DRAFT - Open Water Communities

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Ecosystem Description

Open water habitats are represented by the sounds and near-shore waters along North Carolina's coast. The open waters receive freshwater drainage from several Coastal Plain rivers and tributaries of the Lumber, Cape Fear , White Oak, Neuse, Tar-Pamlico, Roanoke, Pasquotank, and Chowan River basins. North Carolina's open waters include the Albemarle, Pamlico, Core, Back, and Bogue Sounds and represents the largest estuarine system along the US Atlantic coast. This habitat is closely associated with Estuarine Communities.

Near-shore waters are those located within three nautical miles of North Carolina's coastal land area and are marine waters. Through tidal influences and storm surge events, near-shore waters contribute saline water to the sounds. This mixing of freshwater from rivers and tributaries with saline waters from near-shore marine waters contributes to seasonal and temporal variability of salinity in the brackish waters within the sounds.

Coastal fresh waters generally have salinity levels between 0 and 0.5 parts per thousand (ppt) as defined by the Venice System (Cowardin *et al.* 1979). Average ocean water salinity levels are between 25 and 35 ppt (CIMS 2005). Salinity is typically less than 5 ppt in the sounds and can be vertically homogeneous in the water column according to the South Atlantic Fishery Management Plan (SAFMP 1998).

North Carolina's open water habitats provide fresh, brackish, and saline environments for a wide diversity of aquatic plants and animals. The NC Coastal Habitat Protection Plan (CCMP) refers to these waters as essential fish habitat (EFH). EFH supports the different life cycles of approximately 1,000 aquatic species managed under the SAFMP, including anadramous species that migrate to freshwaters to reproduce (SAFMP 1998). The CCMP and SAFMP describe five EFH components of the open water habitat in North Carolina:

- Soft Bottom is the unconsolidated, unvegetated sediment that occurs in freshwater, estuarine, and marine systems. It is an important component of designated Primary Nursery Areas (PNAs), Anadramous Fish Spawning Areas (AFSA), and Anadramous Nursery Areas (ANA) (NCDMF 2005).

- Shell Bottom habitats are the oyster beds, rocks, reefs, and bars found in estuarine intertidal or subtidal areas. It is composed of surface shell concentrations of living or dead oysters (*Crassostrea virginica*), hard clams (*Merceneria merceneria*), and other shellfish (NCDMF 2005).

- Ocean Hard Bottom varies in topographic relief from a relatively flat, smooth surface to a scarped ledge with vertical, sloped, or stepped relief. It is formed of exposed rock,

consolidated sediments, or relic reef and may be covered by algae, sponges, corals, other live animals, and live plants attached to the hard surface (NCDMF 2005).

- Submerged Aquatic Vegetation (SAV) is defined as bottom vegetated by living structures of submerged, rooted vascular plants, (i.e., roots, rhizomes, leaves, stems, propagules), as well as temporarily unvegetated areas between vegetated patches. Native aquatic grasses are the primary species and can occur in fresh, brackish, and saline waters. SAV beds can be transient communities comprised of a few plants or many and cover small patches or extensive areas. They provide important habitat for most fish and shellfish species in the sounds, while also creating oxygen and removing excess nutrients in the water (APNEP 2005, 2012).

- Water Column is an aquatic environment and its physical, chemical, biological characteristics, and connectivity to other habitats will determine which species use it.

Table 1 at the end of this report provides a summary of expected climate change impacts to open water communities.

Predicted Effects to Wildlife Species

Tables 2 through 6 at the end of this report identify the species of greatest conservation need (priority species) that use habitats in this ecosystem.

The South Atlantic Fishery Management Council reports 40 species of fish and invertebrates have been captured on seagrass beds in North Carolina. Larval and juvenile fish and shellfish such as gray trout, red drum, spotted seatrout, summer and southern flounder, blue crabs, hard shell clams, and bay scallops utilize the SAV beds as nursery areas. SAV meadows are also frequented by adult spot, spotted seatrout, bluefish, menhaden, summer and southern flounder, pink and brown shrimp, hard shell clams, and blue crabs. Offshore reef fishes including black sea bass, gag, various snapper species , and spottail pinfish. They are the sole nursery grounds for bay scallops in North Carolina (SAMFP 1998).

Meteorological processes influence coastal and estuarine circulation which influences larval transport in the estuarine system and colonization of nursery locations for flounder species. For flounder, a combination of winds determine the overall supply of larvae to the system and some combination of wind and river discharge determines migration and settlement into specific nursery locations (Taylor et al. 2010).

Concentrations of prey organisms (worms, algae, crustaceans, mollusks, other invertebrates) associated with soft, shell, and ocean bottoms provide forage for numerous species of fish, shrimp, and crabs (NCDMF 2005). Ospreys, egrets, herons, gulls and terns feed on fauna in SAV beds, while swans, geese, and ducks feed directly on the grass itself. Green sea turtles utilize seagrass beds and juveniles may feed directly on the seagrasses (SAMFP 1998). Increased salinity will affect species assemblages and influence food web dynamics by reducing available habitat for species adapted to a specific range in water chemistries.

Warming trends can impact corals and SAVs (CSCOR 2012) and disrupt normal processes such as timing of phytoplankton blooms and larval development (NFWP CAS 2012), thus affecting food chain dynamics. Larval dispersal will be affected by changes in water circulation patterns, flooding, and intense storm events (DiBacco *et al.* 2006, Cowen and Sponaugle 2009, Tisseuil *et al*. 2012) which will influence geographic distribution of marine species (Block *et al*. 2011, Haase *et al*. 2012).

Climate Change Compared to Other Threats

Current research suggests that climate change and associated sea level rise will be a significant stressor in the region for the near future (APNEP 2012). Table 7 summarizes the comparison of climate change with other existing threats.

Table 7. Comparison Of Climate Change With Other Threats

Threat	Rank Order	Comments
Bottom Trawl Fishing Gear	1	The weight and movement of bottom trawl fishing gear disturbs bottom sediments, displace SAVs, and damages shell and hard bottom habitats. Mobile species may temporarily disperse but cumulative impacts from repeated use of bottom trawl gear in the same areas can lead to long-term habitat loss.
Dredging	1	Dredging disturbs and damages soft, shell, and hard bottoms, SAV beds, and suspends sediments that cause turbidity within the water column. Localized impacts may allow dispersal of mobile species but long-term damage can occur to bottom habitats.
Pollution	1	Pollution includes chemicals and toxins from point source discharges (e.g., industrial effluents and smoke stacks, stormwater discharges, wastewater treatment facilities) and nonpoint sources (e.g., roads, surface water runoff, marinas, boatyards). Aging infrastructure and rising sea levels are two challenges that must be addressed to reduce bacteria, viruses, and other microorganisms from entering public waters through identified sources (APNEP 2012).
SAV Loss	1	Loss of SAV beds or meadows reduces connectivity between spawning areas, primary nursery areas, and water column habitats for larval, juvenile, and adult species of aquatic species (DiBacco et al. 2006).
Shoreline Hardening	2	Hardened shorelines will prevent natural migration of marsh habitats toward inland areas as inundation occurs from rising sea levels. Use of natural and living shorelines should be encouraged and regulatory impediments removed.
Base Flow Reductions	2	Low flow conditions can occur due to drought, hydraulic drawdown, and upstream impoundment. Reductions in freshwater inputs from rivers and tributaries will allow influence salinities. Salt water intrusion and concentrations upstream are likely to increase. Occurrence of temperature stratification and anoxic conditions are likely to increase.

Table 7. Comparison Of Climate Change With Other Threats		
Threat	**Rank Order**	**Comments**
Offshore Development	3	Mineral mining, gas and oil exploration, and wind energy turbines will damage bottoms, introduce contaminants into the water column, and displace species assemblages through loss of habitat.
Climate Change	3	Climate change impacts will be cumulative and to some degree mitigation options are limited. Mobile species can be expected to disperse to more favorable conditions.
Invasive Species	4	Warmer water can allow range expansion of non-native species into open waters previously not colonized.
Infrastructure	5	Dams block the passage of diadromous fish species and limited the access to upstream spawning habitat for anadramous fish species.

Summary and Recommendations

SAV beds and water column habitats act as nursery areas for most planktivorous larvae and juvenile pelagic species (*e.g.*, bluefish, river herring, menhaden, Spanish mackerel) (NCDMF 2010). In addition to fully aquatic species, these habitats are also important foraging areas for sea turtles and migratory and resident pelagic seabirds and waterfowl associated with open water areas.

Recommended Actions

Surveys

- Facilitate the mapping of significant ecological, bathymetric, geologic, demographic, and cultural features (APNEP 2012).
- Conduct surveys of fish populations, including collecting fish samples for toxicological and water quality studies, to evaluate the efficacy of management practices, detect changes in fish communities, and to identify trends which may be occurring within the fishery resources.

Monitoring

- Develop and maintain an integrated monitoring network to collect information for assessment of ecosystem outcomes and management actions associated with the implementation of management actions (APNEP 2012).
- Facilitate the development of protocols and conduct rapid assessments to determine presence and potential threat of invasive species (APNEP 2012).
- Develop sensors for biological and chemical sensing to determine status and trends, as well as tagging and tracking of wildlife (NIEPS 2010).

Research

- Most species and their interrelationship associated with this habitat are poorly understood.

- Support research on adapting to impacts associated with climate change and sea level rise (APNEP 2012).
- Facilitate risk assessments of targeted personal care and pharmaceutical products in the aquatic system (APNEP 2012).
- Facilitate risk assessments of heavy metals and other toxic contaminants in sediments (APNEP 2012).
- Assess the impact on fisheries productivity from changes in estuarine habitats due to climate change (NIEPS 2010).

Management Practices

- Development and implementation of best management practices (BMPs) will reduce stormwater carrying pollutants from draining into open water habitat.
- Utility operators will need to upgrade or move wastewater treatment facilities and associated infrastructure located in areas subject to sea level rise in order to minimize or eliminate risks (APNEP 2012).
- Restore water quality by eliminating targeted sources of water pollution
- Restore areas capable of supporting SAVs. This will require study of effective restoration techniques, bathymetric mapping, water quality monitoring, and other efforts (APNEP 2012).
- Develop and refine ecological flow requirements for each major river (APNEP 2012).
- Protection of critical buffer areas of upstream drainages, sound planning, the adoption of low impact development criteria, and other best practices will reduce potential water pollution.
- Establish contaminant management strategies for waters not meeting water quality standards. Strategies that address pathogens, toxics, and nutrients are needed, not just the traditional total maximum daily load (TMDL) plans which primarily manage industrial point sources and municipal stormwater (APNEP 2012).
- Plug drainage ditches and install tide gates in agricultural fields so that sea water does not flow inland through them (DeWan et al. 2010).
- Based on survey and monitoring results, consider closing fisheries for declining species during the spawning season.

Ecosystem Protection

- Facilitate the protection of natural riparian buffers to reduce runoff. Riparian buffers trap and filter polluted runoff, preventing sediments, nitrogen, phosphorus, pesticides, and other substances from entering the sounds.
- Facilitate the development of state and local policies that support the use of low impact development (LID) practices to reduce runoff (APNEP 2012).
- Facilitate the use of best management practices on agricultural and silvicultural lands (APNEP 2012).

- Facilitate protection of designated anadromous fish spawning areas and inland primary nursery areas from marina Impacts (APNEP 2012).
- Establish marsh habitats in cleared areas that are likely to become wetlands in the future due to inundation or frequent flooding.
- Protect conservation corridors that run from shorelines inland to facilitate habitat migration (DeWan et al. 2010).
- Establish oyster reefs and SAV beds offshore to help buffer shorelines (DeWan et al. 2010; Pearsall and Poulter 2005).
- Consider establishing marine reserves to provide refuge from fishing pressure, facilitate adult migration patterns and larval dispersal pathways, and support fisheries restoration efforts (DiBacco et al. 2006).

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Table 1. Predicted Impacts of Climate Change	
Climate Change Factor	**Comments**
Sea Level Rise -- Inundation	Sea level rise could potentially increase the area of this habitat. However, as water inundates new land areas, contaminants and toxins can enter the water from soils, sewage systems, and impervious surfaces. Inundation of barrier island and near shore beaches will reduce nesting habitat available for sea turtles and some shore birds.
Sea Level Rise -- Salt Intrusion	Salt water wedge will move upstream in freshwater drainages. Salinities may increase in brackish waters when storm surge and rising water levels allow greater marine water input. Shellfish are susceptible to the parasites *Perkinsus marinus* and *Haplosporidium nelsoni*, which thrive in saline waters and may become a serious threat as salinities increase (USEPA 1998, Rogers and McCarty 2000).
Flooding	Increased severity and frequency of storm events, similar to hurricanes, will disturb SAV beds. Receding flood waters carry toxins and contaminants from inland areas.
Increased Temperature	Noyes *et al*. (2009) indicates an increased magnitude and duration of high summer water temperatures will increase thermal stratification within the water column and contribute to rising water levels through thermal expansion and lead to anoxic conditions. Warmer waters will enhance toxicity of contaminants and impact aquatic species that have specific temperature tolerances (NFWPCAS 2012). May contribute to low dissolved oxygen in freshwaters, contributing to increased fish kill events. Harmful algal blooms will likely be more frequent and widespread (Sellner *et al*. 2003).
Drought	Drought will affect freshwater rivers and tributaries that drain to the sounds. Low freshwater input will contribute to increased salinity of open waters.
Offshore Development	Legislative requirements for utilities to develop renewable and alternative energy resources will increase the likelihood that offshore wind turbines or oil drilling remain a threat. Offshore mining would disturb the ocean bottom; drill operations would introduce oil and chemical contaminants to the water column. Wind turbines pose a risk of strikes to sea birds and water fowl.
Increased Atmospheric CO2	Continued greenhouse gas emissions will lead to absorption of atmospheric CO2 by open waters, leading to acidification of the water column. Ocean pH is projected to drop by 0.3 to 0.4 units by century's end (NFWPCAS 2012) which will be especially harmful to corals and shellfish.

Table 1. Predicted Impacts of Climate Change	
Climate Change Factor	**Comments**
Increased Storm Intensity	Atmospheric warming and increased water surface temperatures influence the location and intensity of winds and surface water circulation patterns (Colling 2001). Changes in these patterns will contribute to increased storm intensity, leading to greater potential for flooding and higher erosion rates. Heavier rainfall will influence nutrient runoff and sediment flows from land to aquatic systems.
Exotic species invasion	Exotic SAVs may outcompete native sea grasses, thereby displacing beds of native vegetation and displacing aquatic wildlife. Some invasive species can be transported and spread when they cling to the hull or anchor of recreational and commercial boats or are discharged along with ballast water from larger vessels. Non-native Eurasian milfoil (*Myriophyllum spicatum*) can grow in water depths up to 10 feet and will spread both vertically and horizontally in the water column, thereby shading out native SAVs and change aquatic community dynamics through species displacement (NCDWR 2010).
Compositional Change	SAV is a key feature to this community and several species may be wholly dependent on particular SAV species. Changes in SAV composition will create trophic level adjustments throughout the habitat.
Structural Change	Inundation from sea level rise and flooding related to frequent and more intense storm events can lead to loss of tidal wetlands and nursery habitats.
Sedimentation	Higher and more severe erosion may occur from upstream areas due to more frequent and more severe storm events. Higher sediment inputs from freshwater drainages can bury SAV seed resources as well as grass beds. Boats running in shallow water cause resuspension of fine sediments, which is similar to the effect of dredging on nearby oyster beds (NCDMF 2005).
Eutrophication	Nutrient enrichment from upstream sources and warmer water temperatures will lead to algal blooms and anoxic conditions within the water column.
Hypoxia/Anoxia	Declining oxygen concentrations will affect behavior and physiologically impair animals residing in the water column, sediments, or attached to hard substrates (Rabalais 2009).

Table 2. Fish Species Utilizing Open Water Communities							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
FISH							
Acipenser brevirostrum	Shortnose sturgeon	G3/S1				E/E/P	
Acipenser oxyrhynchus	Atlantic sturgeon					T/SC/P	
Bairdiella chrysoura	silver perch						
Brevortia tyrannus	menhaden						
Centropristis striata	black sea bass						
Cynoscion nebulosus	spotted seatrout						
Cynoscion regalis	gray trout						
Displodus holbrooki	spottail pinfish						
Haemulon plumieri	white grunt						
Leiostomus xanthurus	spot						
Lutianus annalis	mutton snapper						
Lutianus griseus	gray snapper						
Lutjanus synagris	lane snapper						
Mugil cephalus	mullet						
Mycteroperca microlepis	gag						
Orthopristis chrysoptera	pinfish						
Paralichthys lethostigma	southern flounder						
Paralichthys dentatus	summer flounder						
Pomatomus saltatrix	bluefish						
Sciaenops ocellatus	red drum						

Table 3. Aquatic Invertebrate Species Utilizing Open Water Communities							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
AQUATIC INVERTEBRATES							
Argopecten irradains	bay scallops						
Callinectes sapidus	blue crabs						
Mercenaria mercenaria	hard shell clams						

Table 4. Bird Species Utilizing Open Water Communities							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
BIRDS							
Anhinga anhinga	Anhinga					/SR/P	
Branta bernicla hrota	Atlantic Brant						
Clangula hyemallis	Long-tailed Duck						population status and long-term trends poorly understood - likely declining over the long-term
Haliaeetus leucocephalus	Bald eagle					T/T/P	
Melanitta fusca	White-winged Scoter						population status and long-term trends poorly understood - likely declining over the long-term
Melanitta nigra	Black Scoter						population status and long-term trends poorly understood - likely declining over the long-term
Melanitta perspicillata	Surf Scoter						population status and long-term trends poorly understood - likely declining over the long-term
Mergus serrator	Red-Breasted Merganser						population status and long-term trends poorly understood - likely declining over the long-term

Table 5. Mammal Species Utilizing Open Water Communities							
Species	**Common Name**	**Element Rank:**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
MAMMALS							
Trichechus manatus	West Indian Manatee					E/E/P	

Table 6. Reptile Species Utilizing Open Water Communities							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
REPTILES							
Alligator mississippiensis	American Alligator					T/T/P	
Chelonia mydas	Green sea turtle					T/T/P	
Eretmochelys imbricata	Hawksbill sea turtle					E/E/P	
Lepidochelys kempii	Kemp's Ridley sea turtle					E/E/P	
Dermochelys coriacea	Leatherback sea turtle					E/E/P	
Caretta caretta	Loggerhead sea turtle					T/T/P	
Malaclemys terrapin	Diamondback terrapin					/ /SC	

*** US/ NC/ WAP Abbreviations (species are subject to reclassification by USFWS, NHP, or WRC).**

E	Endangered	SC	Special Concern	P	WAP Priority Species
T	Threatened	SR	Significantly Rare		
FSC	Federal Species of Concern	W	Watch Category		
T(S/A)	Threatened due to Similarity of Appearance				

NatureServe Element Rank: http://www.natureserve.org/explorer/ranking.htm

USFWS Endangered Species Listing Status: http://www.fws.gov/raleigh/es_tes.html

NC Natural Heritage Program Status:
http://www.ncnhp.org/Images/2010%20Rare%20Animal%20List.pdf

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