

# North Carolina Ecosystem Response to Climate Change: DENR Assessment of Effects and Adaptation Measures

DRAFT

## Estuarine Communities

### **Ecosystem Group Description:**

Estuarine communities are affected by tidal waters in and along the sounds and drowned river mouths. Salt Marshes occur where tides regularly flood the area with undiluted sea water. This environment of repeated flooding and exposure and high salt levels is limited to only a few plant species, but is very fertile and productive. Saltmarsh cordgrass strongly dominates these communities, and only a few other vascular plants occur. Algae may also be an important part of the plant productivity. The abundance of invertebrates such as mollusks and crustaceans indicates the transitional nature of these communities between terrestrial and marine systems. Brackish Marshes occur in areas where the tidal waters are partly diluted by fresh water. They too are low in diversity of plants, with black needle rush usually dominating vast areas. Salt Flats occur in fairly small areas of slight depression at the upper edge of salt or brackish marshes. Salty water floods these areas only occasionally. Once flooded, the water is trapped in the depression and evaporates, leaving salt concentrated in the soil. Vegetation is usually a sparse collection of extremely salt-tolerant plants such as salt grass and glasswort. The center of the Salt Flat may be completely barren. Salt Shrub communities occur on the upper edge of salt and brackish marshes, where salt water rarely reaches or where salt is diluted by fresh water seepage. They are dominated by salt-tolerant shrubs with marsh herbs often occurring in openings.

### **Ecosystem Level Effects:**

#### **Predicted Impacts of Climate Change:**

Climate Change Factor:	Likelihood:	Effect:	Magnitude:	Comments:
Storm Surge	High	Neg	Med	
Flooding	High	Neg	Low	
Drought	High	Neg	Low	
Coastal Erosion	High	Neg	Med	
Sea Level Rise -- Inundation	High	Neg	High	
Sea Level Rise -- Salt Intrusion	High	Neg	High	

The Climate Wizard median model for the mid-emission scenario (upper Albemarle Sound), indicates an annual average temperature 3.7 degrees higher by 2050 (Maurer et al., 2007). Individual models range from 2.3-5.4 degrees of temperature increase. The median rainfall value is a decrease of 2 inches. Individual model rainfall predictions range from an increase of 15 inches to a decrease of 15 inches.

These communities will be some of the most severely affected by rising sea level and by changes in the barrier islands. Large expanses of the estuaries are currently wind tidal and brackish, because of limited

connection to the ocean. Breaching of the Outer Banks would drastically change their salinity and tidal regime. More dramatic collapse of the Outer Banks could also change tidal ranges and expose some of the sounds to ocean waves. These changes will be exacerbated by more severe hurricanes and their associated storm surge. Inundation and increased shoreline erosion will destroy areas of marsh and increase the area of open water. Brackish and salt marshes will migrate farther upstream in the estuaries.

More extreme weather, both drought and flooding, in the inland watersheds may have some further effect on the estuaries, causing more dramatic salinity fluctuations because of varying freshwater input.

**Predicted Ecosystem Responses:**

Ecosystem Response:	Likelihood:	Effect:	Magnitude:	Comments:
Inland Migration	High	Mix	High	Estuarine communities will migrate inland along upper sounds and rivers.
Elevation Change	High	Mix	High	Marshes will migrate to higher elevations, and new open water areas will be created by inundation and coastal erosion.
Compositional Change	High	Mix	Med	Substantial brackish marsh communities will become salt marsh.
Acreage Change	High	Unkn		Net losses will occur in the sounds, but inland migration will create new area. The balance is uncertain.

Estuarine communities will be one of the Ecosystem Group most dramatically affected by climate change. As the lowest-lying communities, much of the existing acreage will be submerged by rising sea level, as well as subject to drastic changes in salinity and tidal regime. However, these communities likely have more ability than most to migrate to higher elevations and inland areas as sea level rises. They have relatively few species, and many are able to disperse by water. They are adapted to colonizing new land and recovering from natural disturbances. They have limited standing biomass, and can establish mature structure quickly.

The net change in acreage for the Ecosystem Group and for the individual community types is uncertain. It is likely to be a net loss, if the large sounds become exposed to the open ocean and the large marsh flats around them are submerged. Uphill areas in northeastern North Carolina may offer substantial new acreage for marshes to colonize, but inland areas and uphill areas in southeastern North Carolina are smaller in extent than the current estuarine communities.

**Habitat Level Effects:**

**Natural Communities:**

Third Approximation Name:	Comments:
Salt Shrub	Salt Shrub communities occur on the edges of Salt Marsh and Brackish Marsh. Many examples are on barrier islands and would be subject to erosion and increased overwash of these islands. These communities should be able to migrate inland with the associated marshes, but the loss of barrier islands will likely lead to a substantial net loss of area.
Salt Flat	Salt Flats are confined to barrier islands, and will be subject to erosion and the change in overwash dynamics. There will likely be a substantial net loss of these communities.
Brackish Marsh	Extensive areas of wind tidal Brackish Marsh in the Embayed Region may be lost, or may turn into Salt Marsh. Brackish Marsh should be able to migrate inland into freshwater tidal areas throughout its range.

Salt Marsh

Most Salt Marsh is in southeastern North Carolina. If barrier islands are able to migrate inland with rising sea level, they will override existing marshes. New marshes may be able to develop inland, but developed areas and hardened shorelines would prevent this. In northeastern North Carolina, vast areas of Brackish Marsh may become Salt Marsh.

**LHI Guilds:**

Guilds with Significant Concentration in Ecosystem Group:    Comments:

Salt-Influenced Marshes

General Marshes

Habitat for these guilds are likely to undergo significant changes in location and extent in response to sea-level rise, salt-water intrusion, increased effects of tides, and higher frequencies of major storms. While their habitat is likely to persist or even spread, some of the guild members may not survive, particularly if breaches of the Outer Banks result in rapid, massive changes in habitat.

**Species Level Effects:**

**Plants**

Species:	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC	Comments:
Eleocharis halophila	G4/S1				/T	This species is at its southern range limit in NC and is known from only 3 populations in NC.
Baccharis glomeruliflora	G4/SH				/SR-P	This species was historically at the northern limit of its range in NC, but has not been relocated in the state since 1949.
Eleocharis cellulosa	G4G5/S2				/SR-P	
Sporobolus virginicus	G5/S1				/SR-P	Of the four known populations from NC, only one is known to be extant (the others are considered "historical").
Paspalum vaginatum	G5/S1S2				/SR-P	
Lipocarpa micrantha	G5/SH				/E	
Eleocharis rostellata	G5/S2				/SR-O	
Eleocharis parvula	G5/S1				/SR-D	Widespread throughout North America, but known from only 4 populations in NC.
Cladium mariscoides	G5/S3				/SR-O	
Bidens trichosperma	G5/SH				/SR-P	
Leptochloa fascicularis var. maritima	G5T3T4Q/S1				/SR-O	
Heliotropium curassavicum var. curassavicum	G5T5/SH				/SR-P	
Elymus virginicus var. halophilus	G5T5/S1				/SR-P	

Many rare plant species associated with Estuarine communities are well-adapted to the naturally dynamic environment. Surviving the changes associated with sea level rise will likely depend on their ability to

migrate with the natural communities. Habitat fragmentation will limit species' dispersal ability. As North Carolina is at the edge of the range for many species (including *Eleocharis halophila* and *Baccharis glomeruliflora*), extirpation within NC could significantly reduce the overall ranges of these species.

The extreme rarity of some of the species in this theme makes them vulnerable to extirpation within NC. Climate change is likely to be one of the major threats to plants associated with Estuarine communities.

**Terrestrial Animals**

Species:	Element Rank:	Endemic	Major Disjunct	Extinction/ Extirpation Prone	Status: US/NC/WAP	Comments:
<i>Macrochilo santerivalis</i>	G3G4/SU				/W3/	
<i>Laterallus jamaicensis</i>	G4/S3B,S2N				FSC/SR/P	
<i>Botaurus lentiginosus</i>	G4/S1B,S3N				/SR/P	
<i>Meropleon diversicolor sullivanii</i>	G4T1T3/S1S3	Yes		Yes	/SR/	The sole known specimens of this taxon were collected by J.B. Sullivan from marsh habitats in the vicinity of Core Sound.
<i>Poanes aaroni aaroni</i>	G4T4/S1S2		Yes	Yes	/SR/	Only a single known population of this species exists in North Carolina, associated with marshes located along the shoreline of the mainland portion of Dare County.
<i>Sterna forsteri</i>	G5/S3B,S5N				/W2/	
<i>Rallus limicola</i>	G5/S3B,S5N				//P	
<i>Neoplynes eudora</i>	G5/SU				/W3/	
<i>Macrodiplax balteata</i>	G5/S2S3				/W3/	
<i>Ixobrychus exilis</i>	G5/S3B				/SR/P	
<i>Nerodia sipedon williamengelsi</i>	G5T3/S3	Yes			/SC/P	This salt-water tolerant subspecies of the northern watersnake is completely confined to the sounds of the North Carolina Coastal Plain, from Cedar Island north to Currituck Sound.
<i>Meropleon cinnamicolor</i>	GU/S2S3		Yes		/SR/	

Several rare, disjunct, or endemic species are associated with brackish marsh habitats in the sounds of the northern Coastal Plain: *Meropleon cinnamicolor*, *Meropleon diversicolor sullivanii*, *Nerodia sipedon williamengelsi*, and *Poanes aaroni aaroni*. Drastic changes in salinity and wave action that are likely to occur if the Outer Banks become breached may drastically affect these species, possibly leading to their extirpation or extinction. If they survive the initial effects of the barrier island breach, however, they may be able to spread to new areas of brackish marsh that will form farther inland on the mainland side of the sounds.

**Combined Threats and Synergistic Impacts:**

**Importance of Climate Change Factors Compared to Other Ecosystem Threats:**

Threat:	Rank Order:	Comments:
Climate Change	1	

Pollution	2	Water pollution from rivers and from nearby development has caused fish kills and shellfish closures in some estuaries.
Development	2	

Climate change, particularly rising sea level and the potential erosion of barrier islands, is the greatest threat to Estuarine Communities. Wetland regulations and extreme wetness protect them from most human exploitation and development. However, development of adjacent areas and water pollution are significant threats in substantial areas. These threats will exacerbate climate change effects. Development on uplands will prevent inland migration of marshes. Increased movement of sediment and nutrients from inland areas by increasingly intense storms will worsen water quality problems in estuaries, though this effect may be less important than the effect of increased urban development in general.

## Recommendations for Action:

### Interventive Measures:

Intervention:	Importance:	Feasibility:	Comments:
Protect Future Sites	High	High	
Preservation of Riparian Buffers/Floodplains	Mediu	High	Protection of buffers and floodplain rivers will benefit estuaries by reducing pollutant input and reducing drastic changes in freshwater input.
Stormwater Controls	Low	Medium	While important for inland rivers, stormwater controls it is of some importance, but more limited, to estuaries.
Restore/Maintain Hydrology	Mediu	Medium	Many marshes are ditched, and ditches may accelerate erosion and the effects of rising sea level.
Control Erosion	Mediu	Medium	Appropriate erosion control may reduce shoreline erosion of marshes, but inappropriate measures may destroy natural marsh or aquatic communities.
Allow Barrier Islands to Migrate	High	Medium	Allowing barrier islands to migrate increases their chance of survival and reduces the chance of sudden and drastic changes in tidal regime in the estuaries.

Because dramatic movement of these communities is probably inevitable as sea level rises, one of the most important things that can be done to help them adapt is to protect areas where they can migrate to. Salt and Brackish Marshes may be among the communities most able to naturally migrate. They will benefit from the protection of Tidal Freshwater Wetlands in rivers and upper sounds, some of which will become the extensive Estuarine Communities in the future. Protection of low-lying shoreline areas that would allow for inland migration is more difficult but would provide important benefits.

Because shoreline erosion is a source of loss of estuarine marshes beyond the effect of inundation, erosion control measures may help prolong their survival. However, measures that alter the shoreline, whether sea walls, "soft" structures, or plantings of off-site species, are potentially destructive to these communities.

## **Ecosystem Group Summary:**

Estuarine Communities are extremely vulnerable to the effects of climate change because of rising sea level and the potential erosion of barrier islands. Breaching of the Outer Banks would cause drastic changes in salinity, tides, and wave action in these ecosystems. Important actions to promote resiliency in Estuarine Communities are to protect inland Tidal Freshwater Wetlands, which will become extensive Estuarine Communities in the future, and allow the barrier islands to migrate.

## **References:**

Galbraith H, Jones R, Park R et al. 2002 Global climate change and sea level rise: potential losses of intertidal habitat for shorebirds. *Waterbirds* 25:173–18

Maurer, E.P, L.Brekke, T.Pruitt, and P.B. Duffy. 2007. Fine-resolution climate projections enhance regional climate change impact studies. *Eos Trans. AGU*, 88(47), 504.

N.C. Coastal Resources Commission's Science Panel on Coastal Hazards. 2010. North Carolina Sea Level Rise Assessment Report. NC Department of Environment and Natural Resources, Raleigh, NC.

---