

**RESEARCH AND MONITORING NEEDS IDENTIFIED BY THE
NORTH CAROLINA
COASTAL HABITAT PROTECTION PLAN**

BY

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Introduction

With passage of the Fisheries Reform Act of 1997, the North Carolina General Assembly established the Coastal Habitat Protection Plan (CHPP) program within the North Carolina Department of Environment and Natural Resources (DENR). The Act (General Statute 143B-279.8) requires preparation of a Coastal Habitat Protection Plan, the goal of which is “long-term enhancement of coastal fisheries associated with each coastal habitat.” The divisions of Marine Fisheries (DMF), Water Quality (DWQ), and Coastal Management (DCM) were designated as the lead agencies for the development of the CHPP document. Specifically, the CHPP is to:

- Describe fisheries habitats and their biological systems;
- Evaluate the functions, fisheries’ values, status, and trends in the habitats;
- Identify existing and potential threats to the habitats and impacts on coastal fishing; and
- Recommend actions to protect and restore the habitats.

To fully attain the CHPP goal, numerous research and monitoring needs were identified by the CHPP Development Team [including staff from the DMF, DWQ, and DCM, the Division of Environmental Health (DEH), and the Wildlife Resources Commission (WRC)] and suggested in the CHPP. By December 31, 2004, the three regulatory commissions responsible under the Act formally adopted the CHPP (Street et al. 2005), including the research and monitoring needs contained therein. The purpose of this research report is to summarize these research and monitoring needs to encourage and facilitate acquisition of this information by the research community. Meeting these research and monitoring needs will aid in implementation of CHPP recommendations.

Current related initiatives

The necessity for conducting cooperative, integrative research and monitoring in coastal settings has been cited in documents recently released by various organizations.

A report generated by the Pew Oceans Commission in May 2003 proposed the following:

“We know the oceans are in crisis. Unfortunately, as the nature, scale, and complexity of threats to marine ecosystems have increased, our national investment in ocean science and research has stagnated...The nation must increase investment in ocean science and research, particularly broader programs to monitor and to understand ecosystems...We need a deeper understanding of the effects of both natural and anthropogenic change on marine ecosystems as well as of the oceans’ interaction with terrestrial ecosystems and the atmosphere. Increased capacity is needed in four areas to improve applied ocean science and research:

1. acquisition of new information, knowledge, and understanding;
2. monitoring to evaluate status and trends;
3. capability to integrate and synthesize existing and new information;
4. sharing of information and knowledge with the public.”

Released in September 2004, the report of the U.S. Commission on Ocean Policy similarly recommended that the National Oceanic and Atmospheric Administration (NOAA) create an expanded, regionally-based cooperative research program that coordinates and funds collaborative projects between scientists and fishermen.

More recently, another federal document, the Environmental Protection Agency's National Coastal Condition Report II (EPA 2005), emphasized the importance of coordinated monitoring efforts within coastal habitats. The report noted that while trying to make best use of available data to characterize and assess estuarine systems, the assessment was based on a limited number of ecological indicators for which consistent data sets were available to support estimates of ecological condition on regional and national scales. The report goes on to say that a multiagency and multistate effort is needed over the continuing decade, to achieve a truly consistent, comprehensive, and integrated national coastal monitoring program that can accurately assess the health of coastal ecosystems.

In North Carolina, the CHPP identifies topics for coordinated interagency research. Because North Carolina's coastal fishery resources exist within a system of interdependent habitats, it is necessary to approach habitat management on the basis of ecosystem integrity and understanding the linkages among all coastal habitats and the outside forces that affect them. Research needed to provide the basis for ecosystem management is, of necessity, multi-disciplinary. In addition, it is also recognized that no environmental issue can be fully evaluated without considering the economic impact of alternative management actions designed to minimize degradation of the ecosystem. Determining effective management actions will thus require the integration of biological, chemical, physical, social, economic, legal and political sciences.

CHPP Research and Monitoring Needs

Table 1 describes research and monitoring needs identified directly or indirectly within the CHPP document. The purpose of Table 1 is to provide researchers and managers a quick reference guide to support their research/monitoring proposals with needs identified in the CHPP text. Thus, there are page references that serve to provide additional context for each research/monitoring need. For the purpose of clarification, the text of selected research and monitoring opportunities has been rephrased from their appearance within the CHPP, so that particular concepts may better function as discrete, "stand alone" ideas.

The research and monitoring needs in Table 1 are grouped into the following categories:

- Stormwater runoff
- Strategic Habitat Areas
- Fish-habitat relationships
- Docks and marinas
- Estuarine erosion and shoreline stabilization
- Boating related
- Beach nourishment
- Fishing gear impacts
- Managing non-native species

- Chemical effects
- Water supply
- Habitat status and trends
- Evaluating existing management measures
- Comprehensive water quality monitoring

Unfortunately, no funding mechanisms have been developed specifically intended to support these identified needs. Interested researchers should pursue all available funding sources. The members of the CHPP development team identified in the CHPP are available to discuss these research and monitoring needs.

Literature Cited

Environmental Protection Agency. 2005. National Coastal Condition Report II. EPA-620/R-03/002. Office of Research and Development/Office of Water, Washington, DC. 271 p.

Pew Oceans Commission. 2003. America's Living Oceans: Charting a Course for Sea Change. A Report to the Nation. Pew Oceans Commission, Arlington, VA. 144 p.

Street, M.W., A.S. Deaton, W.S. Chappell, and P.D. Mooreside. 2005. North Carolina Coastal Habitat Protection Plan. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 656 pp.

U.S. Commission on Ocean Policy. 2004. An Ocean Blueprint for the 21st Century. Final Report of the U.S. Commission on Ocean Policy - Pre-Publication Copy. Washington, DC. 455 p plus appendices.

Table 1. Research needs identified in the North Carolina Coastal Habitat Protection Plan.

Issue	Description of Need	Type [^]	CHPP page reference*	Status (Aug 05)
Stormwater runoff	<i>The major cause of water quality degradation in coastal North Carolina today is stormwater runoff. While methods to control direct discharges to surface waters have greatly improved over time, there are still many questions concerning the interaction of stormwater runoff and fish habitat, and how to effectively control non-point runoff of pollutants. Research is needed to identify the causative relationships between ecosystem conditions and land cover, hydrology, and runoff characteristics. Identifying causative relationships will allow managers to predict the impact of increasing development on coastal ecosystem conditions and prescribe management actions.</i>			
	Complete watershed mapping of hydrology/land cover and monitoring of downstream water quality in order to build models predicting runoff characteristics. Water quality parameters measured should include those determined to affect the survival of sensitive biological indicators (e.g. submerged aquatic vegetation, oysters).	R-M	*49, 69, *75, 77, *88-89, 109-110, 135, 332, 340-343, 412	
	Determine the relationship between changes in drainage characteristics and changes in distribution and status of sensitive biological indicators in receiving waters.	R	78	
	Identify water quality parameters (e.g., TSS, chlorophyll a, nutrients, color) and standards (e.g. average concentration, variation in concentration) that are necessary to support sensitive biological indicators.	R	34, 63, 66, 80, 89, 115, 127, 131, 224-225, *257, *274, *286-287, 335, *340, *472	
	Assess the conditions and ecological functions of black water ecosystems to determine their value as strategic buffers/filters between upland runoff and coastal fisheries habitats.	R-M	319	
	In blackwater swamp systems, assess dissolved oxygen (DO) levels and associated biological impacts, differentiating between DO derived from inflow of swamp waters and DO derived from anthropogenic nutrient loading.	R-M	34-35, 64, 85, 89, 100, *101, *103-104, *223-224	
	Evaluate the cumulative amount and extent of land cover and hydrological changes that can be accommodated by natural ecosystems before reaching some critical threshold of change in ecosystem integrity* within a watershed. Ecosystem integrity is the capability of a system to support services of value to humans.	R	86, 88	
	Determine stormwater control strategies needed to prevent watersheds from reaching the critical threshold of change in ecosystem integrity.	R	79, *88, *100, *111-112, 131	
Strategic Habitat Areas	<i>All aquatic areas are important for the propagation and production of fish and shellfish resources. However, some specific areas stand out as being of key importance for certain species or biological communities, and the overall maintenance of ecological stability. Identification of these Strategic Habitat Areas (SHAs) is a high priority, but we lack sufficient data and tools to fully identify them. Research items below were noted in the CHPP as being necessary to help fill these information gaps so that North Carolina's coastal ecosystem can be adequately protected.</i>			
	Develop ecologically based criteria for locating and defining SHAs, including biological indicators of ecosystem integrity.	R	62, 268, *292, 462, 466, *483	Advisory Committee established

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Strategic Habitat Areas	Expand and improve juvenile fish sampling programs to provide regional information on status and trends in juvenile utilization of various types of nursery habitat and their contribution to production of fishery stocks. This information could serve as a basis for identifying or validating important strategic habitat areas.	M	263, *272, *380, 383-384	
	Develop techniques/technology to improve and expedite aquatic habitat mapping in order to identify the spatial extent of SHAs.	R	*483	Being addressed by shell bottom and SAV mapping
	Determine if and where foraging or refuge habitat is more limiting to fish production for that area than spawning or nursery habitat.	R	61-62, 209-210, 266, 268, 324-325, 375, 381, 458, 481	
	Identify important spawning areas for key fishery species and demonstrate their importance in terms of contribution to fisheries production.	R	53, 209, 266, 326, 378, 458, 481	
	Assess use and importance of nearshore hard bottom areas as spawning or secondary nursery areas for estuarine-dependent or reef species.	R	*458-459	
	Determine if there are core habitat areas that are key to submerged aquatic vegetation (SAV) expansion, particularly in the Albemarle Sound system, that justify special monitoring and protection.	R	*272	
Fish-habitat relationships	<i>There are many gaps in information regarding the specific relationships between habitat characteristics and viable fish populations. Few clear cause and effect relationships have been demonstrated between changes in habitat condition and status of fish populations due to the complexity of the coastal system and lack of data. A better understanding of fish-habitat relationships is the cornerstone to fish habitat protection.</i>			
	Determine the effect of bivalve shellfish location and filtering capacities on water quality parameters, such as nutrients, sediments, and chlorophyll a.	R	*108, 204	
	Evaluate recruitment enhancement of oysters and other key organisms provided by low-density cultch planting in nursery areas.	R	*210	
	Fully evaluate the role of SAV in the spawning success of red drum, weakfish, spotted sea trout, and other important species.	R	*266	
	Determine spatial and biological characteristics of SAV beds that maximize their ecological value to important finfish and invertebrate species. This information will aid in design of seagrass restoration projects and location of SHAs.	R	*267	
	Examine the effect of spatial connectivity between habitats (ie. marsh edge and SAV) on juvenile predatory fish use, survival, growth, and abundance (i.e. red drum, spotted seatrout).	R	216, *269, *326, 381	

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Fish-habitat relationships	Determine if long-term declining trends in bay scallop and blue crab populations are related to declines in, or degradation of, SAV.	R-M	*272	
	Determine what pocosin areas are directly used by estuarine fishes, and the contribution of those areas and fish to overall production in the estuary.	R	*322	
	Assess if reef fish populations in North Carolina are limited by the amount of available hard bottom habitat by comparing differences in fish abundance before and after artificial reefs are added using a Before-After-Control-Impact Paired Series (BACIPS).	R	*463	Coordinate with similar work
	Determine if and to what extent artificial reefs in North Carolina simply concentrate available fish or if they effectively increase fish biomass.	R	*463	
	Determine the critical frequency and extent of hypoxia and anoxia, above which significant changes in biotic community structure occur.	R-M	104, 223, 318	
	Determine the critical amount and quality of living and dead shell bottom in a water body below and above which significant changes in biotic community structure (e.g., SAV, oyster reef) occur.	R-M	*215	
	Identify biological indicators of ecosystem integrity that also indicate viable populations of traditional fishery species.	R	13, 135, 262, 289, 372	Coordinate with existing work (APNEP)
	Locate potential SAV and oyster restoration sites using a combination of seed/larval transport, water quality, physical habitat models, coincidence with watershed restoration efforts, and other available information.	R	*218, 224, 230, *257, *267, *272	Coordinate with existing work
Docks and Marinas	<i>As coastal, human population increases, there is a continuing demand for additional individual and multi-slip boat docking facilities and marinas, and decreasing availability of highly suitable locations. More answers are needed regarding the direct, indirect, and cumulative effects of these facilities and their use on fish habitat so that future dock and marina siting guidelines can minimize habitat impacts.</i>			
	Determine if marina basins in freshwater and low-salinity nursery areas produce toxic chemicals at sufficient concentrations and critical times to impact local fish populations (especially considering egg and larval life stages).	R-M	118, *121	
	Determine if existing dock siting criteria allow adequate light beneath dock structures to maintain SAV and coastal wetland habitat. If existing criteria result in adverse effects on SAV or coastal wetlands, modified dock siting specifications that allow adequate light penetration should be identified.	R	*279	Preliminary DMF research available
	Analyze marina development, design, siting and operation to determine the best management practices to minimize impacts of multi-slip docking facilities.	R	*123	Advisory committee established (Sea Grant)

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Issue	Description of Need	Type [^]	CHPP page reference*	Status (Aug 05)
Docks and Marinas	Quantify the cumulative effect of multi-slip docking facilities and associated development on water quality, characteristics of runoff, and the impacts on adjacent fish habitat.	R-M	*125, *279, *391	Advisory committee established (Sea Grant)
	Evaluate the impact of dock-associated prop dredging on shallow nursery habitats.	R-M	*391	
Boating related	<i>In addition to the effects of docking structures, information is needed on the individual and cumulative effects of boat use on coastal waters and habitat. As boat use changes over time, additional information may also be needed.</i>			
	Assess the impact of jetties on successful larval passage through inlets into estuaries, particularly in Pamlico Sound where inlets are limited.	R-M	*83	
	Examine the relative contribution of channel deepening to saltwater intrusion and evaluate subsequent oyster mortality (i.e. from predation) in order to determine appropriate management actions.	R-M	*228	
	In areas of heavy boat traffic and extensive SAV beds, periodically assess the level of damage to SAV from prop scarring.	R-M	*277	Some NOAA work
	Determine what effect the Ocean Dredge Material Disposal Site (ODMDS), located near the mouth of the Cape Fear River, has had or will have on nearby hard bottom habitat.	R	*469	
	Determine the impact of chronic oil pollution from boating and runoff on estuarine nursery areas.	R-M	*122-123	
	Determine the impact of waves propagated from boat operations on adjacent marsh and shell bottom shorelines.	R-M	*222, *350	
Estuarine erosion and shoreline stabilization	<i>Shallow water habitats adjacent to the estuarine shoreline are critical to North Carolina's coastal fish populations. Therefore, managing shoreline stabilization activities in a manner that minimizes habitat impacts is an important issue. Research that aids in understanding shoreline processes and the effect of man-made structures on the estuarine environment will help in implementing the CHPP recommendation to revise estuarine and public trust shoreline stabilization rules for protecting fish habitat.</i>			
	Periodically assess where and how much of the estuarine shoreline is hardened. Accurate information is key to assessing the level of impact to fishery resources.	M	*347	Preliminary DMF research available
	Examine if and how oyster shell could be utilized as an alternative to rock or wooden stabilization structures to create "living shorelines" that are effective in stabilizing the shoreline.	R-M	*349, *392	
	Develop accurate coast-wide estuarine erosion rates to assess sea-level rise and storm impacts, determine adequate development guidelines, and shoreline stabilization policies that minimize impacts on fish habitat (e.g., soft bottom, wetlands, shellfish).	R-M	*105, *349	DCM workgroup discontinued

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Beach nourishment	<i>The demand for beach nourishment projects has greatly increased in recent years. It is therefore increasingly important to fully understand the long-term consequences of this activity to the coastal system and fish populations, so that an ecologically based, comprehensive beach and inlet management plan can be prepared, per the CHPP recommendation.</i>			
	Compile detailed mapping studies of coastal subtidal bottom in a comprehensive and comparable manner in order to evaluate changes and trends in substrate character.	R-M	*370	Pilot project completed
	Determine if and to what extent sand from nourished beaches is transported onto nearshore hard bottom and the effect of sand deposition on the hard bottom habitat and associated biological community.	R-M	*465	
	Assess the cumulative impact and effectiveness of beach bulldozing and determine appropriate guidelines for inclusion in a coastal beach management plan.	R-M	*393	One study completed
	Assess direct and indirect effects, and cumulative impacts of beach nourishment activities on surf-zone organisms (finfish and invertebrates), their habitats and recovery rates from individual and cumulative nourishment events.	R-M	*398, *402	
Fishing gear impacts	<i>While most bottom disturbing fishing gears have been restricted from use in highly sensitive areas, the effect of some gears is still uncertain, and more information is needed to determine needed fishery management changes. Information regarding fishing gear impacts will help implement the CHPP recommendation to protect structured habitats from fishing gear effects.</i>			
	Measure in situ rates of growth, mortality, and recruitment for selected benthic organisms that are regularly exposed to trawling.	R	*405	
	Evaluate the effect of trawling on benthic algal growth and primary productivity overall.	R	*405	
	Conduct large-scale, long-term experiments with and without fishing pressure, rather than short-term, small-scale studies, to examine and quantify cumulative fishing impacts and recovery patterns on estuarine soft bottoms and benthos.	R-M	*407	
	Monitor the impact of hook and line fishing and anchoring on hard bottom.	R-M	*467	
	Determine whether fishing gear impacts and/or other factors are causing the decline observed in bay scallop abundance.	R	*281	
	Assess turbidity impacts to SAV from mechanical shellfish harvesting gear in southeast Pamlico Sound, Core Sound, and other mechanical clam harvest areas.	R-M	*282	
	Assess the effects of shrimp and crab trawling; crab, oyster, clam, or scallop dredging; and clam kicking on SAV, particularly in Core and Bogue sounds.	R-M	*284	
	If turbidity or other gear impacts from operation of bottom disturbing fishing gear degrades nearby SAV habitat, determine what additional protective buffers are needed between SAV and areas where such gear are used in order to minimize impacts.	R	*292	
	Identify the location and duration of trawling over soft bottom habitat, as well as over structured habitats (shell bottom, hard bottom and SAV), and quantify the effects of trawling on the habitats.	R-M	*405	
Determine turbidity levels generated by different commercial fishing gear configurations and the subsequent rates of redeposition at various distances from the origin under varying wind and current conditions.	R	*405		

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Fishing gear impacts	Compare the significance of natural forms of disturbance on soft bottom habitat to that of trawling effects on soft bottom habitat.	R-M	*405	
	Sample areas normally subjected to trawling to describe the local benthic community, identifying seasonal cycles of species abundance and recruitment, to determine the times of year that benthos would be most sensitive to trawling disturbance.	R-M	*405	
Managing non-native species	<i>The accidental or intentional introduction of non-native species is a growing issue in natural resources management. Understanding the effect of non-native species on the ecological integrity of our native ecosystems is necessary for effective ecosystem management.</i>			
	Conduct testing on the aquacultural use of non-spawning, non-native oysters before decisions are made opposing or supporting introduction.	R	*229	Research ongoing
	Compare the fish habitat value of Eurasian watermilfoil relative to native vegetation.	R	*291	
	Develop ways to prevent proliferation of non-native species by sterilizing ballast water, testing non-native species before introduction, and assessing legal mechanisms to prevent introductions.	R-M	*129	
Chemical effects	<i>Growing use and disposal of chemicals in support of modern lifestyles has undoubtedly had an effect on the viability of organisms in receiving waters. While there is some information available on the toxicity of certain chemicals to selected organisms, under certain conditions, more work is needed to fully evaluate the potential impact of chemical pollution on fisheries resources.</i>			
	Identify pesticides that are "safe" for spraying over open waters, and for those pesticides whose toxicity is impacted by salinity, appropriate application rates for controlling mosquitoes.	R	*125	
	Determine the sources, prevalence, and effects of hormone-altering chemicals on important fish species in North Carolina's coastal waters.	R-M	*118	
	Examine the effects of existing contaminant levels and other environmental stressors on water quality, benthic food organisms, and fish.	R-M	118, 224, *411, *469	
	Evaluate the biological impact of any new materials (wood, plastic, cement, etc.) used in water-dependent structures on the aquatic ecosystem.	R	*121, *226	
Water supply	<i>With increasing demands for fresh water, the allocation of existing water resources among direct human uses and the needs of native fish and wildlife species is becoming an increasingly difficult issue.</i>			
	Assess the impact of increasing municipal, industrial, and/or agricultural surface water withdrawals as well as reservoir management on instream flows (water column habitat) on dependent anadromous fish populations in coastal rivers.	R	*73	
	Assess groundwater supplies in coastal counties to determine the potential environmental consequences of increasing subsurface water withdrawals.	R-M	*74	
	Determine effects of brine effluent disposed from filter backwash and reverse osmosis water treatment facilities on biological communities in coastal receiving waters.	R-M	*128-129	

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Habitat status and trends	<i>Determining the status and trends in condition of fish habitats is vital in evaluating the need and effectiveness of management actions intended to protect them.</i>			
	Conduct change analysis of existing shell bottom by DMF's Shellfish Habitat and Abundance Mapping Program on a subset of priority areas. Prioritization should include consideration of functional significance, economic value, and the magnitude of growth and development affecting the area.	R-M	*211	
	Determine the status of hard clams, sheepshead, black drum, and resident non-fishery species (e.g., oyster toadfish) as indicators of shell bottom conditions, using fisheries-independent-data.	R-M	*215	
	Evaluate status and trends in coast-wide distribution and condition of SAV at regular intervals. Comprehensive maps of all existing and potential SAV habitat should also be developed.	M	*272, *291	Workgroup established
	Determine wetland restoration success criteria based on long-term monitoring of hydrology, soil, and vegetation characteristics at established reference sites.	R-M	*332	Coordinate with EEP
	Determine the cumulative impact of small wetland losses on the distribution and abundance of wetland types in selected watersheds. The cumulative losses could then be related to the nature and extent of development pressure in those watersheds in order to formulate a model predicting untracked losses in other watersheds.	R-M	*339	
	Evaluate the susceptibility of freshwater wetlands to soil loss from sulfate metabolism in coastal North Carolina.	R	*352	
Evaluating existing management measures	<i>Prior to establishing new or additional management measures, resource agencies must first evaluate and determine if existing management measures are adequate and effective in achieving their intended management goals.</i>			
	Evaluate the functional viability of shellfish (primarily oysters) in closed shellfishing waters and their value as protected shell bottom habitats.	R-M	*231	
	Assess the N.C. Pesticide Board's policies on aerial drift of pesticides and suggest changes if necessary to ensure adequate protection for aquatic life and water quality from pesticide impacts.	R	*126	
	Evaluate water quality conditions and effectiveness of the nutrient reduction strategies in the Neuse River and the Tar-Pamlico River.	R-M	*133	On-going
	Evaluate effectiveness of ORW and HQW rules in protecting SAV and other habitats.	R-M	135, *292-293, *337	
	Evaluate the CRC's beach nourishment rules and determine changes needed to minimize impacts from beach nourishment and dredge disposal on soft bottom communities.	R	*277	

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Evaluating existing management measures	Examine and propose revisions to current CRC shoreline stabilization rules using best scientific information to minimize impacts from this activity to soft bottom and wetlands, particularly intertidal estuarine shorelines.	R	*391-392	
Comprehensive water quality monitoring	<i>The overall status of water quality in North Carolina has been difficult to evaluate because of the variety of uncoordinated water quality monitoring efforts covering different areas over different time periods. The gaps in completing a comprehensive evaluation of coastal water quality are many. Some of these needs were noted in the CHPP and are listed below.</i>			
	Expand water quality monitoring in North Carolina's nearshore ocean waters to improve our understanding of existing conditions and processes in coastal waters and the effect of estuarine inputs and human activities on local water quality.	M	*66	
	Assess water quality trends and causes of degradation in tidal creek systems, particularly in southern coastal counties that are highly important nursery and shellfish areas and are under intense development pressure, and determine effective preventive and restoration measures.	R-M	*100-101	
	Monitor the effect of estuarine water quality, particularly nutrient and sediment loading, on nearshore ocean hard bottom.	R-M	*469	
	Additional water and tissue analysis at hard bottom sites is needed to determine if the benthos of the hard bottom community or the surrounding waters exhibit toxin levels that exceed designated levels of concern.	M	*469-470	
	Assess the impact of historic and recent wetland drainage activities on coastal water quality.	R-M	*80, 222, *340	
	Assess the effects that oceanfront septic systems have on nearshore coastal water quality.	R-M	*116	
	Once the appropriate water quality conditions for protection of SAV are determined, current water quality monitoring stations and methods should be re-evaluated and modified (if necessary) so that data adequately assess if SAV-based water quality criteria are being met (both baseline and potential SAV habitat). The Neuse, Tar-Pamlico and White Oak basins should be a high priority for monitoring of SAV and water clarity.	R-M	*287	Contingent on research results

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