8.35. Total acres of approved impacts in NC, statewide, over the past 30 years.<sup>77</sup>

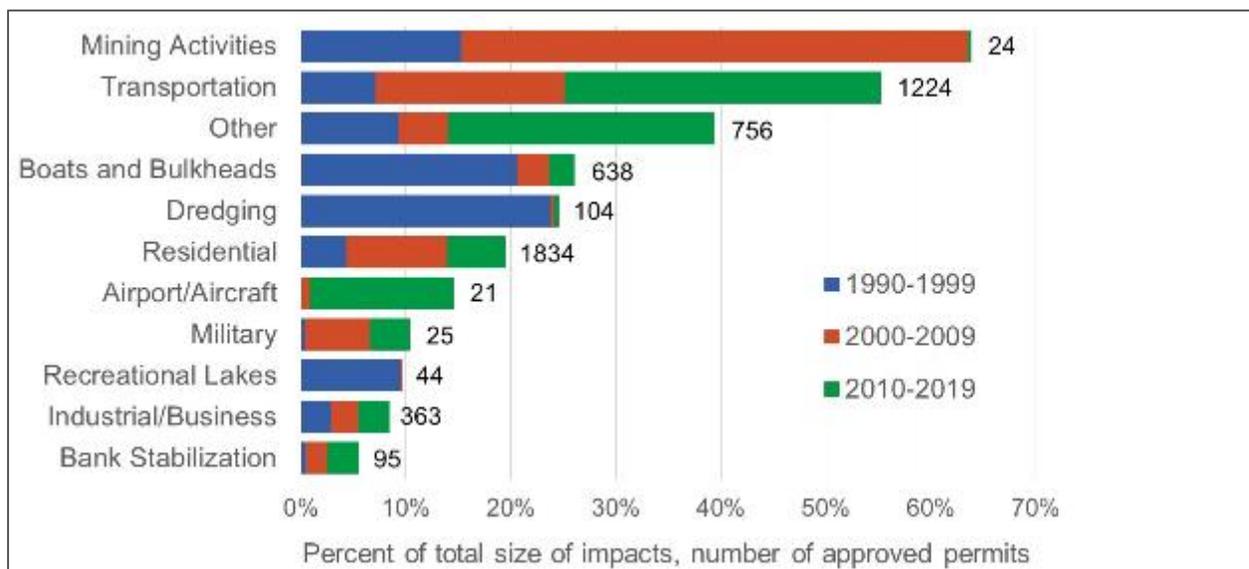


Figure 8.36. Permitted wetland impacts by primary activity type in NC's 20 coastal counties, over the past 30 years.<sup>77</sup>

North Carolina's official wetland monitoring program was initiated by the Division of Water Quality (now DWR) in 2004. Since its inception, wetland monitoring conducted by DWR has been funded primarily by the EPA Wetland Program Development Grants (WPDG). While the first grant primarily supported efforts to monitor headwater wetlands, subsequent grants have provided funding to monitor basin wetlands, riverine swamp forests, and bottomland hardwood forests located across multiple watersheds. Between 2004 and 2015, projects funded largely by the EPA resulted in the monitoring of

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248 wetland sites, 132 of which are in the CHPP region (Figure 8.37). Due to the grant duration and project objectives, most (147 of 248, or 59 percent) were monitored for one year or less.

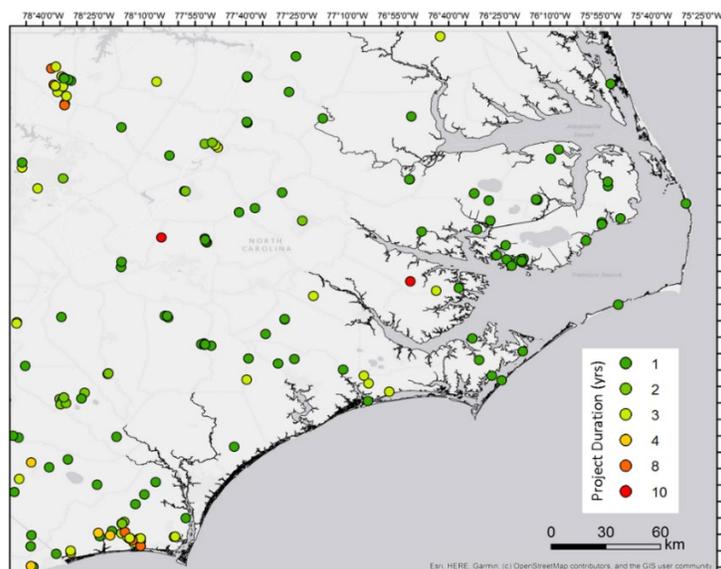


Figure 8.37. Location and sampling duration of wetland monitoring projects conducted by NC Division of Water Resources (DWR) and partners, 2004-2015.

Since 2004, NC DWR wetland projects have ranged from field evaluation of restored mitigation wetlands, to study of headwater wetlands, characterizing isolated wetland hydrologic connectivity, water quality, and biota, and assessing use of natural wetlands for stormwater assimilation, among others.<sup>78</sup> These were all short-term studies. Since the dissolution of the NC DWR Wetland Program Development group in 2013, some wetland monitoring efforts by state agencies have continued, but at a much more limited scale. The Wetland Program Plan (NC WPP) is developed by NC DWR with a stakeholder group on five year cycles to guide actions to research and protect wetlands. The plan is currently being updated and will be finalized in 2021. The Division of Mitigation Services (DMS) also compiles monitoring reports for compensatory mitigation projects, and the Wildlife Resource Commission (WRC) has conducted monitoring to assess abundances of select fauna of interest.

In contrast to the short-term monitoring by NC DWR typical of EPA Wetland Program Development Grant-funded projects that took place between 2004 and 2015, the NC Sentinel Site Cooperative (NCSSC), one of five cooperatives established throughout the US with NOAA funding in 2012, has established long-term monitoring of coastal habitats in eastern NC. The cooperative consists of partners from NOAA, NC Coastal Reserve, DCM, NC Sea Grant, Department of Defense, National Park Service, the NC Aquarium at Pine Knoll Shores, academia, and town governments, with the goal of leveraging resources across organizations to provide stakeholders with information to address sea level rise (SLR) and coastal inundation. A component of the work the NCSSC conducts is the monitoring of coastal habitats to address impacts of SLR. This has entailed leveraging existing and establishing new sites for the long-term monitoring of elevation change using surface elevation tables (SET), which are portable mechanical instruments that provide high-resolution measurements of elevation change within wetland sediments.<sup>79</sup> There are currently over 125 SETs throughout coastal NC generating information on the degree to which coastal marshes are keeping up with SLR (Figure 8.38).

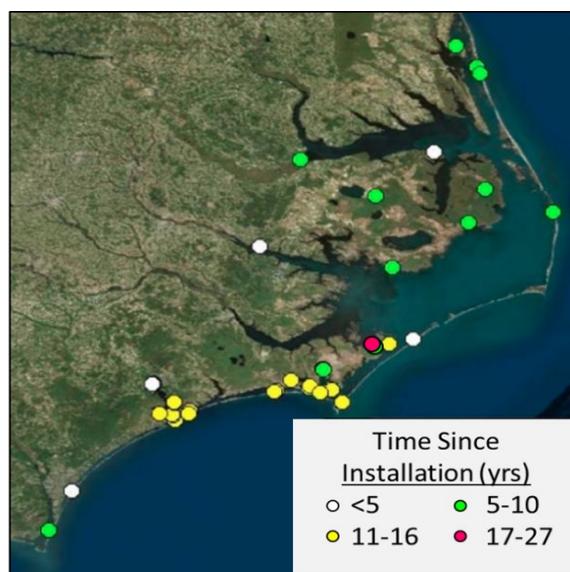


Figure 8.38. Surface elevation table (SET) locations in NC for monitoring long-term of elevation change.<sup>80</sup>

### Hard Bottom

#### Background

Oceanic hard bottom is the primary habitat for offshore marine organisms on the continental shelf of NC.<sup>81, 82</sup> These exposed structures function as foundation for sessile invertebrates and algae, refuge for free moving benthic invertebrates and vertebrates, as well as juvenile, bait, and economically important fishes.<sup>83, 84</sup>

#### Extent in North Carolina

Hard bottom in NC is limited to specific areas of the continental shelf with 90 percent of existing hard bottom occurring south of Cape Hatteras. These natural and important areas are susceptible to overfishing due to their scarcity and abundance of inhabitants. A 1983 study estimated the amount of natural hard bottom reefs between Cape Hatteras and Cape Fear to be around 504,095 acres, or 14 percent of the substratum.<sup>85</sup> Nearshore hard bottoms were considered to be in “good general” condition overall in 1998.<sup>86</sup> Although limited information exists on the distribution of hard bottom off the NC coast, little information is available to evaluate the status and trends of hard bottom habitat in state territorial waters.<sup>87, 88, 89, 90</sup>

While some surveys have been conducted by federal agencies and the energy exploration industry, the exact extent and distribution of productive live bottom habitat on the continental shelf north of Cape Canaveral is unknown. Although a number of attempts have been made, estimations of the total area of hard bottom are confounded due to the discontinuous or patchy nature of the habitat type. It has been estimated that about 4.3 percent of the Georgia Bight is hard bottom, but this is considered an underestimate.<sup>91</sup> It has also been reported that live bottom reef comprises a larger area of the South Atlantic Bight.<sup>92</sup>

Anecdotal information from fishermen and residents in coastal NC suggests that many nearshore hard bottom sites in the mid-twentieth century are now covered by sand, reducing the abundance of fish in these areas. Some areas have already been lost to the effects of beach nourishment.<sup>93</sup> Hard bottom

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habitat off the coast of Wrightsville Beach was buried under two to six inches of sand through erosion off the nourished beach. These once productive fishing grounds no longer support the number or diversity of fish they once did. The observed declines in species abundance and richness lead researchers to conclude that the conflict between beach nourishment and hard bottom productivity is a very serious conflict that will only get worse.<sup>81, 94</sup>

### Artificial Reef Program

As of 2020, DMF's Artificial Reef Program manages 63 artificial reefs including 22 estuarine reefs, 15 of which serve as oyster sanctuaries, and 43 offshore reefs (13 in state waters and 30 in federal waters) with the goal of supporting and functioning similarly to nearby natural reefs while providing user access opportunities (Figure 8.39). The artificial reefs have been shown to support a similar community as natural reefs on multiple metrics.<sup>95, 96</sup> The artificial reefs also provide habitat for top predators and fishes at the edges of their distribution ranges.<sup>97, 98</sup>



Photo Credit: ncoif.com

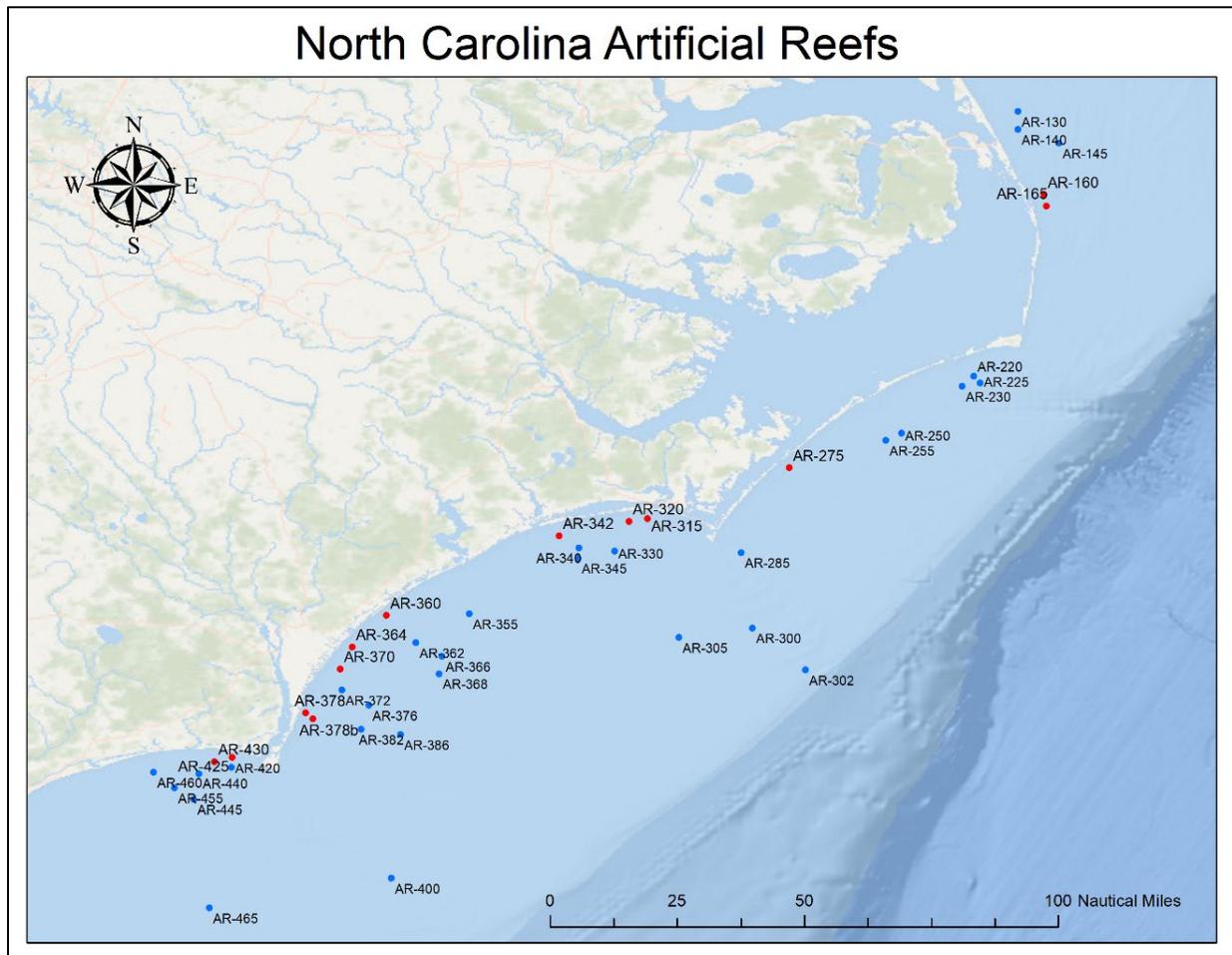


Figure 8.39. Map of all offshore NC Division of Marine Fisheries (DMF) artificial reefs. Blue sites are located in federal waters and red sites are located in state waters.

Currently, the artificial reefs in NC are being monitored by the Artificial Reef Program for material stability and major storm effects on a yearly basis. These reefs are also the focus of research supported by a CRFL grant to compare them to neighboring natural reefs being conducted by NC State University (NCSU) and the National Centers for Coastal Ocean Science (NCCOS). The goal of this research is to determine usage of artificial and natural reefs by fishes at fine and broad scales as well as develop tools for improved monitoring and planning of artificial reef construction. The NCCOS is also in the process of prioritizing the offshore areas of NC, SC, and GA to survey more of the natural and artificial reefs in the areas.

### Soft Bottom

#### Background

Marine sediments constitute one of the largest habitat types on earth, covering roughly 80 percent of the ocean bottom.<sup>99</sup> The only requirement for the persistent presence of soft bottom is sediment supply. These soft sediment environments are complex ecosystems containing strong physical gradients that affect the distribution of species and physicochemical conditions.<sup>100</sup> Environmental characteristics,

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such as grain size, salinity, DO, depth, and flow conditions affect the condition of the habitat and the organisms using it. The characteristic common to all soft bottom is the mobility of unconsolidated sediment.<sup>101</sup> Soft bottom is in a constant state of flux, as other habitats expand or contract. The loss of more structured habitat, such as SAV, wetlands, and shell bottom, leads to gains in soft bottom habitat. Gains in new soft bottom habitat may not be as beneficial as mature soft bottom habitat. An analysis of satellite images (1984-2016) that mapped the global extent of tidal flats, defined as sand, rock, or mud flats that undergo regular tidal inundation, found that this habitat type occupies over 31 million acres worldwide.<sup>102</sup> About 70 percent of the global extent of tidal flats is found in three continents (Asia, 44 percent; North America, 15.5 percent; and South America, 11 percent), with 49 percent being concentrated in just eight countries (Indonesia, China, Australia, the United States, Canada, India, Brazil and Myanmar). It is estimated that approximately 16 percent of tidal flats were lost between 1984 and 2016 due to coastal development, lack of sediment transport, increased erosion, and SLR.

### Extent in North Carolina

In NC, soft bottom covers approximately 90 percent of the estuaries and coastal rivers.<sup>103</sup> As part of the Strategic Habitat Area (SHA) assessments, soft bottom area has been described for all CHPP regions and was usually derived using a combination of the DCM's estuarine shoreline GIS layer, the NOAA bathymetry contour dataset, and the NWI dataset (Table 8.17).<sup>104, 105, 106, 107</sup> As expected, the most extensive amounts of soft bottom can be found in CHPP regions 1 and 2, which include the vast open waters of the Albemarle and Pamlico sound systems. The deep soft bottom (>6 ft) is dominant with at least more than twice the amount of shallow soft bottom (≤6 ft) in every region. However, due to overlapping inlet regions, and the resolution of the data used, this is an over estimation of soft bottom habitat in NC. No targeted mapping efforts exist for soft bottom and bathymetry data are out dated. Therefore, it is not possible to quantify how the extent of soft bottom habitat has changed through time.

Table 8.17. Estimated acreage of estuarine and marine shallow, deep, and unknown depth soft bottom habitat within Coastal Habitat Protection Plan (CHPP) regions of NC. Due to overlapping inlet regions, and the resolution of the data used this is an over estimation of soft bottom habitat in NC.<sup>30, 31, 32, 33</sup>

CHPP Regions	Shallow Soft Bottom (≤6 ft)	Deep Soft Bottom (>6 ft)	Soft Bottom (Unknown)	Total Soft Bottom
Albemarle Sound to Northeastern Coastal Ocean (1)	232,608	610,733	64,908	908,248
Pamlico Sound System (2)	193,417	1,172,449	63,887	1,429,753
White Oak River Basin (3)	128,282	242,402	10,996	381,680
Cape Fear River Basin (4)	31,951	184,556	13,978	230,485
Total				2,950,166

### Benthic Community

The condition and quality of soft bottom habitat can affect species abundance and diversity of the benthic community and could be considered a more important factor for soft bottom than extent. Sediments in soft bottom habitat can accumulate both chemical and microbial contaminants, potentially impacting benthic organisms and the community structure. Tidal creeks are sensitive to various aspects of human activity, but sensitivity depends on the size and location of the creeks. Because tidal creeks are the nexus between estuaries and land-based activities, the potential for contamination is great. Smaller intertidal creeks closer to headwaters demonstrate greater concentrations of nonpoint source

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contamination than larger systems closer to the mouth.<sup>108</sup>

The EPA NCCA is the only regular monitoring of soft bottom in NC. In 2010, the biological quality of 77 percent of the waters in the Southeast coastal region was rated as good based on the benthic index (Figure 8.40).<sup>10</sup> Based on the sediment quality index, 65 percent of the Southeast Coast region was rated good, and sediment toxicity findings indicated that 81 percent were in good condition. The contaminants that most often exceeded the lowest observed adverse effect level (LOAEL) thresholds were selenium, mercury, arsenic, and (in rare instances) total DDTs.



Photo Credit: Nolen Vinay

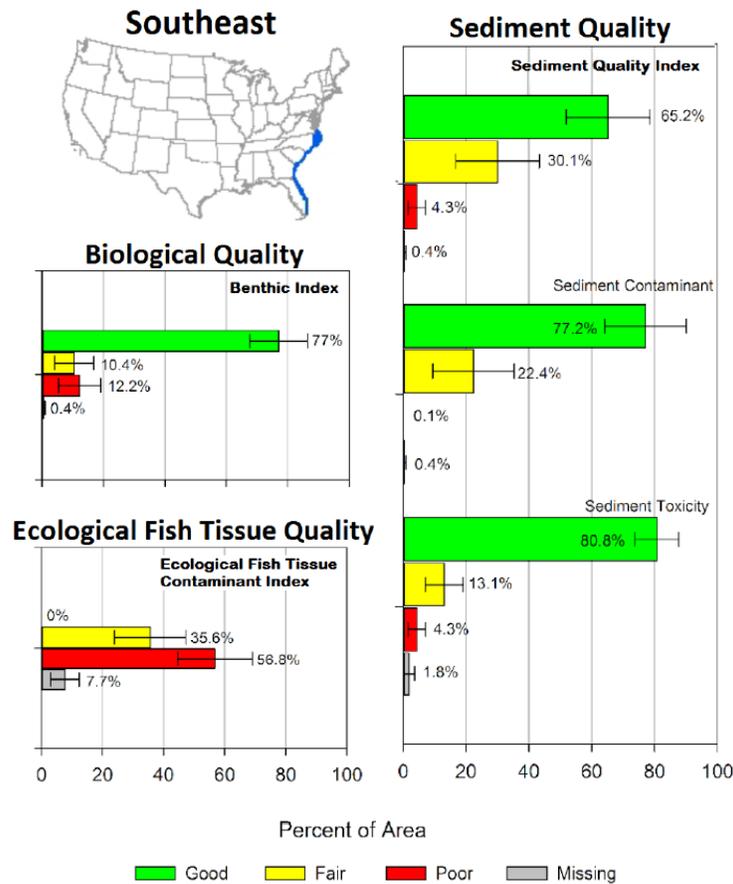


Figure 8.40. The United States Environmental Protection Agency (EPA) National Coastal Condition Assessment (NCCA) 2010 biological, sediment, and ecological fish tissue quality index results for the Southeast Coastal region. Bars show the percent of coastal area within a condition category for specific indicators. Error bars represent 95 percent confidence intervals. Note: The sum of percent of area for each indicator may not add up to 100 percent due to rounding.<sup>10</sup>

Between 2005–2006 and 2010, there was a significant decrease of 27 percent in the area rated good for sediment quality. The sediment contaminants indicator appears to be the driver for this change, while the sediment toxicity indicator shows an opposite result. For the benthic quality index, there is a large, statistically significant increase of 14 percent in waters rated good between 2005–2006 and 2010 (Figure 8.41). While these results might appear contradictory, the sediment and benthic indicators do not necessarily respond to stressors in the same manner. As additional data are collected and analyzed for the NCCA 2015, clearer patterns may emerge. However, in NC it has been shown that sites having higher concentrations of contaminants have lower indices of biotic integrity.<sup>109</sup> This study also found the spatial extent of sediment contamination and toxicity in NC to be much less compared to other US coastal regions where similar studies have been performed.

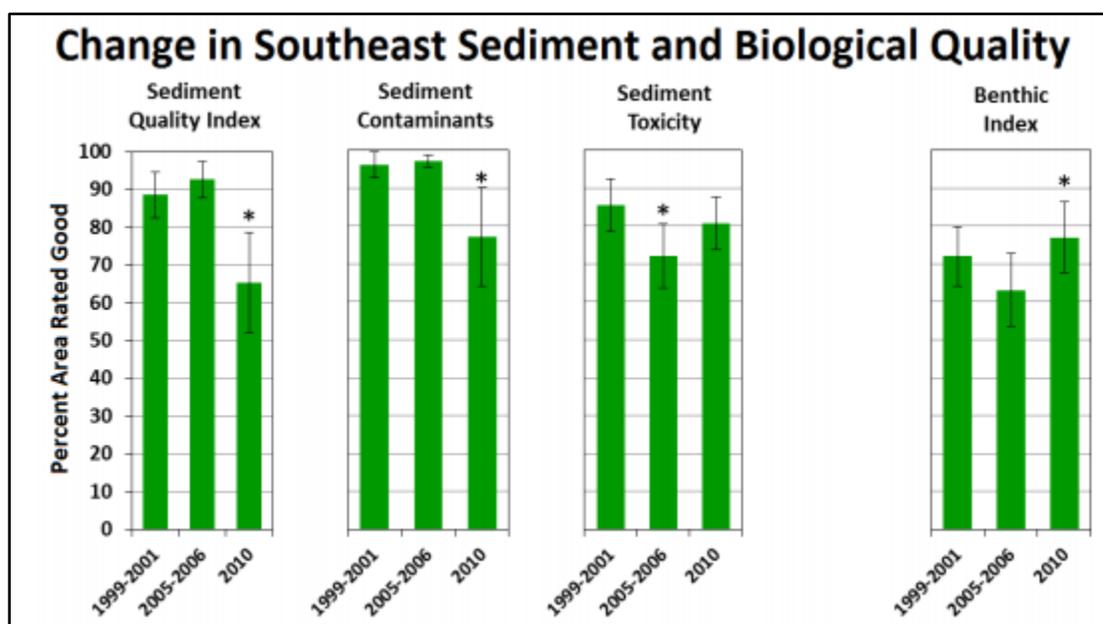


Figure 8.41. The United States Environmental Protection Agency (EPA) National Coastal Condition Assessment (NCCA) 2010 comparison of the percent area rated good for sediment and biological quality over three periods in the Southeast. Note: Asterisks indicate statistically significant change between periods.<sup>10</sup>

Since 1978, DWR Bioassessment Branch has been sampling benthic macroinvertebrates in the wadeable and non-wadeable lotic waters of the state. To date, no benthic sampling occurs within the estuarine waters.

### 8.3 Discussion

The first step for coastal resource managers is to raise public awareness of the problems caused by degradation and destruction of the natural environment and identify the social causes of environmental damage.<sup>4</sup> The complex interactions between and within NC's coastal habitats, the estuarine ecosystems as a whole, and the human population has to be considered by coastal resource managers. This creates the need for regular standardized monitoring and assessments of these habitats in order to quantify their extent and condition using habitat and ecosystem indicators. Ecosystem indicators are measures of a state or level that informs about what is happening in the environment by using a set of metrics, or quantitative measures that provide a standard used to assess an ecosystem indicator, to detect changes in status and trends over time. This information is then used to educate the public about the condition of NC's coastal habitats, inform protection and restoration efforts, and evaluate the effectiveness of management actions and strategies to achieve the CHPP goal of *the long-term enhancement of coastal fisheries associated with coastal habitats*. This need has also been acknowledged in several of DMF's fisheries management plans (Table 8.18).

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Table 8.18. A list of NC Division of Marine Fisheries (DMF) fishery management plans that included habitat and water quality management actions.

NC Fishery Management Plan	Habitat and Water Quality Management Actions
Bay Scallop Amendment 2 <sup>110</sup>	<ul style="list-style-type: none"> <li>Identify and designate SHAs that will enhance protection of the bay scallop</li> <li>Remap and monitor SAV coverage in NC to assess distribution and change over time</li> <li>Accelerate and complete mapping of all shell bottom in coastal</li> </ul>
Kingfishes <sup>111</sup>	<ul style="list-style-type: none"> <li>Identify and delineate SHAs that will enhance protection of southern, Gulf, and northern kingfishes</li> <li>Completely map all SAV in NC</li> </ul>
Red Drum Amendment 1 <sup>112</sup>	<ul style="list-style-type: none"> <li>Identify and designate SHAs using ecologically based criteria, analyze existing rules and enact measures needed to protect SHAs, and improve programs for conservation and acquisition of areas supporting SHAs</li> <li>Complete and continue mapping of SAV to assess distribution and change over time.</li> <li>Conduct cooperative DMF/NOAA research to assess environmental conditions needed to support SAV, and model potential SAV habitat</li> <li>Complete shell bottom mapping throughout the coast</li> </ul>
River Herring Amendment 2 <sup>113</sup>	<ul style="list-style-type: none"> <li>Develop, identify and clarify what critical habitat actions are needed to protect, enhance and restore habitats and water quality affecting river herring</li> </ul>
Southern Flounder Amendment 1 <sup>114</sup>	<ul style="list-style-type: none"> <li>Coordinate SAV mapping efforts such that statewide monitoring and trend analysis can be conducted most efficiently</li> <li>Identify and designate Strategic Habitat Areas (SHAs) and Primary Nursery Areas (PNAs) that will help conserve southern flounder habitat</li> <li>Acquire updated and coast-wide data on bathymetry, sediment type, and pollutant concentrations</li> <li>Continue mapping and monitoring the extent and quality of shell bottom in coastal NC</li> <li>Employ land use data and sea level rise projections to determine priorities for wetland protection, enhancement, or restoration</li> <li>Increase coverage of waters assessed for aquatic life and increase coverage of continuous monitoring stations</li> <li>Monitor estuarine salinities for long-term trends related to climate change</li> </ul>
Spotted Seatrout Revision <sup>115</sup>	<ul style="list-style-type: none"> <li>Continue mapping of SAV in NC to assess distribution and change over time</li> <li>Identify and designate SHAs that will enhance protection of spotted seatrout</li> <li>Expand nursery sampling to include high and low salinity SAV beds to adequately evaluate their use by spotted seatrout and other species, and trends in those species</li> <li>Accelerate and complete mapping of all shell bottom in coastal NC</li> </ul>
Shrimp <sup>116</sup>	<ul style="list-style-type: none"> <li>Identify and delineate SHAs that will enhance protection of penaeid shrimp</li> <li>Completely map all low and high salinity SAV in NC</li> </ul>
Striped Mullet Amendment 1 <sup>117</sup>	<ul style="list-style-type: none"> <li>Develop and maintain accurate maps and documentation of wetlands, soft bottom, SAVs, and water column</li> <li>Monitor to determine if additional areas should be designated as Primary Nursery Areas due to their nursery importance to mullet</li> </ul>

The background section summarizes the most up to date and available monitoring and assessment data to describe the current status and trends of coastal habitats. However, there is no formal process in place for continuously monitoring or establishing standardized ecosystem indicators, thresholds, or reference points for coastal habitats. Ecosystem indicators including quantitative biological, chemical, physical, social, or economic measurements can be used as proxies of the conditions of attributes of the coastal habitats, the estuarine ecosystem, and socio-economic systems.<sup>118, 119</sup> The integration of social and ecological information relevant to stakeholders and managers is an essential component when trying to reach management goals and remediate environmental impacts (Figure 8.42).<sup>8, 120</sup>

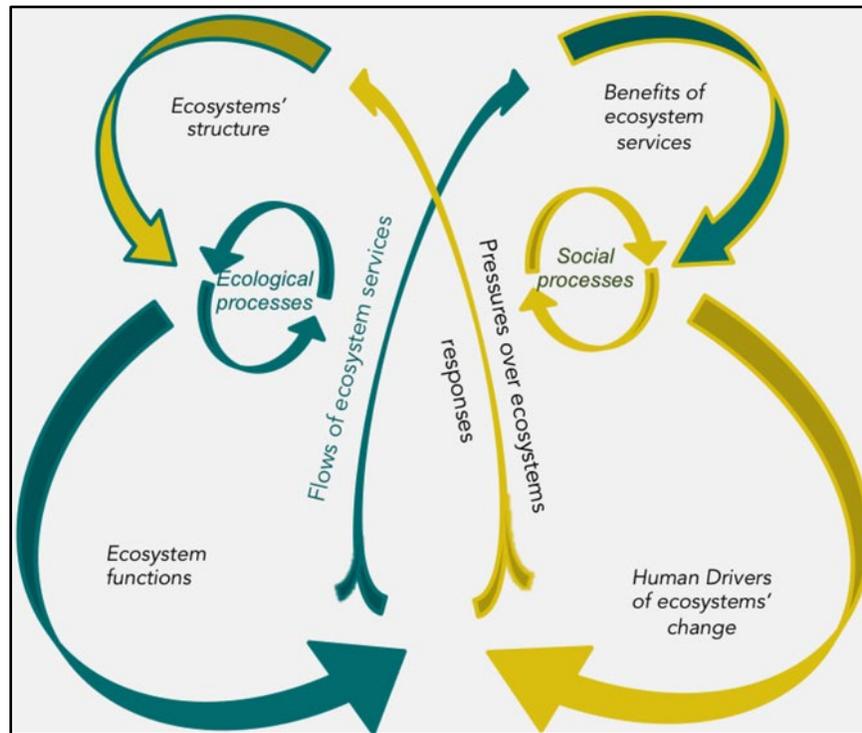


Figure 8.42. The butterfly diagram, a new model for the assessment and design of Ecosystem-Based Management. Supply side is shown in blue; demand side is shown in yellow. Social-ecological systems as interlinked, complex, adaptive systems.<sup>120</sup>

The APNEP has taken significant steps towards identifying coastal habitat and estuarine ecosystem indicator metrics in NC in their comprehensive ecosystem assessment of the Albemarle-Pamlico region.<sup>121</sup> This and similar efforts could be the foundation to identify the suite of indicators to be reported for coastal habitat types as well as by CHPP regions and coastwide.<sup>122, 123</sup> Once indicator metrics with reference points or thresholds are selected, the monitoring needs and data gaps in the extent, resolution, and frequency of the data needed to calculate those metrics can be addressed. Then the condition of coastal habitats, as well as overall estuarine and regional conditions, can be reported in regular intervals. With the push toward EBM, this would give managers the ability to assess changes over time and develop performance criteria for management actions while also creating a condition report, vital signs, or report card, for communicating coastal habitat and ecosystem conditions to the public.<sup>10, 124</sup>

### 8.3.1 Monitoring Needs and Data Gaps

Habitat indicators metrics by coastal habitat types, CHPP regions, and coastwide should be defined by agency and monitoring program staff along with regional experts and academics. Through this process, monitoring needs and data gaps should be determined and addressed to obtain the best available continuous data to inform these metrics. Existing DEQ programs and efforts should be evaluated and standardized whenever possible, and the expansion of existing programs should be explored to fill data gaps before initiating new programs. While some of these efforts are currently underway and several data gaps and monitoring needs have already been identified, this is a vast undertaking that should be done systematically and with the best available data and technologies while also taking into consideration the funding, staff, and resource limitations.

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### Water Column

Water quality monitoring is of the utmost importance for determining the health and condition of the estuarine ecosystem. Poor water quality can have significant impacts on the extent and distribution of coastal habitats and the fauna that use them. Having the ability to determine long-term temporal and spatial trends of water quality indicators and cause and effect relationships are critical for coastal managers. This information is needed to make informed management decisions and evaluate the effectiveness of management actions. While several state and federal agencies and academic institutes collect water quality data at various spatial and temporal scales, DWR's AMS is the most comprehensive long-term, continuous monitoring program along NC's coast. However, the 149 active monitoring stations within the CHPP boundaries are mostly concentrated in riverine and upper estuarine waters with some large spatial gaps existing along the coast. Currently, except for Albemarle Sound, there are no AMS stations in the sounds, at the mouths of the White Oak, New, and Cape Fear rivers, or many of the southern tidal creeks. Concerns for this lack of stations, especially in New River, were discussed by the DMF Shrimp Fishery Management Plan Advisory Committee at their March 2021 workshops.

Most AMS stations are monitored monthly and a core suite of indicators are measured at all stations. These include water temperature, specific conductance, pH, turbidity, total suspended solids (TSS), dissolved oxygen (DO), and fecal coliform. Additional indicators may be included depending on site-specific concerns such as stream classification, discharge types, and historical or suspected issues. Examples of site-specific indicators, which are monitored monthly or quarterly, include salinity, water clarity, flow, nutrients (NH<sub>3</sub>, NO<sub>2</sub>+NO<sub>3</sub>, TKN, TP), fluoride, sulfate, total hardness, color, oil and grease, and chlorophyll *a*. These and all other water quality parameters should be evaluated to determine indicator metrics for tracking the status and trends of the water column habitat. Water quality indicator metrics may also involve other coastal habitats that have threshold tolerances like SAV and shell bottom. Expansion of the AMS to fill the identified spatial data gaps along with the addition of selected parameters chosen for indicator metrics will increase the ability to determine causal relationships between water quality and the natural and human-induced impact to the estuarine system, including fish populations. These data can be used, not only to track the status and trends of the water quality of coastal NC, but also to evaluate the effectiveness of a suite of management actions and allow for the potential for adaptive management of other coastal habitats like SAV and shell bottom that exhibit threshold tolerances. However, like most existing monitoring programs, funding and staff resources are a limiting factor. In addition to the AMS station monitoring, environmental conditions and evaluations associated with a response to fish kills, algal blooms, or other environmental investigations in coastal waterbodies requires dedicated staff.

Algal blooms and fish kill events often involve a host of factors and underlying causes. Therefore, it is crucial to gather as much information as possible surrounding an event from all involved parties. In 1996 the DWR Water Sciences Section (WSS), in consultation with Regional Office staff, Wildlife Resources biologists, and DMF personnel, instituted a new fish kill investigation procedure to be used by the DWR Regional Offices, Monitoring Teams, and other agencies to collect and track information on fish kills throughout the state. Fish kill and fish health data are recorded via standardized methods and sent to WSS where the data are reviewed. Fish kill investigation reports and supplemental information are compiled in a central database where the data can be managed, retrieved, and reported to state officials, scientists, and other concerned parties. Similar efforts have been undertaken with algal blooms, but a standardized procedure for algal bloom investigation across involved agencies is needed to collect the appropriate metrics at the time of the event, which can often be hard to capture. With increased reporting of both fish kills and algal blooms through the online portal and hotline, cross-

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training staff to perform these investigations is of increasing importance.

Public health concerns arise from some algal blooms that are harmful (HABs), producing toxins such as Microcystin that can cause adverse health effects. With technical support from DWR, local health departments and the NC Department of Health and Human Services, appropriate responses (swimming closures, contact advisories, issuance of public notifications, etc.) need to be determined. Due to these concerns, DMF's SSRWQ is currently conducting a pilot study and has prepared a Marine Biotxin Contingency Plan to quickly respond to the emergence of any harmful algae species within State waters that may threaten the health and safety of shellfish consumers. The plan includes sentinel site monitoring for early warning of potential issues, the actions that will be taken to protect public health, and the steps that will be taken to reopen areas to shellfish harvest once the threats have subsided. This plan will begin to collect baseline data in areas not previously covered while complementing DWR's current monitoring efforts. Tracking the number of fish kills and algal blooms could prove to be useful indicator for overall estuarine ecosystem health, as well as development of criteria for determining success of management actions.

### Shell Bottom

Despite what is currently understood regarding the value and necessity of retaining a healthy oyster population in NC's estuaries, there remains several critical knowledge gaps that limit management's ability to confidently evaluate restoration success, oyster reef performance, and estimate population sizes (stock assessment). There is a lack of contemporary, high resolution maps of subtidal hard bottom habitat that naturally occur throughout waterbodies suitable for sustaining oyster populations. There is also limited information regarding the impacts of the commercial oyster dredge fishery on natural oyster reefs, its ability to recover post-harvest, and the proportion of annual harvest that originates from cultch planted reefs.

Through grant funding, DMF is currently working in collaboration with NCSU, The Nature Conservancy, and local oystermen to conduct research in support of a stock assessment survey for oysters in NC.<sup>35</sup> To best assess the subtidal oyster populations, a fishery-independent methodology was developed and piloted across natural reefs in the Pamlico Sound. This methodology makes use of side-scan sonar, diver excavation surveys, and oyster dredges to establish oyster densities, new mortality, size-frequency demographics, and reef condition. This can result in an ideal overall representation of the area's oyster reefs due to careful calibration of the oyster dredge using diver surveys, standardized sampling methods, and the incorporation of gear experts from the commercial fishery. While the typical oyster dredge has low efficiency, this research is demonstrating how it can be effectively used to sample large areas and generate a robust overall average density and abundance estimates.

While this work is focused on modifying DMF's subtidal oyster management trigger sampling program for use in a stock assessment, these outcomes can also be used to standardize subtidal oyster sampling methods and metrics across all programs that encounter subtidal oysters, including oyster sanctuary and cultch planting monitoring. A similar gear comparison pilot study on cultch planted reefs in Stump Sound will be conducted during the 2021 season. Data from this pilot study will be used to assist DMF staff in determining future monitoring of cultch planted reefs to update the Spatfall Evaluation Program 610. Standardizing metrics across the programs that sample subtidal oysters will provide more robust data to be used in the stock assessment that will be used to better track the status and trends of NC's subtidal oyster population. Along with standardized metrics, modified and expanded monitoring designs will also improve siting of future oyster sanctuary and cultch planting sites and the ability to report metrics of success for the rehabilitative efforts.

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Methods to evaluate and monitor NC's intertidal oyster population are also being evaluated. NC's intertidal oyster reefs remain difficult to access and navigate for monitoring due to the short tide windows that they are exposed and the shallow muddy characteristics of the habitat. To address such challenges, remote sensing technology paired with traditional quadrat groundtruth sampling is being explored. Remote sensing by use of Unmanned Aerial Systems (UAS) has considerable potential to radically improve environmental monitoring.<sup>125</sup> Compared to traditional air or space borne remote sensing, UAS-mounted sensors provide high spatial detail over relatively large areas in a cost-effective way and an entirely new capacity for enhanced temporal retrieval. These new survey methods can be used to evaluate the ability to detect changes in density, size-frequency demographics, and reef footprint over time (Bowling et al 2021 unpublished).<sup>35</sup> Preparations are underway to start an updated bottom mapping program. This new shellfish mapping program pilot study Remote Sensing Estuarine Bottom Habitat Mapping (Program 636) will use the remote sensing technology in conjunction with groundtruth sampling to obtain higher resolution mapping with standardized metrics with a focus on the natural intertidal oyster populations along the NC coast.

During the initial pilot study phase (2021-2022), 12 sites across the coast were selected to be mapped and sampled to develop best practices for drone monitoring and standardize groundtruth sampling methods. The sites are 100 acres and were chosen to represent the differing geography, hydrography, and available resource across the CHPP regions. All or a subset of these sites may be selected as long-term monitoring sites, or sentinel sites. The same 24 bottom type strata from the original Estuarine Bottom Habitat Mapping Program will be used, but may be modified and groundtruth sampling methods will be standardized across all DMF subtidal and intertidal oyster sampling programs whenever possible to provide more robust data for an oyster stock assessment to better track trends in the NC oyster population. A new and improved rapid assessment method would allow for a better understanding of the status and trends of the intertidal oyster population in NC, while also producing metrics that could also be used to evaluate and support the effectiveness of management actions.

Initial sampling for the subtidal portion of the study found notable impacts from hurricanes Florence and Dorian were also observed. These observations included heavy sedimentation on oyster reefs, strong water column stratification, hypoxic and anoxic conditions, and reduction in reef material. This sampling showed an overall decrease in oyster density during the same time period. In some cases, a 90 percent decrease in oyster density per square meter across study reefs were found, with an average overall decrease in density of 64 percent for the entire study area.<sup>35</sup> With a projected increase in the strength and intensity of tropical storms, fishery-independent surveys will be important for monitoring water quality and storm-induced mortality. While further study is needed, oyster reef size, profile, and location are thought significantly influence the severity of storm disturbance and resulting oyster mortality. This information could prove to be critical in providing resilience to oyster sanctuary and cultch planting sites through improved site selection and construction criteria.

### Submerged Aquatic Vegetation

Understanding the distribution and health of SAV in NC is critical to understanding the dynamics of shifts in SAV species extent, distribution, and compositions. As previously described, mapping of SAV has occurred at irregular intervals over the last 40+ years by several different agencies and universities, across different extents, and with varying methodologies and resolutions. A comprehensive monitoring and assessment program for SAV should be developed using the best available technology. The use of the most comprehensive, highest resolution, and cost effective methods available should be explored and used. This program should be developed by a team of partners, and should include a full-scale, routine (occurring at least every five years), coast-wide assessment and monitoring program. Sentinel

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sites should be re-evaluated and expanded along the coast, with regular groundtruthing using standardized metrics (i.e. water quality, species composition, density, and condition). This will allow managers to account for changes in SAV over time, giving the ability to evaluate the success of management actions and determine causative relationships between changes in SAV species extent, distribution, and composition. Through regular monitoring and assessment, protection of this habitat can be improved and targeted, benefiting the diversity and resiliency of the entire coastal ecosystem.

Initial steps towards a coastwide, long-term, standardized SAV monitoring plan have been undertaken by APNEP.<sup>126</sup> The APNEP monitoring plan provides the information needed to initiate an SAV monitoring strategy for the Albemarle-Pamlico Estuarine System (APES). The assessment questions used to guide the development of the monitoring design were: 1) how is SAV condition changing in estuarine waters? and 2) are estuarine water quality conditions suitable to sustain the ecosystem services provided by SAV species? The SAV monitoring recommendations within the SAV monitoring plan for APES were based on a series of APNEP SAV Team high-salinity subcommittee and low-salinity subcommittee meetings during September and October 2020. The APNEP SAV team includes APNEP and DMF staff, as well as SAV experts and researchers from across the NC coast. A three-tiered hierarchical framework for SAV monitoring was adopted by both subcommittees and the APNEP Leadership Council to guide the development of recommendations.

This method was first tested in northeastern US and has since been applied in other regions, including the Gulf of Mexico, and is an efficient and feasible way to detect and predict changes in seagrass systems in relation to management actions.<sup>127, 128</sup> In short, Tier 1 monitoring characterizes a few ecosystem properties simultaneously over large spatial scales, typically using satellite or remote sensing methods which are useful to quantify the extent and distribution of the SAV across the coast and geographic regions. Next, Tier 2 monitoring addresses specific environmental issues or ecosystem properties at a higher resolution, generally using ground-based approaches. This allows for monitoring of a limited number of metrics at a large number of sites across the coast or geographic regions. Tier 2 data can be used to quantify stressor/response relationships, and produce estimates of the ecological condition of resources over broad areas, or the quality of the system as a function of physical, chemical, or biological parameters. However, Tier-2 data are generally insufficient for developing predictive capabilities. Finally, Tier 3 monitoring addresses a larger number of metrics at a much smaller number of locations or subset of locations (e.g., sentinel sites). Intensive monitoring of drivers of change, ecosystem responses, and ecological processes at Tier 3 focuses on determining cause and effect relationships and can be used to help explain system wide changes. Both Tier 1 and Tier 2 data can influence targeted monitoring in Tier 3 and can be used to inform the adaptive management process.

Due to limited funding and staff resources, the APNEP monitoring plan proposes a rotational monitoring design, where one SAV region in the APES would be monitored per year until all regions were monitored one time, at which time the rotation would begin again (Figure 8.34).<sup>126</sup> The exact sampling design, including sampling numbers, site selection, sampling techniques, and collected metrics for Tier 2 was determined prior to the 2021 monitoring season. Tier 3 monitoring metric and sites still being determined. Once the three-tiered monitoring framework in the APNEP SAV monitoring plan is established in the high and low salinity regions within APES, this monitoring plan could be expanded to include the southern SAV regions of the state outside of the APES (Figure 8.34). However, like most monitoring, dedicated funding and staff are needed to ensure the long-term continuation of coastwide SAV monitoring. This monitoring is crucial to the understanding of the extent and condition of NC's SAV, as well as supporting management actions and decisions.

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### Wetlands

Comprehensive inventories of natural resources are recognized as critical components for informed management, policy, and conservation actions. Wetland maps are fundamental to wetland inventories, which are critical to management, restoration, protection, and informed development. Inventories informed by robust mapping efforts provide managers the information needed to assess the impacts of anthropogenic activities, changes over time that are attributable to natural phenomena, and the outcomes of management actions and restoration efforts. Consequently, shortcomings in wetland mapping, either in their resolution or comprehensiveness, can impede the development of comprehensive wetland inventories, pose a challenge to conducting robust environmental impact assessments, and broadly hinder data-driven natural resource management. Therefore, safeguarding NC's natural resources, while allowing for sustainable development, hinges on the collection and availability of comprehensive data on the distribution, characteristics, and function of NC's wetlands, 95 percent of which occur within the Coastal Plain.

The two primary wetland mapping sources that provide coastwide wetland distribution data include DCM's Wetland Inventory, and the National Wetland Inventory (NWI). The NWI produces wetland and deepwater habitat maps throughout the United States using photo-interpretation of aerial imagery and is the most extensive inventory of wetlands in the United States. A major shortcoming of the use of aerial imagery is the time lapse between image acquisition and production of wetland maps.<sup>129</sup> Further, the accuracy of imagery interpretation that informs NWI maps coming from multiple sources, is dependent on the quality of the imagery, availability of groundtruthing data, and repeatability by photo-interpretation analysts.

The DCM created a coastwide wetland inventory in the mid-1990's using NWI data, landcover classification from satellite imagery (Landsat data), and county-level soils data. The resolution and accuracy of DCM's wetland inventory, along with the older age of the imagery limits the products utility today. The United States Geological Survey (USGS) and NOAA have federal mapping efforts related to wetlands. NOAA's C-CAP inventories coastal intertidal areas, wetlands, and adjacent uplands on one- to five-year intervals at a spatial resolution of 30 x 30 meter pixels using Landsat data, aerial photography, and field observations.<sup>130</sup> Landsat data remains challenged by the relatively long period between revisits (16-18 days), cloud cover obstructing data collection, and shadows confounding interpretation.<sup>131</sup> As a result, the C-CAP has an accuracy target of 85 percent overall and 80 percent per habitat class.<sup>132</sup>

National and state inventories for land cover and wetlands are important tools used to formulate and evaluate the effectiveness of wetland policies and are integral to models used to predict the aerial extent of wetlands under a variety of future scenarios.<sup>133</sup> Therefore, the accuracy and resolution of these datasets have cascading effects throughout natural resource management and the research by which it is informed. While the spatial and temporal resolution of current NOAA C-CAP data has proven valuable for detecting large-scale changes in wetlands, particularly when the conversion occurs between distinct land cover types, numerous studies using higher-resolution imagery have documented wetland conversions that were not depicted using C-CAP data.<sup>134, 135</sup> Fortunately, there are efforts underway by NOAA C-CAP to generate spatially robust, high resolution (1m x 1m pixel) land cover inventories and map products. High resolution NOAA C-CAP mapping remains limited to a select few partner cost-share pilot projects around the country.<sup>136</sup> While nationwide one-meter resolution mapping is a goal of NOAA C-CAP within the coming decade(s), acquiring this data in the near-term and deriving the competitive advantage will require collaboration and funding through establishing partnerships.

The dramatically improved maps resulting from these pilot projects hold considerable promise to improve natural resource managers' ability to track wetland loss, gain, and land conversions. Further,

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higher resolution mapping of land cover has appreciable potential to improve predictive models critical to allocating scarce conservation and restoration resources. For example, high-resolution mapping of impervious surfaces and other barriers to marsh transgression is imperative to the identification of priority marsh migration corridors.<sup>137</sup> During the CHPP Wetland Workshop, NOAA representatives indicated the possibility of including NC mapping at the one-meter resolution as a pilot project, however state matching funds would be required. The value of high-resolution land cover mapping extends well beyond coastal resource management applications, providing information invaluable to planning and administration of transportation, agriculture, utilities, and infrastructure, to name a few. As such, coastal resource management agencies should consider working with other state agencies to pull together the funding necessary to commission one-meter land cover mapping.

There are several emerging technologies that have potential to allow more precise mapping with greater efficacy. Satellite data (Landsat) and aerial imagery (LIDAR) are more available but have low to moderate resolution. Unmanned Aircraft Systems (UAS) (i.e. drones), can provide rapid high resolution mapping but are not practical for a coastwide assessment.<sup>138</sup> A process known as data fusion, can use the high resolution UAS imagery, that has been field verified, to train classifications of lower resolution satellite imagery, such as WorldView (1.24 m resolution) or RapidEye (5.0 m resolution), improving accuracy of habitat classification with the satellite imagery, and is a method to generate 3D data Gray et al. in press; DEQ 2020). Another technique known as deep learning neural network uses a time series of satellite imagery to evaluate land cover change in a way that reduces post-processing time and increases speed of map creation. The Duke Marine Lab evaluated change in land cover in the Albemarle-Pamlico region between 1989 and 2011 with Landsat imagery and this deep learning technique. They were able to depict where farmland had transitioned to wetland; wetlands transitioning particularly along ditches and canals; and wetland forests along the estuarine shoreline converting to ghost forests (dead trees due to saltwater intrusion).<sup>139, 140</sup> Once proven, this technique would allow automated habitat classifications and change analysis rapidly. The ability to assess wetland change rapidly and accurately is critical to focusing management and restoration actions in priority areas in a time-effective manner.

North Carolina is also home to numerous universities and NGOs conducting research involving coastal wetland monitoring. However, the various sampling methodologies in these studies have impeded efforts to combine data to generate a meaningful picture of habitat condition at broader spatial or temporal scales. The development of standardized protocols to monitor wetlands, coupled with a central repository to submit reports or standardized data would facilitate policy managers and natural resource managers' ability to formulate actions based on robust, scientifically validated information. A repository of standardized wetland monitoring, which would include information from both published and unpublished studies, could minimize redundant sampling by researchers unaware of similar projects and facilitate synergistic collaborations. At the 2020 CHPP Wetland Workshop, most participants recognized the value of standard sampling protocol but thought that would be difficult due to different research objectives and funding sources. There was strong support for a central repository that included a database of who and where monitoring was occurring and completed reports. Both the formulation of some minimum standardized sampling protocol and the development of a centralized repository will require an inclusive process of consultation between practitioners, managers, and other user groups.

Expanded long-term funding opportunities should also be explored. Wetland monitoring conducted by DWR has been funded primarily by the EPAs WPDG that typically focus on short term monitoring projects. To provide a spatially robust inventory of the condition of the state's wetland resources over ecologically meaningful temporal scales, there is a need to move away from a dependence on external grant funding, which can be intermittent and variable in their research objectives, to a recurring state

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appropriation for standardized wetland monitoring that is critical to generating the data needed for science driven management.

### Hard Bottom

Many aspects of the artificial and natural reef systems in NC have yet to be explored. A major concern with artificial reefs is if they are aggregating fishes from natural reefs where they are more easily overfished. Determining whether artificial reefs function only as refuge or if they support and increase fish populations is an important distinction that has not yet been addressed. There is also limited information on the biomass that can be supported by natural reefs and the comparison of artificial reefs. Currently, the artificial reefs in NC are being monitored by the Artificial Reef Program for material stability and major storm effects annually. However, there is no consistent monitoring of the condition of natural hard bottom within state waters. In addition to material and storm monitoring, and research to determine the function of artificial reefs, a monitoring program should be evaluated to inform the extent of natural hard bottom in NC state waters as well as the condition of both natural and artificial reefs.

### Soft Bottom

Coastal soft bottom, sandy shoals and muds flats, are dynamic and ever shifting as other habitats expand or contract. These soft sediment environments are complex ecosystems containing strong physical gradients that affect the distribution of species and physicochemical conditions.<sup>100</sup> As coastal managers continue to mitigate environmental impacts with human needs, bathymetry data and the information that can be derived from it such as predictive models of tides, currents, temperature, and salinity, play a pivotal role in using and managing and understanding the status and trend of NC's coastal resources. Improved and updated bathymetry data of the sounds and NC's coastal waters will not only aid in the management of NC's soft bottom resource for activities such as aquaculture, but it will also contribute important information needed to determine the condition and support management decisions for almost all of the other coastal habitats as well.

In addition to updated information on the extent of soft bottom, it is also important to know the condition and quality of soft bottom habitat since it can affect species abundance and diversity of the benthic community. Monitoring of the sediments in soft bottom habitat for accumulated chemical and microbial contaminants, as well as the benthic organisms potentially impacted by these contaminants, is vital to understanding the status and trends of the soft bottom habitat. While some academic studies have been conducted and the NCCA does collect sediment quality data, the spatial and temporal scales are limited and there is no comprehensive coastwide estuarine soft bottom monitoring in NC. The Bioassessment Branch of DWR has been conducting benthic macroinvertebrate assessments in the wadeable and non-wadeable lotic waters of NC since 1978. However, most sampling stations occur in the headwaters and very few occur in the tidal creeks. This program should be evaluated to expand existing sampling and parameters to fill this monitoring need.

## **8.4 Recommended Actions**

### **8.4.1 Planning**

- 8.1 By 2022, convene interagency workgroups of DEQ agency staff, academics, and subject matter experts by coastal habitat type (i.e., water column, shell bottom, SAV, wetlands, hard bottom, and soft bottom) to define indicator metrics and identify data gaps and monitoring needs for the ability to determine long-term status and trends of coastal habitats and the estuarine ecosystem.

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### 8.4.2 Outreach

- 8.2 By 2026, develop a document determined by the workgroups to communicate the ecosystem conditions of NC to the public.

### 8.4.3 Water Column

- 8.3 By 2023, DWR will evaluate and prioritize estuarine ambient monitoring system sites to address gaps in spatial, habitat, or parameter coverage.
- 8.4 By 2022, DWR will update standardized procedures for algal bloom investigations and evaluate the potential to cross-train other DEQ divisions to perform estuarine and marine investigations.

### 8.4.4 Submerged Aquatic Vegetation

As recommended in the Chapter 4. Submerged Aquatic Vegetation Protection and Restoration through Water Quality Improvements Issue Paper.

- 4.5 By 2023, DEQ will develop and implement a full-scale assessment program to conduct coastwide SAV mapping and monitoring at regular intervals ( $\leq 5$  years).
- 4.6 By 2023, DWR will evaluate and prioritizes the incorporation of shallow water sites ( $< 1\text{m}$  mean lower low water (MLLW)) that currently or historically contain(ed) SAV into the statewide ambient monitoring system.

### 8.4.5 Wetlands

As recommended in the Chapter 5. Wetland Shoreline Protection and Enhancement with Focus on Nature-Based Solutions Issue Paper.

- 5.1 By 2023, DEQ will obtain state matching funds for the NOAA Coastal Change Analysis Program (C-CAP) program to map NC's Coastal Plain at 1m resolution and additional funding to expand wetland monitoring conducted by DWR and other state agencies.
- 5.2 By 2024, DEQ will pursue the use of emerging technologies such as data fusion or deep learning neural networks, that rely on a combination of satellite imagery, drone imagery, and field verification for Coastal Plain wetland mapping and change analyses.
- 5.3 By 2022, DEQ will form an interagency workgroup to develop a Coastal Plain wetland mapping and monitoring plan, including a minimum set of standardized metrics and a potential centralized location to store relevant reports and information.
- 5.4 By 2026, DEQ will determine the status and trends of Coastal Plain wetland acreage, condition, and function, based on the additional mapping and monitoring data obtained.

### 8.4.6 Hard Bottom

- 8.5 By 2023, DMF will develop a monitoring strategy to determine how best to map natural hard bottom reefs in NC state waters and monitor the condition of both natural and artificial reefs.

### 8.4.7 Soft Bottom

- 8.6 By 2023, DWR will examine the feasibility of expanding the benthic macroinvertebrate sampling to address spatial gaps in assessing the estuarine soft bottom benthic community condition.

## 8.5 Literature Cited

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### 9. SUMMARY OF RECOMMENDED ACTIONS

#### 9.1 Priority Habitat Issues Recommendations

##### 9.1.1 Chapter 4. Submerged Aquatic Vegetation Protection and Restoration Through Water Quality Improvements

###### Funding

- 4.1 By 2023, the NC Department of Environmental Quality (DEQ) will pursue recurring funding as well as from state, federal, and private sources that includes the adequate amount of staff to successfully evaluate and meet the submerged aquatic vegetation (SAV) acreage goals and implement all of the SAV recommended actions that contribute to meeting the goals.

###### Planning

- 4.2 By 2022, DEQ will commit to protecting and restoring SAV to reach an interim goal of 191,000 acres coastwide with specific targets by SAV waterbody regions (Table 4.5; Figures 4.1-4.9).
- 4.3 By 2022, DEQ will form an interagency workgroup with non-government organizations (NGOs), and local governments to inform and guide development of watershed restoration plans to protect, restore or replicate natural habitats (i.e., SAV, water quality, coastal habitats) and hydrology through natural and nature-based solutions.
- 4.4 By 2022, DEQ will form a workgroup with the NC Division of Water Resources (DWR), NC Division of Energy, Mineral, and Land Resource (DEMLR), Division of Soil and Water Conservation, local governments, and other partners to increase best management practices (BMPs) to the extent possible related to water quality within the SAV waterbody regions consistent with current funding level and request increased state cost-share funding.

###### Mapping and Monitoring

- 4.5 By 2023, DEQ will develop and implement a full-scale assessment program to conduct coastwide SAV mapping and monitoring at regular intervals ( $\leq 5$  years).
- 4.6 By 2023, DWR will evaluate and prioritize the incorporation of shallow water sites ( $< 1\text{m}$  mean lower low water (MLLW)) that currently or historically contain(ed) SAV into the statewide Ambient Monitoring System.

###### Potential Rulemaking

- 4.7 By 2022, the Environmental Management Commission (EMC) will receive guidance from the Nutrient Criteria Development Plan (NCDP) Scientific Advisory Council (SAC) on establishing a water quality standard for light penetration, with a target value of 22 percent to the deep edge (1.7 m) of SAV for all high salinity SAV waterbody regions, and a light penetration target of 13 percent to the deep edge (1.5 m) for all low SAV waterbody regions (Table 4.5; Figures 4.1-4.9).
- 4.8 By 2022, at the request of the EMC, the NCDP SAC will evaluate the chlorophyll *a* water quality standard and as needed, recommend it be revised by the EMC to ensure protection of SAV in high and low salinity waterbody regions, beginning with the Albemarle Sound and Chowan River, and continuing with other waterbodies that support SAV (Table 4.5; Figures 4.1-4.9).
- 4.9 By 2024, the EMC will enact the rule making process to adopt scientifically defensible nitrogen and/or phosphorus criteria if recommended through the NCDP process, to help protect and restore ~12,900 acres of low salinity SAV habitat in the Albemarle Sound SAV waterbody region

## Chapter 9. Summary of Recommended Actions

and continuing with other waterbodies that support SAV.

### Research

- 4.10 By 2025, DWR will determine with assistance from research academia, the loading and sources of nutrients and sediments, their quantitative linkages to chlorophyll *a* concentrations, and their effect on water quality and SAV.
- 4.11 By 2022, NC and DEQ, through the Secretary of Emergency Management, will request more accurate estuarine bathymetry data from the National Oceanic and Atmospheric Administration (NOAA).
- 4.12 By 2022, DWR will request the NC Policy Collaboratory to investigate the impacts of agricultural practices and land use change on water quality within SAV waterbody regions, to determine types and location of BMPs needed to effectively improve water quality.

### Outreach

- 4.13 By 2022, DEQ Office of Education and Public Affairs will work with local governments and NGOs to start the development of public education and stewardship programs with social media campaigns and citizen science monitoring to increase public awareness of SAV's importance for fish habitat and other co-benefits, as well as instill public commitment to SAV conservation.

### **9.1.2 Chapter 5. Wetlands Shoreline Protection and Enhancement with Focus on Nature-Based Solutions**

#### Mapping and Monitoring

- 5.1 By 2023, DEQ will obtain state matching funds for the NOAA Coastal Change Analysis Program (C-CAP) program to map NC's Coastal Plain at 1m resolution and additional funding to expand wetland monitoring conducted by DWR and other state agencies.
- 5.2 By 2024, DEQ will pursue the use of emerging technologies such as data fusion or deep learning neural networks, that rely on a combination of satellite imagery, drone imagery, and field verification for Coastal Plain wetland mapping and change analyses.
- 5.3 By 2022, DEQ will form an interagency workgroup to develop a Coastal Plain wetland mapping and monitoring plan, including a minimum set of standardized metrics and a potential centralized location to store relevant reports and information.
- 5.4 By 2026, DEQ will determine the status and trends of Coastal Plain wetland acreage, condition, and function, based on the additional mapping and monitoring data obtained.

#### Conservation

- 5.5 By 2022, DEQ will provide information to NC legislators regarding the need for increased appropriated funds for the three state conservation trust funds to increase conservation of critical wetland properties and critical corridors that will allow for future marsh migration.
- 5.6 By 2022, DEQ will actively participate in and support the development of a Southeast Regional Marsh Conservation Plan, which is a partnership with the Department of Defense along with federal, state, and private groups that have been initiated by the Southeast Partnership for Planning and Sustainability (SERPPAS).
- 5.7 By 2026, DEQ will work with researchers, federal and local governments and NGOs to facilitate marsh migration through the conservation of migration corridors, including participation in the

## Chapter 9. Summary of Recommended Actions

Pew Charitable Trusts-SERPPAS Salt Marsh Initiative.

### Restoration and Living Shoreline

- 5.8 By 2022, the NC Division of Marine Fisheries (DMF) will determine potential mechanisms to prevent harvesting from living shorelines constructed with oysters.
- 5.9 By 2025, DEQ will determine if living shoreline projects can be built in a manner that qualifies for salt marsh or nutrient mitigation credits.
- 5.10 By 2025, DEMLR and other divisions should increase education, outreach, and training to consultants, local government, and landowners for nature-based stormwater and watershed management strategies.

### Research

- 5.11 By 2024, DEQ should partner with other organizations to facilitate coastwide completion or enhancement of coastal vulnerability assessment tools, such as living shoreline siting, and marsh migration and wetland restoration prioritization.
- 5.12 Determine optimal parameters for thin layer sediment deposition to ensure wetland success.
- 5.13 Assess trends in salt marsh elevation, inundation, and distribution to prioritize areas for wetland restoration.
- 5.14 Determine the impact of degrading plastics and marine debris on wetlands, sediment, and the benthos.
- 5.15 Research the nutrient (nitrogen, phosphorus) reduction benefits provided by living shorelines and use that information to provide incentives for living shoreline projects.
- 5.16 Study the effects of silvicultural timber harvesting in bottomland swamp forests on hydrology, water quality, and wetland condition; include assessment on the efficacy of forestry BMPs to minimize ecological impacts.
- 5.17 By 2022, DEQ should support efforts to incorporate Coastal Plain wetlands and other coastal habitats into NC's Greenhouse Gas (GHG) Inventory.

### **9.1.3 Chapter 6. Environmental Rule Compliance and Enforcement to Protect Coastal Habitats**

#### Funding

- 6.1 By 2023, through legislative appropriations or budget reallocations, DEQ will increase staffing in DWR and DEMLR by a minimum of two staff (one per office, per agency) in the Washington and Wilmington regional offices.
- 6.2 By 2023, DEQ will seek funding through grants or other sources to supplement state-appropriated compliance efforts.

#### Outreach

- 6.3 By 2022, DWR and DEMLR should work with the NC Division of Environmental Assistance and Customer Service (DEACS) to establish a public portal on DEQ's website that provides information on compliance issues, allows the public to submit complaints, and potentially highlights a list of repeat violators.
- 6.4 By 2023, DWR, DEMLR, and NC Division of Coastal Management (DCM) should develop and hold

## Chapter 9. Summary of Recommended Actions

outreach workshops for NGOs, home owner associations (HOAs), and other interested public, on rules related to land disturbing activities that affect wetlands and water quality, and how to identify violations to improve the effectiveness of public complaints.

- 6.5 By 2022, DEMLR will initiate and continue outreach to stormwater permit holders on rules and required maintenance of stormwater control measures and structures.

### **9.1.4 Chapter 7. Wastewater Infrastructure Solutions for Water Quality Improvement**

#### Policy

- 7.1 By 2024, DEQ will request that funding programs under the purview of the State Water Infrastructure Authority (SWIA) give additional priority for projects with a direct benefit to sensitive estuarine waters, including SA waters, fish nursery areas, and impaired waters, particularly those adversely impacting estuarine fish and their habitat.
- 7.2 By 2025, DWR will develop additional incentives to encourage improved maintenance of the collection system (e.g., incentivize owners and operators of wastewater lines for both existing systems and potential new systems to adopt construction designs that minimize the potential for sewer spills over the long-term).
- 7.3 By 2025, DCM and DWR will work with NC Office of Recovery and Resiliency (NCORR) and local governments in the coastal counties to develop strategies regarding flood-proofing wastewater infrastructure; siting new and relocating existing infrastructure away from sensitive estuarine waters and floodplains; upgrading sewer infrastructure; and develop strategic priorities for public and natural infrastructure improvements.

#### Potential Rulemaking

- 7.4 By 2023, DWR will evaluate modifications of EMC rules to require deemed permitted collection systems under select criteria (e.g., 100,000 or more GPD) to have a certified operator as an Operator in Responsible Charge (ORC). DWR shall provide an update on this evaluation effort to the Water Quality Committee in approximately one year.
- 7.5 By 2023, DWR will investigate modification of EMC rules to require deemed permitted collection systems to be cleaned annually on a systematic basis (e.g., 3 to 5 years). The DWR shall provide an update on this evaluation effort to the Water Quality Committee in approximately one year.

#### Research

- 7.6 Prioritize research on alternative wastewater collection system designs that may be better suited for coastal conditions (i.e., alternative sewer systems, composting toilets).
- 7.7 Evaluate the feasibility of re-designing and re-engineering existing systems that are inadequately protecting ground and surface water quality.

### **9.1.5 Chapter 8. Coastal Habitat Mapping and Monitoring to Assess Status and Trends**

#### Planning

- 8.1 By 2022, convene interagency workgroups of DEQ agency staff, academics, and subject matter experts by coastal habitat type (i.e., water column, shell bottom, SAV, wetlands, hard bottom, and soft bottom) to define indicator metrics and identify data gaps and monitoring needs for the ability to determine long-term status and trends of coastal habitats and the estuarine ecosystem.

## Chapter 9. Summary of Recommended Actions

### Outreach

- 8.2 By 2026, develop a document determined by the workgroups to communicate the ecosystem conditions of NC to the public.

### Water Column

- 8.3 By 2023, DWR will evaluate and prioritize estuarine ambient monitoring system sites to address gaps in spatial, habitat, or parameter coverage.
- 8.4 By 2022, DWR will update standardized procedures for algal bloom investigations and evaluate the potential to cross-train other DEQ divisions to perform estuarine and marine investigations.

### SAV

See the Submerged Aquatic Vegetation (SAV) Protection and Restoration Through Water Quality Improvements Issue Paper Mapping and Monitoring recommended actions 4.5 and 4.6 in section 9.1.1.

### Wetlands

See the Wetlands Shoreline Protection and Enhancement with Focus on Nature-Based Solutions Issue Paper Mapping and Monitoring recommend actions 5.1-5.4 in section 9.1.2.

### Hard Bottom

- 8.5 By 2023, DMF will develop a monitoring strategy to determine how best to map natural hard bottom reefs in NC state waters and monitor the condition of both natural and artificial reefs.

### Soft Bottom

- 8.6 By 2023, DWR will examine the feasibility of expanding the benthic macroinvertebrate sampling to address spatial gaps in assessing the estuarine soft bottom benthic community condition.

### **9.2 North Carolina Coastal Federation/Pew Charitable Trusts Water Quality Stakeholder Workgroup**

During the January 2021 CHPP Steering Committee meeting (CSC), they discussed a request from NC Coastal Federation (NCCF) and Pew Charitable Trusts (Pew) to form a stakeholder workgroup to develop supplemental water quality recommendations that could be accomplished quickly, and have stakeholder support. The NCCF and Pew formed a small workgroup of stakeholders whose focus was to identify actionable strategies to address cross-cutting concerns about water quality as related to nutrient enrichment and sedimentation. A report with recommendations was completed by the workgroup and presented to the CSC meeting on August 3, 2021 and included during the public comment period. The stakeholder workgroup report can be found in Appendix A.

Based on this report and public comment, the following recommendation was added by the CHPP Steering Committee.

- 9.1 By 2022, DEQ will support the formation of a public/private partnership that will engage a diverse group of stakeholders to assist in developing, implementing, and securing decision-maker support and funding for measures in this 2021 CHPP Amendment that protect and restore water quality.

### **9.3 Recommendations from Other Plans Supported by the Coastal Habitat Protection Plan**

Since the 2016 Coastal Habitat Protection Plan (CHPP), several coastal resilience planning documents and reports were developed citing the CHPP with recommendations that are consistent with and are supported by the issue papers in this Amendment. These include the NC Risk and Resiliency Plan 2020,

## Chapter 9. Summary of Recommended Actions

the Natural Working Lands Action Plan 2020, the NC Oyster Blueprint 2021-2025, the Action Plan for Nature-Based Stormwater Strategies, and the State Water Infrastructure Authority Report.<sup>1, 2, 3, 4, 5</sup>

Table 9.1 includes a partial list of existing recommendations adapted from these other plans that are strongly supported by the CHPP and the CHPP Steering Committee (CSC). Several DEQ divisions that implement CHPP recommendations participated in the development of these planning documents and included specific recommendations in the plans to implement through the CHPP. These staff will continue to support and assist with the implementation of these plans through the CHPP and other avenues.

Table 9.1. Recommendations adapted from planning documents that will benefit protection and restoration of coastal habitats and are consistent with the goals and recommendations of the Coastal Habitat Protection Plan (CHPP).

Source(s)	Recommendations	Issue Paper
NC Risk and Resiliency Plan <sup>1</sup>	Enhance outreach, particularly to landowners and decision makers, on the need to have accurate and updated wetland maps due to their high value for fisheries, ecosystem services, and coastal resilience.	Wetlands
	Incorporate climate risk and expected hydrologic and shoreline changes into wetland related policies, such as buffers and wetland impact permitting.	Wetlands
	Actively pursue partnerships with state and federal agencies and NGOs to increase wetland restoration and conservation along coastal rivers and streams to increase ecosystem services and coastal resiliency, taking climate change and SLR into consideration.	Wetlands
Natural Working Lands Action Plan <sup>2</sup>	Facilitate increased conservation and restoration of forested wetlands within floodplains through economic incentives, acquisition, easements, and strategic floodplain buyouts to conserve forested wetlands, enhance ecosystem services, and improve coastal community resilience.	Wetlands
	Facilitate the development of specific policies through local, state, and federal pathways that encourage and incentivize the protection of coastal habitats (including SAV).	SAV
NC Risk and Resiliency Plan & Action plan for nature-based stormwater strategies <sup>1, 4</sup>	Advance state and local policies that promote and incentivize the use of nature-based strategies for public and private landowners when rebuilding damaged infrastructure and managing stormwater runoff to increase coastal resilience. Nature-based stormwater strategies should be designed to achieve “runoff volume matching” as specified in the state’s stormwater design manual.	Wetlands
Action plan for nature-based stormwater strategies <sup>4</sup>	Educate the North Carolina congressional delegation on opportunities to substantially increase the amount of financial resources for working lands and conservation coming from the federal Farm Bill and other federal programs.	Wetlands
The Oyster Blueprint 2021-2025 <sup>3</sup>	The NC Living Shoreline Steering Committee will devise and implement communication and education strategies and publicize the benefits of living shorelines, targeting property owners and contractors.	Wetlands
	Expand current science-based tools for siting and design of living shorelines in all coastal counties.	Wetlands
	Seek monetary incentives (cost share, funding, tax credits, mitigation credits, etc.) to increase the development of living shorelines in place of bulkheads where appropriate.	Wetlands
State Water Infrastructure Authority Report <sup>5</sup>	Request adequate and recurring state appropriated funds needed for the viable utility reserve.	Wastewater
	Request the NC General Assembly modify legislation to allow SWIA flexibility in establishing grant conditions for programs under their authority, to ensure grant funds are used to help systems achieve long-term viability.	Wastewater
	Increase regional planning, incentives for regionalization, consolidation of failing systems, and customer assistance programs.	Wastewater

## Chapter 9. Summary of Recommended Actions

### 9.4 Literature Cited

<sup>1</sup> NCDEQ (North Carolina Department of Environmental Quality). 2020. North Carolina Climate Risk Assessment and Resiliency Plan. North Carolina Department of Environmental Quality, Raleigh, NC. <https://files.nc.gov/ncdeq/climate-change/resilience-plan/2020-Climate-Risk-Assessment-and-Resilience-Plan.pdf>

<sup>2</sup> NCDEQ (North Carolina Department of Environmental Quality). 2020. North Carolina Climate Risk Assessment and Resiliency Plan, Appendix B: North Carolina Natural and Working Lands (NWL) Action Plan, Raleigh, NC. <https://files.nc.gov/ncdeq/climate-change/resilience-plan/Appendix-B-NWL-Action-Plan-FINAL.pdf>

<sup>3</sup> NCCF (North Carolina Coastal Federation). 2021. The Oyster Restoration and Protection Plan for North Carolina: A Blueprint for Action 2021-2025. Ocean, NC. <https://www.nccoast.org/wp-content/uploads/2021/04/Oyster-Blueprint-2021-2025-April-2021.pdf>

<sup>4</sup> NCCF (North Carolina Coastal Federation). 2021. Action plan for nature-based stormwater strategies: Promoting natural designs that reduce flooding and improved water quality in NC. Ocean, NC. 28 p.

<sup>5</sup> NCDWI (North Carolina Division of Water Infrastructure). 2020. Report on the water infrastructure fund and state water infrastructure authority. Fiscal year 2020. North Carolina Department of Environmental Quality. Raleigh, NC. 183 p.



Photo Credit: Casey Knight

## APPENDIX A. NORTH CAROLINA COASTAL FEDERATION AND THE PEW CHARITABLE TRUSTS STAKEHOLDER WORKGROUP REPORT



August 5, 2021

Jimmy Johnson, Coastal Habitats Coordinator  
Albemarle-Pamlico National Estuary Program  
943 Washington Square Mall  
Washington NC, 27889

### **RE: Water Quality Recommendations to Protect and Restore North Carolina's Coastal Habitats**

Dear Jimmy Johnson,

Please find the attached Findings, Conclusions, and Recommendations by an independent stakeholder workgroup convened by the NC Coastal Federation (Federation) and The Pew Charitable Trusts (Pew) during development of the 2021 amendment to the NC Coastal Habitat Protection Plan (CHPP).

Interest in convening a stakeholder workgroup was discussed at the January 2021 CHPP Steering Committee meeting (Coastal Habitat Protection Plan Steering Committee minutes, January 21, 2021). At the April 2021 CHPP Steering Committee meeting, DEQ staff and Steering Committee members encouraged Pew and the Federation to convene such a workgroup by passage of a unanimous motion of support (Coastal Habitat Protection Plan Steering Committee minutes, April 28, 2021).

From May to July of 2021, and in coordination with members of the CHPP Steering Committee and DEQ staff, partners and various stakeholders, the Federation and Pew convened a nine-member Stakeholder Workgroup to identify a set of voluntary water quality improvement actions that would support CHPP goals, could be taken over the next five years, and help minimize the need for regulatory actions.

Based upon its extensive work to protect coastal resources since 1982, the Federation identified a group of stakeholders for the Workgroup that it knew would help identify and then support and implement voluntary water quality improvements. All parties, including the Workgroup, recognized that constraints imposed by limited time and capacity prevented reaching out to a larger set of potential stakeholders during this process. In the future, such efforts would benefit from being more inclusive of additional stakeholder interests and engaging in a robust process to identify an appropriate universe of stakeholders and their shared concerns and interests.

The Workgroup members shared their expertise in farming; fishing; wetland and water quality mitigation practices; land development; local governments; environmental programs, laws and regulations; environmental engineering and management; and property management. Using their combined experiences, they reached consensus and recommended an array of non-regulatory actions to improve water quality.

Once the updated CHPP is final, the stakeholders encourage the CHPP Steering Committee and DEQ staff to form a public/private partnership to focus on implementing CHPP recommendations over the next

## Appendix A. North Carolina Coastal Federation and the Pew Charitable Trusts Stakeholder Workgroup Report

five years. Many of the stakeholders are offering to participate if this partnership is organized.

On August 3, the CHPP steering committee reviewed these recommendations, and voted to include this report as an appendix in the draft plan. The Steering Committee conveyed its interest in receiving comments from interested parties regarding these ideas during the public review period for the CHPP update. Once it is able to review and consider any comments or suggestions it receives, the Steering Committee will then decide how it should incorporate these recommendations into the final CHPP update. The Federation and Pew are ready to work with the CHPP steering committee and its staff to help incorporate these recommendations into the overall plan once the public review period is complete.

The Federation and Pew thank the CHPP Steering Committee, N.C. DEQ staff, Coastwise Partners, the Albemarle-Pamlico National Estuary Partnership, Dr. Jud Kenworthy, Dr. Hans Paerl, Dr. Nathan Hall, and the workgroup members for their tireless dedication to protecting and restoring North Carolina's coast. The Federation and Pew hope that this workgroup is the beginning of a long and successful private/public partnership to implement cross-cutting water quality safeguards to protect and restore coastal fish habitats.

Sincerely,



Todd Miller  
Executive Director  
North Carolina Coastal Federation



Leda Cunningham  
Officer  
The Pew Charitable Trusts

## Appendix A. North Carolina Coastal Federation and the Pew Charitable Trusts Stakeholder Workgroup Report

### Recommendations from the CHPP Stakeholder Workgroup to Protect and Restore NC CHPP Habitats through Voluntary Water Quality Improvement Actions

#### Issues Addressed

A group of stakeholders convened by the North Carolina Coastal Federation (the Federation) and The Pew Charitable Trusts found that maintaining and restoring water quality is essential to the health and productivity of the habitats that are the focus of the Coastal Habitat Protection Plan (CHPP). They determined that there is an immediate and urgent need to invest in and undertake a range of *voluntary actions*, working with partnering stakeholders, that can help reduce the need for regulatory actions in future years. These actions depend on building strong partnerships with stakeholders, aligning these actions with existing and newly funded programs to address issues such as coastal flooding and storm resiliency, and acknowledging that water quality degradation is worsening. Time is of the essence to avert serious and catastrophic fishery habitat declines in the years to come.

#### How the Stakeholder Process was Organized and Conducted

The North Carolina Coastal Federation, the Pew Charitable Trusts, and the CHPP Steering Committee (Coastal Habitat Protection Plan Steering Committee, January 21, 2021) recognized the value of engaging stakeholders to help implement voluntary management actions in and build public support for the 2021 CHPP update. They identified an opportunity to convene a small group of stakeholders to provide input to the CHPP update through a facilitated workgroup process. This was an “organic” process in that the Federation and Pew, in partnering with NC DEQ and APNEP since 2019 to organize technical workshops and bring the best available science into the CHPP update, offered to help fill a widely recognized need for more public engagement in the CHPP process.

Environmental consultants Rich Batiuk and Holly Greening (CoastWise Partners) were asked by the Federation and Pew to facilitate meeting discussions and to interview participants to help identify common concerns and ideas to address those concerns. The Stakeholder Workgroup met three times during the spring and summer of 2021. Locally knowledgeable expert scientists educated workgroup members on the sources of water quality degradation. Workgroup members and scientists then formulated conclusions and proposed actions that were also informed by their areas of individual expertise. By facilitated consensus, the Workgroup arrived at recommendations that, if successfully implemented over the next five years, are expected to help address water quality concerns common throughout the CHPP.

Members of the Workgroup include:

- **Paul Cough**, Former Director of the Oceans and Coastal Protection Division, U.S. Environmental Protection Agency, member APNEP Leadership Council
- **Marion Deerhake**, member, North Carolina Environmental Management Commission (EMC) and Water Quality Committee Chairperson
- **Jonathan Hinkle**, Professional Engineer, GPI (formerly LDSI)
- **Barrett Jenkins**, Mitigation Professional, Restoration Systems
- **Keith Larick**, Natural Resources Director, North Carolina Farm Bureau
- **Clark Wright**, Attorney, Davis Hartman Wright, PLLC
- **Eugene Foxworth**, Assistant County Manager and Planning Director, Carteret County
- **Brian Kramer**, Town Manager, Town of Pine Knolls Shores
- **Stevenson Weeks**, Attorney, Wheatley Law Group, Owner and Operator, Newport River Shellfish Farm

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These meetings were supported by the following people:

### Science Advisors:

- Dr. Hans Paerl, Kenan Professor of Marine and Environmental Science, UNC Institute of Marine Sciences
- Dr. Nathan Hall, Assistant Professor, UNC Institute of Marine Sciences
- Dr. Jud Kenworthy, NOAA, retired and member, Science and Technical Committee, Albemarle-Pamlico National Estuary Partnership

### Facilitators:

- Rich Batiuk, Coastwise Partners
- Holly Greening, Coastwise Partners

### Observers:

- Larry Baldwin, Vice-Chair, Coastal Resources Commission (CRC) and CHPP Steering Committee
- Yvonne Bailey, member, Environmental Management Commission, and Groundwater and Waste Management Committee Chairperson and CHPP Steering Committee
- Dr. Martin Posey, member, Marine Fisheries Commission (MFC) and Chair, CHPP Steering Committee
- Jimmy Johnson, Coastal Habitats Coordinator, Albemarle-Pamlico National Estuary Partnership, North Carolina Department of Environmental Quality (DEQ)
- Anne Deaton, Habitat Program Manager, N.C. Division of Marine Fisheries, North Carolina Department of Environmental Quality

### Staff Organizers:

- Leda Cunningham, Officer, The Pew Charitable Trusts
- Todd Miller, Executive Director, North Carolina Coastal Federation
- Kelly Garvy, Coastal Habitat Coordinator, North Carolina Coastal Federation

### Summary of Discussions of Stakeholders

The CHPP stakeholder workgroup made the following *fact-based findings*. It then developed *consensus-based conclusions* based on the findings. The conclusions form the foundation for the workgroup's recommendations for voluntary actions.

### Findings on Coastal Habitats:

1. Healthy and sustainable fisheries depend on suitable water quality and productive fisheries habitats. These natural resources are the focus of the North Carolina Coastal Habitat Protection Plan.
2. Productive fishery habitats, including submerged aquatic vegetation (SAV), depend on coastal waters that are not degraded by excess nutrients, sediments, pathogens, and other pollutants, and which maintain the appropriate balance of fresh and salt waters that are characteristic of natural conditions in North Carolina's estuaries.
3. SAV and other coastal fishery habitats are becoming increasingly degraded in many estuaries.
4. SAV are declining in quality and extent because most of the important shallow water habitats are not receiving enough sunlight for long term survival. The lack of sunlight is attributed to water quality degradation that includes excessive levels of algae and turbidity.

### Findings on water quality, quantity, and flow:

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1. There is an overall decline in coastal water quality in North Carolina despite management efforts implemented for several decades to control sediment, nutrients, sediment, pathogens, and other pollutants. However, our state has made progress on reducing some forms of nitrogen, the most stimulatory nutrient for algal growth.
2. While some inorganic nitrogen loads have declined, recent water quality monitoring indicates that organic nitrogen is rising.
3. More intensive rainfall due to climate extremes exacerbates coastal water quality degradation by increasing surface runoff.
4. Rapid population growth is leading to more intensive urban and rural land use which changes watershed hydrology. This results in greater volumes and rates of surface runoff transporting nutrients, sediment, pathogens, and other pollutants downstream to estuaries.

Findings on pollutant loading and delivery to the estuaries:

1. Non-point sources within the watershed are the largest contributors to nutrient, sediment, pathogen, and other pollutant loadings to the estuaries.
2. In other states, there are locations where such nutrient, sediment, pathogen, and other pollutant loadings reached a “critical pollutant load” that resulted in major declines in healthy and productive fishery habitats such as SAV. However, coastal habitats can recover if adequate actions are taken to improve water quality. Over the past decade, actions in the Chesapeake Bay to restore SAV have been successful.

Based upon these findings, the CHPP stakeholder workgroup agreed to the following conclusions.

### Conclusions:

1. Strategic uses of existing public and private expertise; federal, state, and local government programs; financial resources; and community stakeholders are key to building new momentum to address ongoing threats to fishery habitats which are attributable to water quality degradation.
2. Habitat protection and restoration measures prioritized by the CHPP need to leverage a broad array of increasingly available financial resources appropriated to help urban areas and rural working lands become more resilient to extreme weather.
3. Progress made in reducing point source pollution is becoming overshadowed by the impacts of nonpoint source pollution.
4. There is a need to prevent and restore degraded water quality to maintain and enhance fishery habitats and fish stocks.
5. Watershed management plans that evaluate water quality monitoring data and identify ways to mimic and restore natural hydrology. These plans are essential for: (1) providing a roadmap to target investments strategically, and (2) taking management actions in the most cost-effective manner.
6. CHPP-recommended actions need to include widespread use of nature-based strategies that protect water quality, help reduce flooding, and make coastal communities more resilient to climate extremes.
7. There is strong scientific and stakeholder agreement that too many pollutants are currently entering our coastal estuaries, presenting an immediate and significant threat to their fishery habitats. It is much more cost-effective to prevent major declines in fishery habitats than it is to restore them, so time is of the essence.

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8. Natural processes that once assimilated pollutants on the landscape no longer protect coastal water quality as effectively because of changes in hydrology on the landscape (i.e., loss of wetlands, pipes and ditches, etc.).
9. Some areas of North Carolina such as portions of Albemarle Sound appear to have reached a critical pollutant loading threshold. North Carolina needs to guard against exceeding critical pollutant loads. The state should act promptly to adopt effective management measures that will reduce water quality degradation and stabilize aquatic systems.
10. Nutrient-reducing management actions are necessary throughout sensitive watersheds that drain into North Carolina's coastal waters. For marine systems which have somewhat small watersheds (e.g., Bogue, Stump and Topsail Sounds), management actions need to be focused near the estuary. For Albemarle and Pamlico Sounds, it is necessary to reduce nutrient inputs from the river basins that drain from hundreds of miles inland.
11. In the next five years, North Carolina should consider the benefits of developing more protective water quality standards in tandem with nonregulatory actions to decrease nutrient, sediment, pathogen, and other pollutant loadings to coastal estuaries.

### Recommended Actions Made by Stakeholders

A set of ambitious and meaningful voluntary actions to help protect and restore water quality and safeguard all CHPP habitats need to be implemented with a sense of urgency over the next five years. All these actions taken together represent a comprehensive, voluntary pollution reduction strategy that can create sufficient momentum to begin to control and reduce nutrient, sediment, and pathogen loadings into the state's estuaries. The goal is for this CHPP update to result in the timely implementation of these voluntary measures so that the damage to coastal habitats caused by water quality degradation will begin to subside and become less severe rather than worsen. To develop and implement these recommended actions, this workgroup recommends the EMC, CRC, and MFC

1. Encourage the CHPP Steering Committee and DEQ to form a public/private partnership to work with stakeholders to further refine and begin to implement the strategy in 2022, and then to continually evaluate and refine the strategy as it's used [1]; and
2. Implement the following actions:
  - (a) Request that the Governor issue an executive order that directs state agencies to work with the CHPP Steering Committee, DEQ, business, industry, agriculture, federal agencies, non-government organizations (NGOs), universities, N.C. Water Resources Research Institute (WRRRI), N.C. Sea Grant, and local governments to implement water quality actions that control and reduce nutrient, sediment, pathogen, and other pollutant loadings in coastal estuaries, and to seek to align those actions whenever feasible with statewide climate resiliency strategies that are being promoted by the Administration.[2]
  - (b) Expand financial incentives and technical assistance to encourage many more communities to voluntarily prepare and routinely update local watershed management and restoration plans. These plans should encourage and enable residents and public and private landowners to identify, plan, and implement cost-effective, nature-based projects and measures that protect, restore and mimic natural hydrology to reduce polluted runoff and flooding, as well as to protect and restore coastal fishery habitat. [3]
  - (c) Focus and prioritize plans and stormwater retrofits funded by the N.C. General Assembly to ensure that coastal fish habitats are protected and restored. [4]

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- (d) Support and promote a financial incentives program that encourages public and private waterfront property owners to use living shorelines to mitigate bank erosion and naturally treat and reduce runoff. [5]
- (e) Promote use of nature-based stormwater practices in state-funded construction in coastal counties and throughout the river basins that flow to coastal habitats. [6]
- (f) Develop and implement a voluntary SAV protection and restoration plan for Bogue Sound. [7]
- (g) Maximize the protection of fishery habitats by encouraging N.C. Department of Transportation (DOT) as well as municipal transportation agencies to adopt nature-based stormwater strategies for highway infrastructure they design, build, and maintain. [8]
- (h) Expand access to financial and technical cost-share assistance and incentives that will help landowners, farmers, foresters, Department of Defense (DOD), and other property owners protect coastal fishery habitats. [9]
- (i) Prioritize nutrient management as a coastal habitat protection strategy to protect and restore the health and productivity of coastal estuaries. [10]

**These endnotes relate to the recommendations summarized above and provide specific ideas for how to implement these actions.**

1. Over the history of the CHPP (adopted 1997), the Steering Committee and DEQ have formed several private/public partnerships to encourage stakeholders to help develop and implement CHPP actions. These partners have provided additional financial and staff resources to assist with public participation, plan documents and videos, and perform monitoring, research, and policy evaluation. Forming such a partnership to help engage stakeholders is essential so that a nutrient, sediment, pathogen, and other pollutant management strategy can be fully refined and implemented by the end of 2022 at the very latest.
2. An Executive Order by the Governor of this nature can help prioritize this issue among the state cabinet agencies. Non-cabinet agencies such as the North Carolina Department of Agriculture and Consumer Services (NCDACS) will need to be consulted and encouraged to partner on this effort.
3. Watershed plans have already been developed by numerous coastal communities and land management groups (including Hyde County, Mattamuskeet Drainage Association, Pine Knoll Shores, Atlantic Beach, Swansboro, Cedar Point, City of Wilmington). These plans provide a competitive advantage in identifying cost-effective projects that reduce the volume and rate of runoff. They help attract federal, state, local, and private funds for projects' design and construction. To make steady progress in developing and carrying out these plans, this workgroup recommends the CRC, EMC and MFC:
  - (a) Encourage the DEQ Secretary to identify and charge one of the Department's divisions with the responsibility of organizing a work group of public and private partners to facilitate the development and implementation of local watershed plans. This DEQ work group should:
    - i. Prioritize which estuarine watersheds are in most urgent need of five-year plans to help protect and restore fishery habitats from water quality degradation;
    - ii. Identify and define cross-cutting purposes for these plans to achieve multiple needs, including enhanced water quality, reduced flooding, and improved fishery habitats, while making communities and their associated working lands more resilient to extreme weather;
    - iii. Work with DEQ and other state agencies, the Governor, and the N.C. General Assembly to secure financial resources for local watershed plan development and implementation; and

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- iv. Identify ways to increase technical assistance to communities for watershed planning and implementation programs.
    - (b) Draft and enact a joint resolution to be sent to public and private funders, stressing the need for local watershed plans aimed at protecting and restoring coastal fishery habitats. Ask them to help secure financial resources to develop and implement local watershed plans.
    - (c) Invite federal and state agencies that oversee and manage coastal resiliency programs and funds to routinely brief Commission members about their programs. Encourage them to work with commissions' staff and private partners to create new opportunities to advance coastal fishery habitat protection and restoration needs as one element of the state's climate resiliency planning.
4. This workgroup recommends the EMC advise and work with DEQ staff to ensure that the stormwater retrofits the State helps to finance address coastal habitat protection needs through the following actions:
  - (a) Encourage DEQ staff to devise program guidance to ensure that a significant portion of appropriated funds target watersheds where water quality needs to be protected and improved to maintain and restore coastal fishery habitat
  - (b) Encourage DEQ to solicit input from the CRC and MFC, their divisions, and the public about which watersheds should be prioritized for stormwater management funds.
  - (c) Allocate a portion of available planning and retrofit funds to determine how to upgrade existing coastal stormwater permitted systems that were designed before the most recent updates to the state's coastal stormwater rules (2008 and later). Many of these older systems have designs that aren't as protective of water quality and have chronic compliance and maintenance issues. The aim is to bring these systems into compliance working with owners to incorporate the latest and most effective stormwater management designs, including nature-based strategies, to the maximum extent practical.
5. Living shorelines are an effective long-term erosion control practice that enhances coastal fishery habitats by reducing pollution and safeguarding water quality. This workgroup recommends the CRC, EMC and MFC:
  - (a) Draft and enact a joint resolution that encourages the N.C. General Assembly, the N.C. Land and Water Fund, the Community Conservation Assistance Program, and other state, federal, and private environmental funders to provide ongoing and consistent support for cost-share programs that offer financial incentives to install living shorelines.
  - (b) Encourage all design professionals and marine contractors that seek and receive authorizations for bank stabilization projects under each commission's laws and rules to obtain training in the use of living shorelines and to work with their clients to consider living shoreline installation at appropriate locations.
6. Nature-based stormwater practices that protect, restore or mimic natural hydrology provide for both water quality enhancements as well as reduce the volume and rate of surface runoff. This workgroup recommends the CRC, EMC and MFC:
  - (a) Draft and enact a joint resolution that encourages the Governor, N.C. General Assembly, state agencies, and public and private funders to promote the use of hydrologic matching (defined in the DEQ stormwater design manual as Low Impact Development (LID)) in state construction projects when such practices are feasible and cost-effective.
  - (b) Encourage the CRC to adopt guidelines to ensure that public water and beach access facilities it helps to finance through grants use nature-based stormwater control measures (SCMs) and provide sanitary bathroom facilities to the maximum extent practicable, and that these facilities

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- serve to set the example for such practices. Through its guidelines, the CRC could encourage informative, educational signage about any nature-based practices used at these access facilities.
- (c) Encourage the N.C. Parks and Recreational Trust Fund to adopt guidelines to ensure that recreational and park facilities it helps finance include nature-based SCMs and sanitary bathroom facilities to the maximum extent practicable, and that these facilities serve to set the example for such practices. Through its guidelines, the Trust Fund should encourage informative, educational signage about any nature-based practices used at these access facilities.
  - (d) Commend and request that the N.C. Wildlife Resources Commission continue and expand its policy of using nature-based SCMs to the maximum extent practicable at its boating access facilities and educate the public about the use of such practices with informative, educational signage at its access facilities.
7. Recent state monitoring by the Albemarle-Pamlico National Estuary Partnership indicates that SAV in Bogue Sound is declining. This workgroup recommends the CRC, EMC and MFC:
- (a) Work with Carteret County, Pine Knoll Shores, and other local governments, as well as private and public partners, to develop and implement a voluntary program designed to protect and restore SAV in Bogue Sound. The program should promote the use of existing and new sources of technical assistance and financial incentives by public and private property owners to encourage them to install living shorelines and nature-based stormwater strategies to reduce sedimentation caused by shoreline erosion, as well as polluted runoff.
  - (b) Encourage scientific monitoring and analysis of this focused SAV restoration program's performance to determine lessons learned so it can be a model for other estuaries where intensifying land use patterns and boating may cause SAV declines.
8. DOT and municipal transportation agencies operate the largest stormwater drainage systems in N.C. This workgroup recommends the CRC, EMC and MFC:
- (a) Encourage DOT and municipal transportation agencies to use nature-based stormwater strategies in their transportation infrastructure when they are practical, technically feasible, and cost-effective.
  - (b) Evaluate their own permitting and authorization processes and rules to ensure they are not creating unnecessary regulatory roadblocks that discourage the use of nature-based strategies (stormwater and living shorelines) in transportation infrastructure.
  - (c) Ask DOT and Commission staff to evaluate and brief the commissions on laws and regulations relevant to their stormwater management programs. This will help identify regulatory hurdles that may discourage the use of nature-based strategies to control stormwater and bank erosion and sedimentation in transportation infrastructure. Work with DOT to seek to remove or reduce hurdles without compromising legally mandated environmental or other goals.
  - (d) Ask DOT to report annually to the EMC, CRC, and MFC on its nature-based stormwater initiatives and adoption progress.
9. This workgroup recommends the CRC, EMC and MFC:
- (a) Provide encouragement and policy assistance to private non-profits (conservation and trade organizations) and mitigation companies to establish a voluntary program through partnerships, funded by entities interested in improving fisheries productivity, water quality, and coastal resiliency, that financially support use of best management practices and other activities that:

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- i. Reduce and remove nutrients from estuaries that experience, or are subject to experiencing, excessive growth of microscopic or macroscopic vegetation that are harmful to fishery habitats;
  - ii. Reduce other pollutants in estuaries that are harmful to fishery habitats; and
  - iii. Make the coastal economy and its residents more resilient to extreme weather. Establish this program as a public/private partnership that will attract financial support from private and public funders interested in maintaining productive fisheries, water quality, and coastal resiliency.
- (b) Encourage the DEQ Secretary to identify and charge one of the Department's divisions with the responsibility of organizing a work group of public and private stakeholders to analyze the need to expand state-funded cost-share assistance for enhanced protection and restoration of coastal fishery habitats. Based on the findings of the Secretary's work group, draft and pass a joint resolution that requests the N.C. General Assembly increase state funds for state-funded cost-share programs that protect and restore water quality and coastal fishery habitats.
- (c) Include the protection of coastal fishery habitats as a priority in the Conservation Plan for North Carolina adopted by the US Department of Agriculture Natural Resources Conservation Service (USDA NRCS). Each year NRCS seeks help from its state and local agency partners, as well as private stakeholders, to identify target areas and priorities where it should focus its conservation funding. Coastal fishery habitats are not currently included in NRCS's Conservation Plan as a specific funding priority. This workgroup recommends the CRC, EMC and MFC:
  - i. Designate a member of each Commission to serve on the NRCS State Technical Committee to help facilitate the use of NRCS's resources to implement the CHPP. These designees would: (1) meet with NRCS state staff and leadership to explore and identify opportunities to help focus NRCS conservation practices and funds on helping to protect and restore coastal fish habitats, and (2) report routinely to their Commissions on how NRCS programs are being focused, aligned, and successfully used to protect and restore fishery habitats.
  - ii. Based upon these discussions, draft and enact resolutions that are sent to the Technical Committee and the NRCS State Conservationist requesting NRCS's help to protect and restore fishery habitats as a priority conservation need in North Carolina. Each joint resolution should include a request that NRCS develop specific programs, funding mechanisms, and technical assistance to engage directly in protecting and restoring marine fisheries habitats that are the focus of the CHPP.
  - iii. Ask NRCS to substantially increase its financial and technical support for protecting and restoring coastal fishery habitats and provide annual progress report presentations to each Commission.
  - iv. Seek ways to help publicize and encourage participation by oyster farmers in the NRCS cost-share program that is currently available. This is a new funding program that should be promoted in the CHPP, and the MFC and other partners should work with NRCS to grow this program substantially over the next five years.
  - v. Encourage NRCS to work with public and private partners to form a Regional Conservation Partnership to promote coordination between NRCS, state agencies, NGOs, and private landowners and businesses to deliver conservation assistance and program contracts or easement agreements that advance the protection and restoration of marine fishery habitats.
- (d) Support through resolutions and letters of support efforts by the U.S. Department of Defense and its private conservation partners to obtain federal funds for land acquisitions and

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conservation easements that enable projects to prevent incompatible land uses that conflict with military training operations, and which can help to protect and restore water quality and coastal fishery habitat.

- (e) Endorse resiliency projects undertaken by the DOD that use nature-based stormwater practices and living shorelines to make military installations and operations in neighboring communities more resilient to extreme weather while at the same time improving water quality and reducing the volume and rates of runoff to the estuary.
  - (f) Request adequate reoccurring appropriations for Community Conservation Assistance Program (CCAP) for water quality practices that control and reduce nutrient, sediment, pathogen, and other pollutant loadings to coastal estuaries.
10. This workgroup recommends the CRC, EMC and MFC:
- (a) Ask the N.C. Attorney General for an opinion if coastal fishery habitats fall within the meaning of “existing use” under the Federal Clean Water Act.
  - (b) Support through Commission resolutions increased funding for robust water quality and habitat monitoring programs. These programs should include those already conducted by state agencies as well as work by expert third parties that help to determine the status and trends in water quality and the health of fishery habitats. Water quality monitoring in the estuary should be expanded to include chlorophyll-a, nutrients, and other pollutant concentrations where important data gaps exist. The CHPP Steering Committee should review and evaluate the adequacy of monitoring program at least once annually and transmit its findings to the public and state leadership.
  - (c) Ask the Albemarle-Pamlico National Estuary Partnership, and other federal, state, or local, and non-profit organizations and the public to provide information during the early stages of the EMC’s Triennial Review process about any water quality-related declines in fishery habitats they have documented.
  - (d) To minimize the need for future mandates for regulatory actions under the Clean Water Act, encourage timely use of non-regulatory actions (such as those identified in these recommendations) to address water quality impairments that degrade coastal fishery habitats.

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## APPENDIX B. PUBLIC COMMENT

A public comment period on the draft plan occurred from September 21 to October 21, 2021. Comments were received at five MFC Advisory Committee (AC) meetings held virtually in October, an online survey, and mailed and emailed comments.

### 2021 CHPP Advisory Committee Input

All five advisory committees voiced support for the CHPP document verbally and in motions that passed unanimously (Table 1). Refer to the MFC AC meeting memos for more details of each meeting. The Southern, Finfish, Shellfish/Crustacean, and Habitat and Water Quality ACs passed identical motions. The Northern AC was similar, but requested additions in the “Wastewater Infrastructure Solutions for Water Quality Improvement” issue paper to address concerns regarding septic tank systems. The Northern and Finfish ACs each made an additional motion.

The identical motion made at the four committees states that they support the draft CHPP, along with the inclusion to explore the formation of a public/private partnership.

There was strong support for a public/private partnership at all the AC meetings and from the public. It was noted that adding a public/private partnership would be beneficial due to increased collaboration and resources to implement CHPP recommendations, and increased public awareness and support. The public and private partners would be able to advocate for action with the General Assembly and others and broaden funding opportunities for implementation.

Table B.1. Motions from the October 2021 Marine Fisheries Commission (MFC) standing and regional advisory committee meetings.

Advisory Committee	Motion
Southern, Finfish, Shellfish/Crustacean, Habitat and Water Quality	The AC supports the intent of the 2021 draft Amendment to the CHPP and the inclusion within the plan of the stakeholder recommendations to explore including the formation of a public/private partnership with stakeholders to seek state, federal and private funding to support the plans recommended actions and stakeholder recommendations.
Northern	The AC accepts the recommendations of the 2021 CHPP with additions to the Wastewater Infrastructure Solutions for Water Quality Improvement Issue Paper relative to concerns about septic systems and infrastructure.
Northern	The AC recommends inclusion of a recommended action in the Protection and Restoration of Submerged Aquatic Vegetation (SAV) through Water Quality Improvements Issue Paper to address and reduce nitrogen loading to the atmosphere from livestock waste lagoons, which is a significant source of nitrogen input to our coastal waters.
Finfish	The document should include that they work with Division of Soil and Water Conservation to introduce vegetative buffer zones on farmland and livestock operations in the coastal region and near river water ways.

All the advisory committees voiced concern over water quality, frustration that more has not been done regarding degrading water quality and expressed a sense of urgency to take action.

## Appendix B. Public Comment

The Southern AC discussed the impact that intense development is having on runoff, flooding, and water quality. They discussed that development is continuing where existing stormwater measures were not being enforced to prevent problems. There was support for establishing nutrient criteria to protect and restore SAV, and to conduct habitat monitoring to quantify the link between land use and water quality. Two members of the public commented, mentioning concern with wastewater entering coastal waters, runoff, and that climate change would exasperate those issues. They said there was a need for more low impact development, using wetlands in nature-based solutions, and establishing a public-private partnership.

The Northern and Finfish ACs agreed with the emphasis on SAV and wetlands protection and restoration. There was discussion about creating areas to retain runoff and allow nutrients to settle. Landowners could possibly be paid an incentive to set land aside for this, or farmers could be given carbon credits for letting land convert back to wetlands. Both committees mentioned that lack of vegetated buffers around farms and animal operations, and that large-scale clearing of wetlands for forestry were major contributors to water quality degradation that need to be addressed. The Northern AC also noted concern that air deposition of nutrients from animal operations were contributing to nutrient increases and should be addressed. Both committees agreed that failing wastewater infrastructure, as well as septic tank systems, contribute to eutrophication and that more information be added into the CHPP to address septic tanks. Septic tank concerns were especially concerning due to rising sea level and low coastal elevations.

The Habitat and Water Quality AC also brought up concerns over agriculture and wanted more action through the CHPP that address agriculture impacts. They said it was important to get the Department of Agriculture involved into the process at a high level. Several members provided additional information regarding trends of high salinity SAV becoming patchier, and the connection of flow conditions to water quality was suggested to be added to the plan. Another member suggested the benefit of changing the permit process so that when a waterfront property owner wants a dock or other water-dependent permit, they should be responsible for offsetting the impact by adding a positive environmental project, such as a living shoreline.

A total of 12 members of the public spoke at the five AC meetings. There were many concerns and suggestions related to water quality, including support for addressing wastewater infrastructure; addressing runoff and flooding through low impact development (LID) and nature-based solutions; and the need for clean water and therefore support for developing water quality standards to sustain SAV. It was also pointed out that clean water is essential for the coastal economy, particularly for shellfish mariculture. Other concerns included emerging contaminants and plastic in wastewater effluent, impacts to wetlands from debris, bulkheads, logging for the wood pellet industry, and the need for additional outreach to the public. Several mentioned support for formation of a public/private partnership and a member of the NC Oyster Steering Committee said the group is willing to collaborate on the CHPP initiative. One person spoke on behalf of the NC Water Quality Association about the SAV Issue Paper. While supportive of protecting SAV and developing water clarity criteria, he provided several specific comments on the approach and did not support development of nutrient criteria.

### 2021 CHPP Public Comment Survey Summary

The draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment Public Comment survey garnered responses from 93 individuals. Almost all of the survey participants lived in North Carolina (88, 95%) with a few from other states including Virginia (3, 3%), South Carolina (1, 1%), and Michigan (1, 1%). The North Carolina residents hailed from 28 different counties including New Hanover (16%), Wake (15%), Carteret (13%), Dare (12%), Mecklenburg (6%), Brunswick (5%), Pender (3%), Onslow (3%), Durham

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(2%), Watauga (2%), Pitt (2%), Craven (2%), Pamlico (3%), and 17% from other counties (Figure B.1). More than 75% of the survey participants expressed an above average knowledge of coastal fish habitats and water quality management with less than 5% expressing no knowledge. Of the survey participants 90% are very concerned about coastal habitats and water quality (Figures B.2). The survey participants represented a wide variety of user groups with the highest number of participants identifying with the following user groups: nature enthusiast (e.g., boating, swimming, beach going, birding) (28%), recreational fishing or associated businesses (17%), coastal resident (not waterfront) (12%), non-coastal resident (10%), and coastal waterfront property owner (9%), scientist/researcher (4%), tourism industry (3%), construction of real estate industry (12%), commercial fishing or associated businesses (2%), along with several others (Figure B.4).

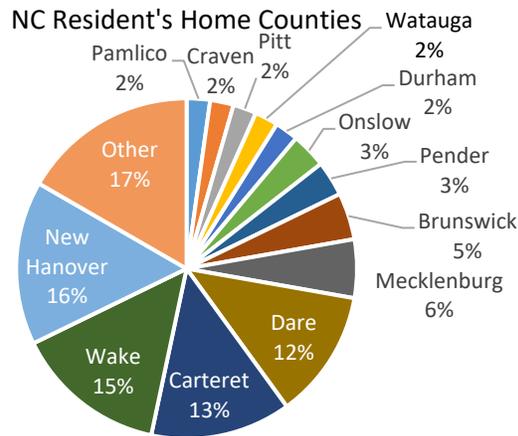


Figure B.1. The home county of the North Carolina residents that participated in the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment Public Comment survey.

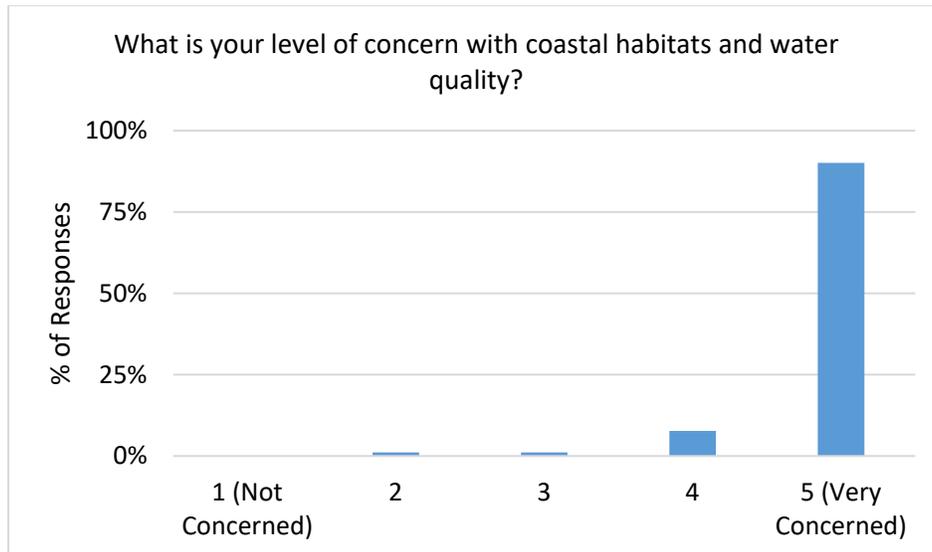


Figure B.2. Level of concern with coastal habitats and water quality of the participants of the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment Public Comment survey.

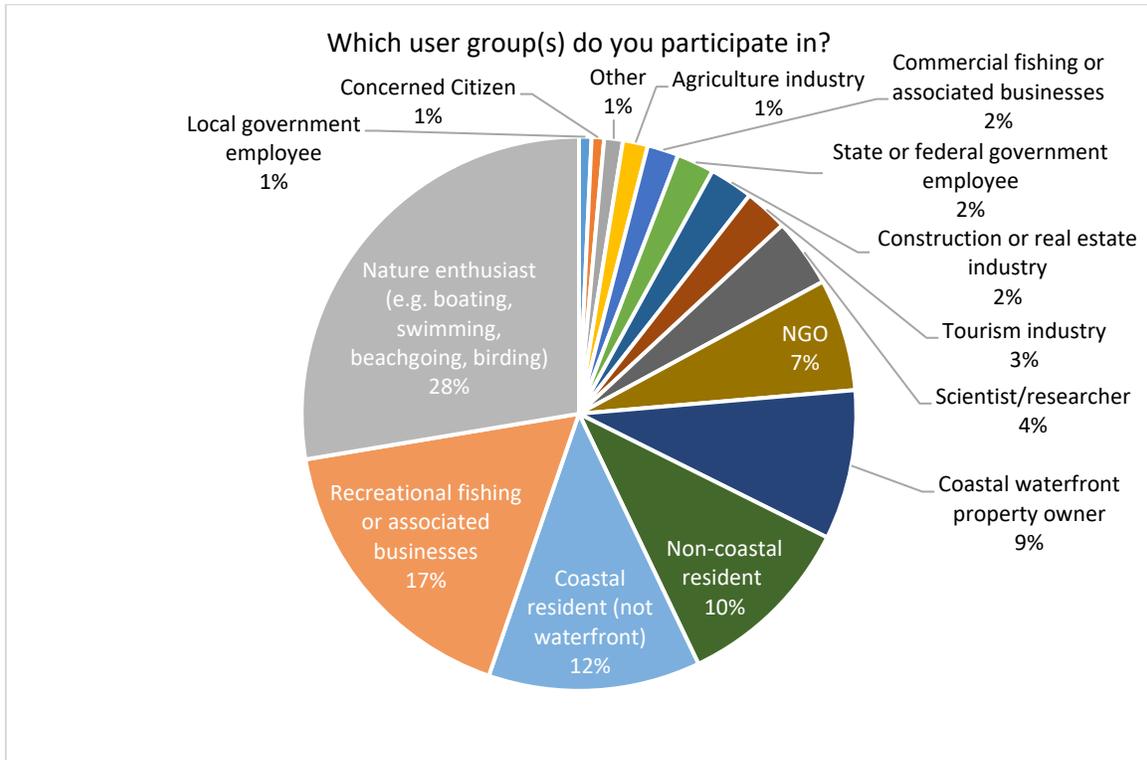


Figure B.3. User groups of the participants of the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment Public Comment survey. Note participants could select multiple user groups. So the total is not representative of the number of participants.

Regarding the “Protection and Restoration of Submerged Aquatic Vegetation (SAV) through Water Quality Improvements” issue paper, over 80% of survey participants strongly agreed with the implementation of nutrient targets/standards (i.e., rules) to improve water quality for SAV, and that state funding should be provided to implement the recommended actions to protect and restore SAV to its documented former extent in acreage. Over 75% of survey participants strongly agreed with implementing a coastwide SAV mapping and monitoring program to determine if management changes are effective. Additionally, over 90% of survey participants strongly agreed that nature-based best management practices (e.g., rain gardens, living shorelines, infiltration basins) and low impact development should be used to a greater extent to reduce runoff associated with development and agriculture was also strongly supported (Figure B.4).

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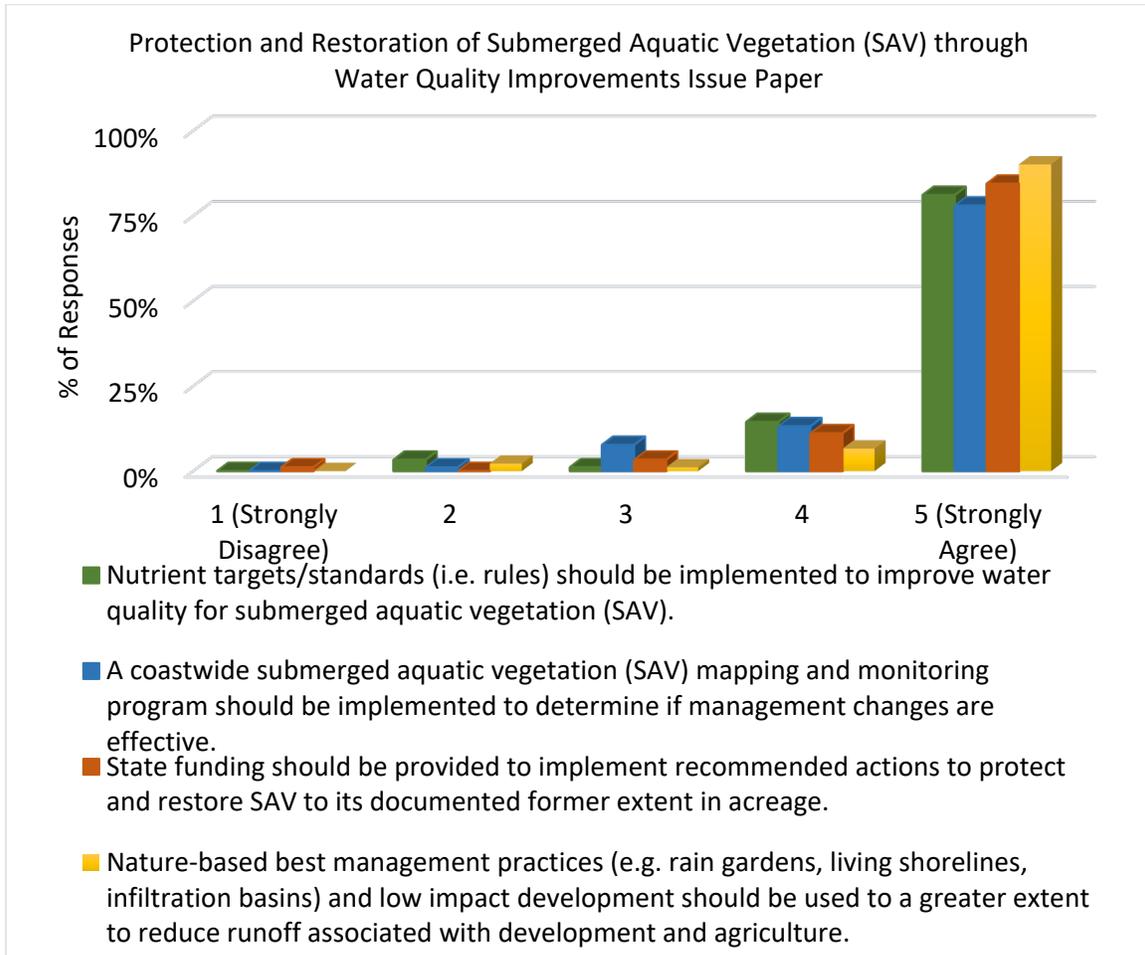


Figure B.4. Responses about “Protection and Restoration of Submerged Aquatic Vegetation (SAV) through Water Quality Improvements” issue paper by the participants of the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment Public Comment survey.

When asked about the “Protection and Restoration of Wetlands through Nature-based Solutions” issue paper, over 75% of survey participants strongly agreed that obtaining accurate maps of wetland habitat are needed to evaluate status and determine if and where restoration and protection efforts are needed, and would be willing to voluntarily use nature-based solutions on owned property to reduce stormwater runoff. Over 90% of the survey participants strongly agreed restoring wetland hydrology and conserving land for marsh migration should be done to increase coastal community resilience (e.g., reduced flooding, improved water quality, improved fisheries), while about 70% strongly agreed that oyster harvest should be prevented from living shorelines that rely on oysters to maintain the integrity of the shoreline stabilization structure (Figure B.5).

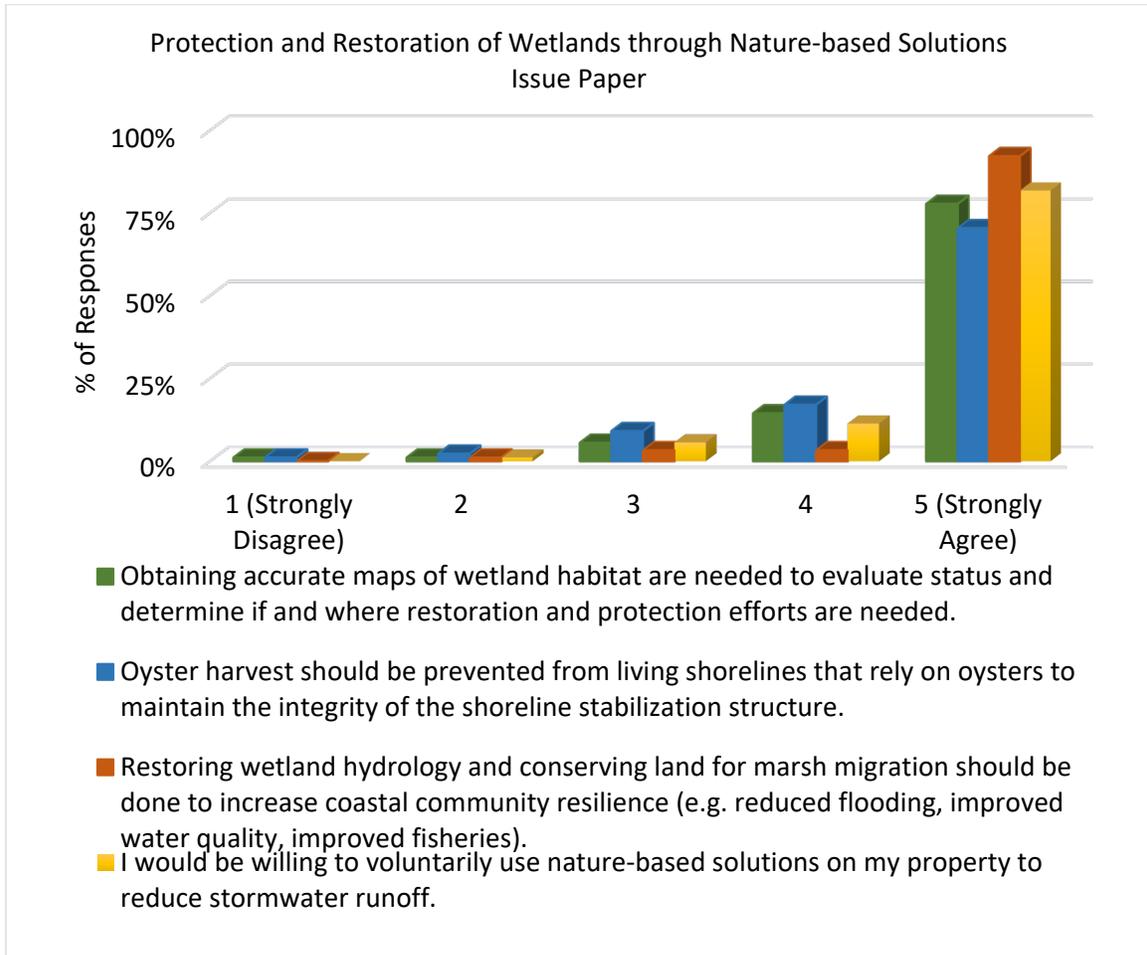


Figure B.5. Responses about “Protection and Restoration of Wetlands through Nature-based Solutions” issue paper by participants of the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment Public Comment survey about “Protection and Restoration of Wetlands through Nature-based Solutions”.

For the “Environmental Rule Compliance and Enforcement to Protect Coastal Habitats” issue paper, almost 90% of survey participants strongly agreed that adhering to environmental rules can prevent habitat and water quality degradation (e.g., following rules on wetland clearing limits, maintaining required sediment and erosion control measures, properly constructing and maintaining stormwater management measures), and increasing staffing and funding to better enforce existing environmental rules to improve compliance. Almost 95% of survey participants said they would report a potential environmental rule compliance violation if they knew how to report it, but just a little over 60% agreed/strongly agreed that they would be interested in attending a workshop to learn about rules related to land disturbing activities affecting wetlands and water quality identifying violations (Figures B.6).

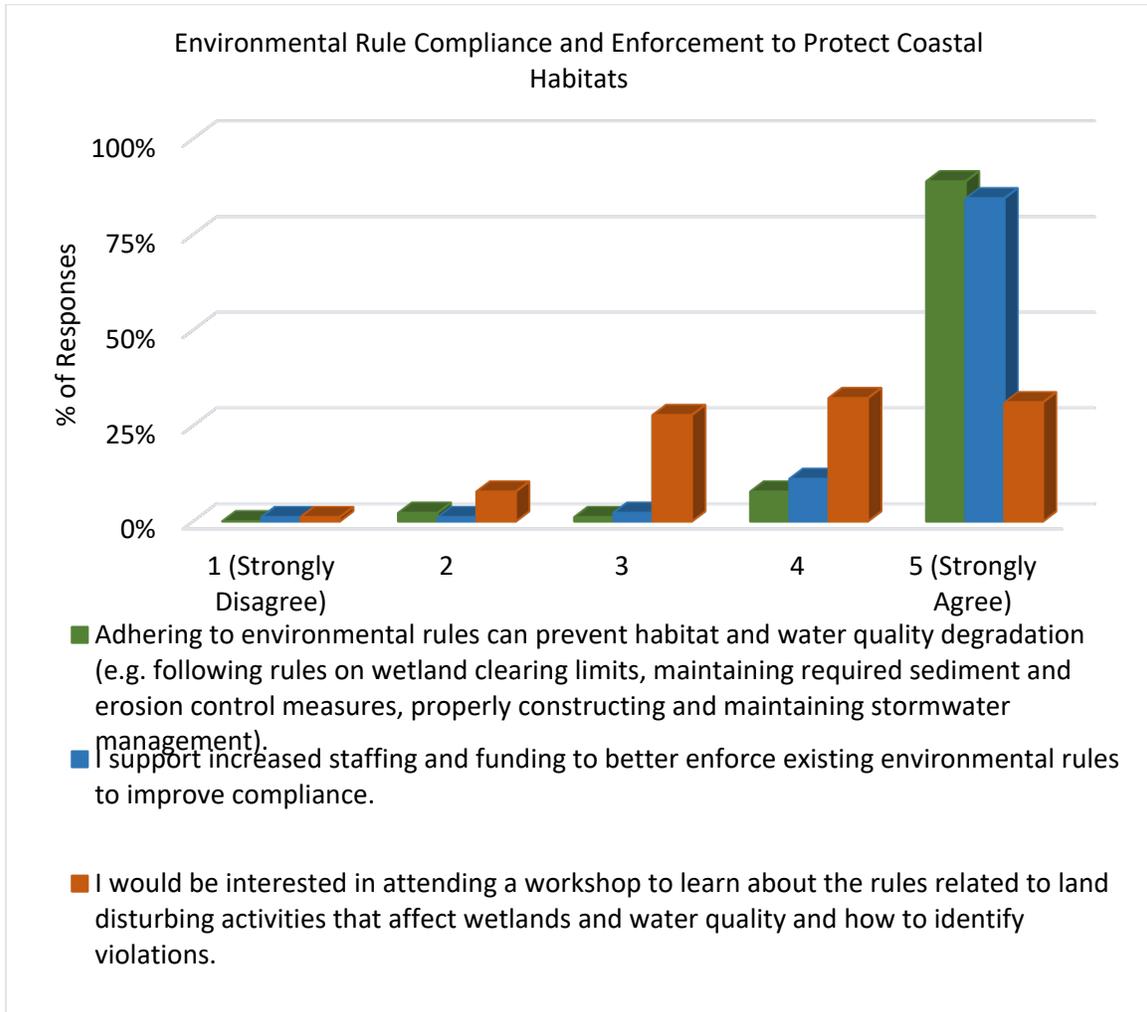


Figure B.6. Responses about the “Environmental Rule Compliance and Enforcement to Protect Coastal Habitats” issue paper by participants of the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment Public Comment survey.

Regarding the “Wastewater Infrastructure Solutions for Water Quality Improvement” issue paper, about 56% of survey participants said they have seen or been affected by a sanitary sewer spill caused by failing wastewater infrastructure (i.e., swimming closures, shellfish closure, unpleasant sights and smells) while over 10% were unsure (Figure B.7). Almost 90% of survey participants strongly agreed that additional priority to maintain and repair wastewater infrastructure projects should be given to projects that would protect sensitive estuarine waters, such as nursery areas and open shellfish harvest waters, and about 75% strongly agreed that to avoid sewer spills, additional maintenance requirements should be required for smaller wastewater collection systems (e.g., 100-200,000 GPD) that are currently exempt (Figure B.8).

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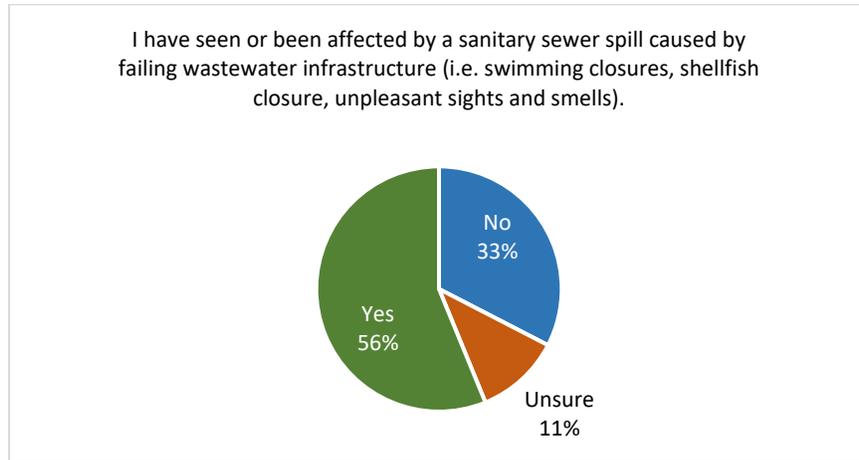


Figure B.7. Response to the “Wastewater Infrastructure Solutions for Water Quality Improvement” issue paper question of whether participants of the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment Public Comment survey have seen or been affected by a sanitary sewer spill caused by failing wastewater infrastructure (i.e., swimming closures, shellfish closure, unpleasant sights and smells).

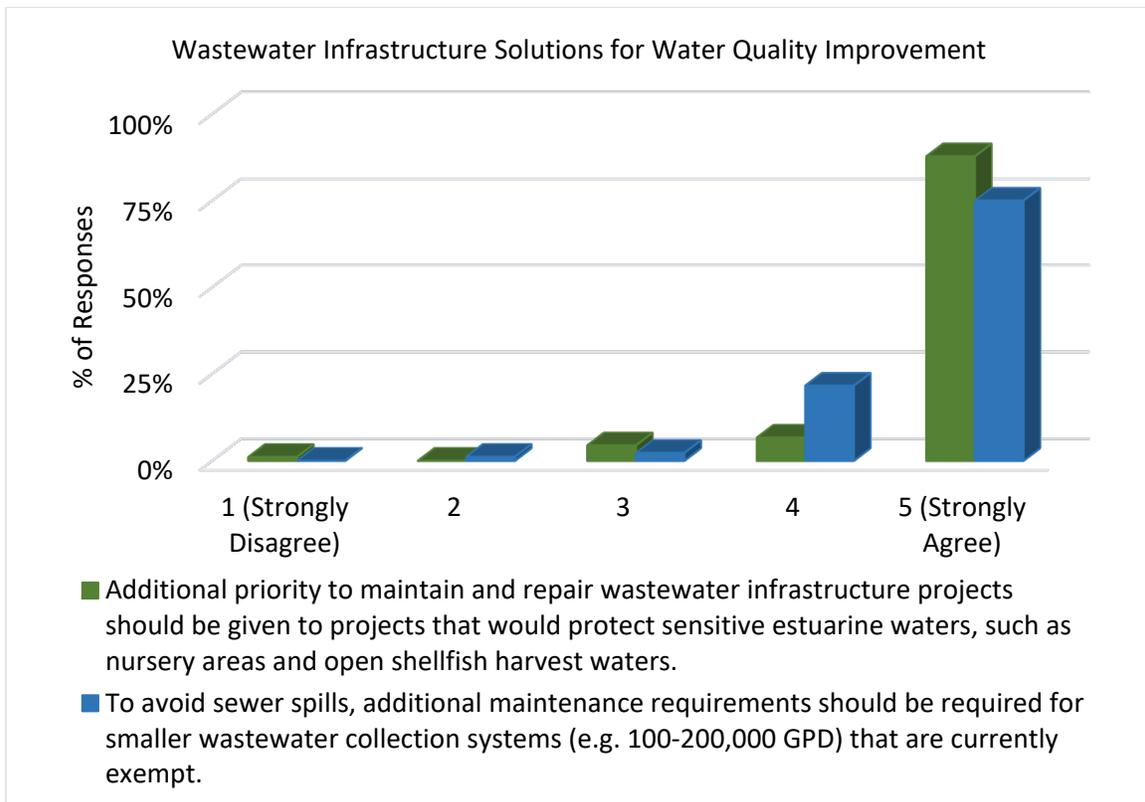


Figure B.8. Responses about the “Wastewater Infrastructure Solutions for Water Quality Improvement” issue paper by participants of the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment Public Comment survey.

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When asked about the “Coastal Habitat Mapping and Monitoring to Assess Status and Trends” issue paper, almost 85% of survey participants strongly agreed that assessing the status and trends of our coastal habitats is important for informing habitat protection, restoration, and management decisions. However, only about 65% strongly agreed that the development of a public document to communicate the status, trends, and ecosystem condition of NC’s coastal habitats would be a valuable outreach tool for the public (Figure B.9). When looking at the ranking of coastal habitats by importance to map and monitor to assess their condition, survey participants ranked wetlands (52%), water column (35%), and SAV (32%) the highest priority (Figure B.10).

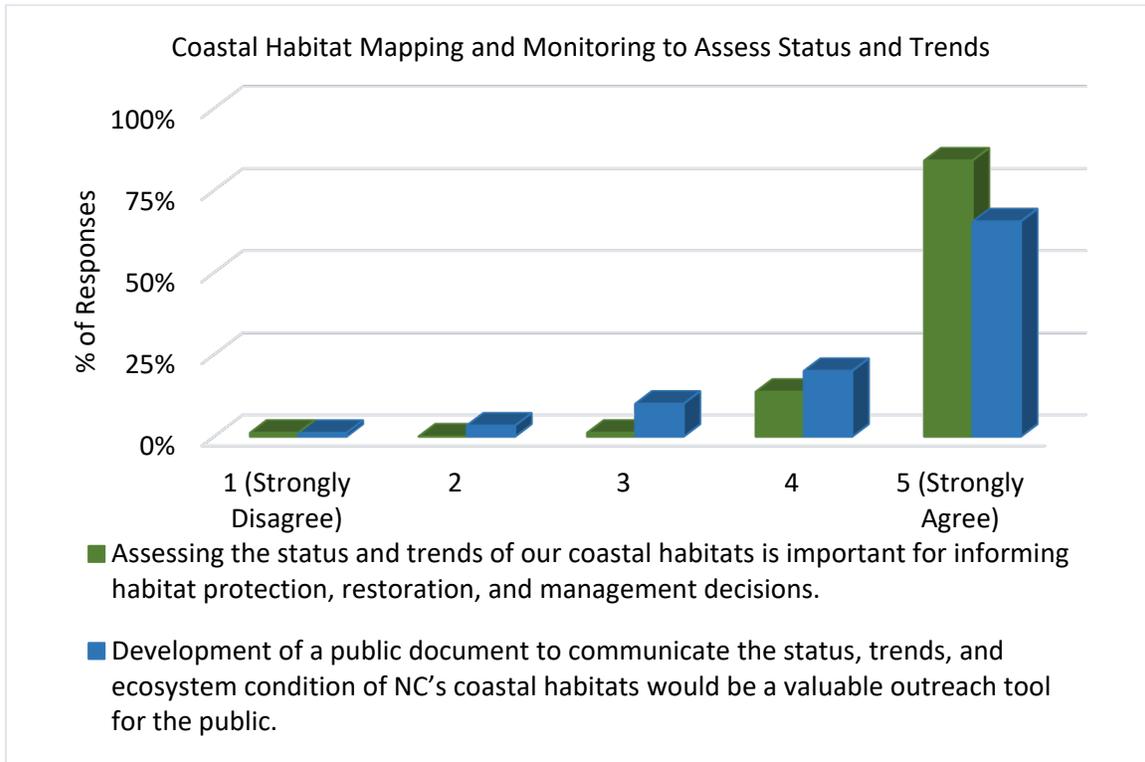


Figure B.9. Responses about the “Coastal Habitat Mapping and Monitoring to Assess Status and Trends” issue paper by participants of the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment Public Comment survey.

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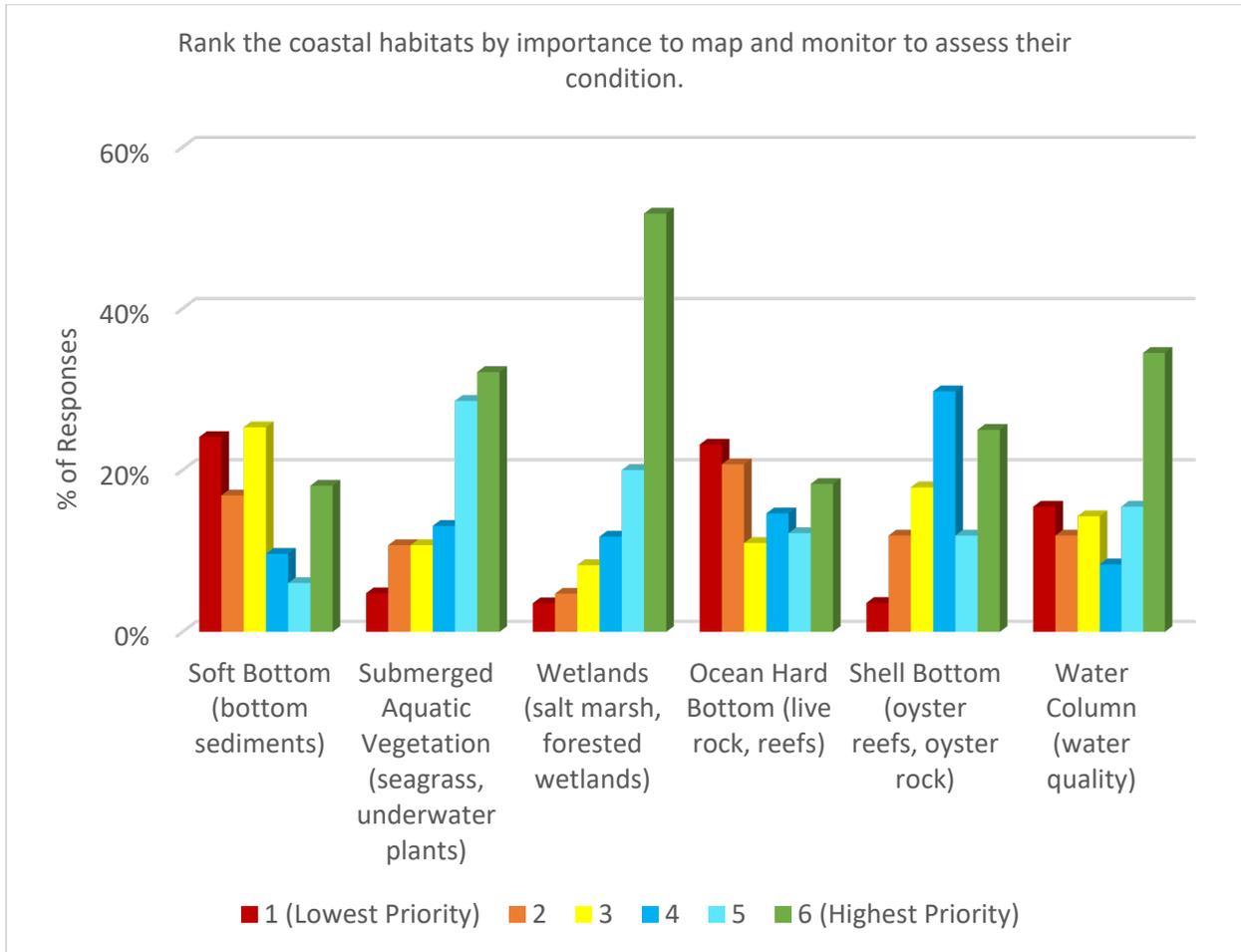


Figure B.10. Responses about the “Coastal Habitat Mapping and Monitoring to Assess Status and Trends” issue paper by participants of the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment Public Comment survey to rank the coastal habitats by importance to map and monitor to assess their condition.

When asked to rank the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment issue papers, survey participants ranked the “Wetland Protection and Restoration through Nature-Based Solutions” the highest priority (43%) followed by “Environmental Rule Compliance to Protect Coastal Habitats” (33%), “Submerged Aquatic Vegetation Protection and Restoration through Water Quality Improvements” (29%), and “Wastewater Infrastructure Solutions for Water Quality Improvement” (25%). The “Coastal Habitat Mapping and Monitoring to Assess Status and Trends” was ranked the lowest priority (20%) (Figure B.11).

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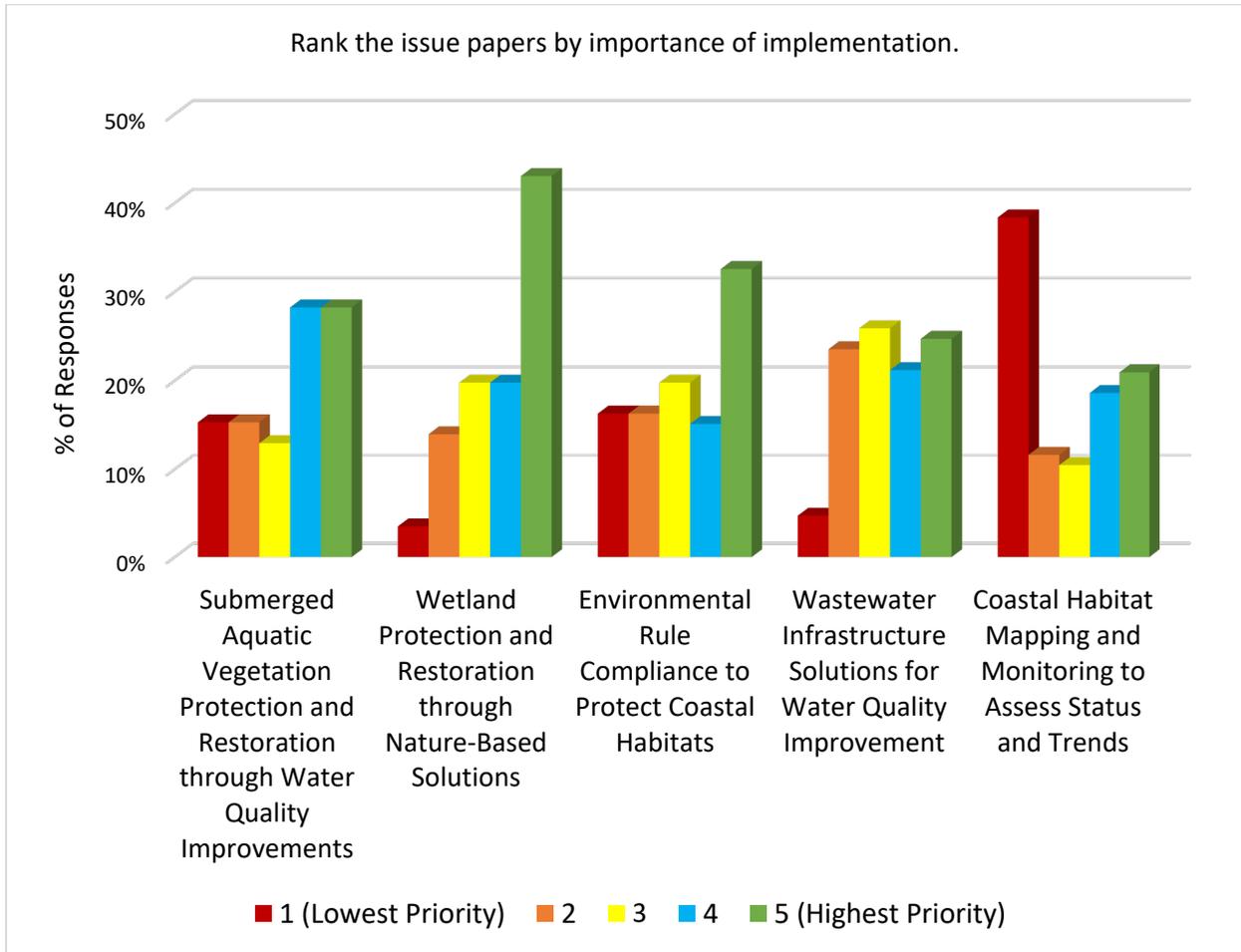


Figure B.13. Responses by participants of the draft 2021 Coastal Habitat Protection Plan (CHPP) Amendment Public Comment survey to rank the issue papers by importance of implementation.

Of the 93 survey participants, 44 provided additional input in the comment box. These comments covered a variety of topics and included the following:

- General support of the CHPP (14)
- Destructive fish gear/practices are not addressed (11)
- Support water quality improvements (4)
- Support protecting wetlands (4)
- No Sense of Urgency in Identifying and Establishing Strategic Habitat Areas (SHAs) (4)
- No discussion on the role of forage species as critical habitat components and the importance of protecting them (4)
- Call to action (3)
- Support a public/private partnership (3)
- Concerned about out of state vessels in NC waters (2)
- Does not support mapping (2)
- Concerned about agriculture impacts (1)
- Concerned about lack of enforcement (1)
- Concerned about marina pollution (1)

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- Concerned about GenX and emerging contaminants (1)
- Concerned about recreational boat traffic causing sedimentation
- Does not support the CHPP (1)
- Concerned about dredging impacts (1)
- Does not support education (1)
- Concerned about funding (1)

Note: Several comments addressed multiple topics. So, the total is not representative of the number of participants that provided comment.

### 2021 CHPP Public Comment Submitted letters

The DEQ received two petitions in strong support of the CHPP amendment and implementation of the recommended actions. NC Audubon submitted 461 signatures, and NC Conservation Network had 796 signatures, from NC residents.

The Department also received 40 letters through email on the CHPP amendment. The majority of the letters (33) were highly supportive of the recommended actions in the plan, while the others supported the CHPP intent but requested changes, or just focused on changes. The organizations that submitted public comment included:

- APNEP Leadership Council
- Chowan Edenton Environmental Group
- Coastal Carolina Riverwatch
- Creation Justice Ministries
- Environmental Defense Fund
- Lower Neuse Basin Association
- NC Audubon
- NC Beach, Inlet and Waterways Association
- NC Catch
- NC Coastal Conservation Association
- NC Coastal Federation
- NC Conservation Network
- NC Council of Churches
- NC Farm Bureau
- NC Fisheries Association
- NC Water Quality Association
- Pew Charitable Trusts
- Restoration Systems, LLC
- Southern Environmental Law Center, on behalf of NC Wildlife Federation, Sound Rivers, Neuse and Tar-Pamlico Riverkeepers

Seventeen letters specifically mentioned supporting a public-private partnership and inclusion of the other recommendations in the Water Quality Stakeholder Report in the CHPP. Eight expressed wanting bottom disturbing gear addressed in the CHPP. Three letters were opposed to regulatory measures to reduce nutrient loading, but supported voluntary approaches. Several other letters supported the plan but suggested new or revised recommended actions.

Comments submitted by the NC Water Quality Association said that they agreed with the need to protect and restore SAV, however they did not support establishment of nutrient criteria that were regulatory. The NC Farm Bureau agreed with comments submitted by NC Water Quality Association. Additionally, they asked for several changes to the recommended actions in the SAV Protection and Restoration through Water Quality Issue Paper (SAV IP), including recommendations be added to request increasing funding for the state cost-share programs administered by the NC Division of Soil and Water Conservation and for continued state funding of the state match for the Conservation Reserve Enhancement Program. The Lower Neuse Basin Association said they supported the voluntary actions included in the Water Quality Stakeholder Report, but did not support establishing standards for chlorophyll a, nitrogen, or phosphorus. The NC Coastal Conservation Association (CCA) supports the

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CHPP, but considered it incomplete because the SAV IP did not adequately address bottom disturbing fishing gear as a source of turbidity.

The Pew Charitable Trusts was supportive of the CHPP, noting overlapping priorities with their organization. They strongly support forming a public/private partnership to increase stakeholder involvement and asked DEQ to spearhead a meeting to determine how to best do this. They provided wording changes to some of the recommended actions in the SAV and wetland issue papers. The NC Coastal Federation also strongly supported the CHPP amendment, including recommendations from the Water Quality stakeholder group. They expressed the importance of focusing on reducing nutrients entering coastal waters quickly, particularly from runoff and to direct financial assistance for cost-share and other management programs effectively to nutrient-impaired coastal waters.

For more details, all submitted letters from organizations and individuals are included in Appendix C.

**APPENDIX C. PUBLIC COMMENT WRITTEN LETTERS**

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