

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

*DRAFT*

## Maritime Grasslands

### **Ecosystem Group Description:**

Maritime Grassland communities all occur along the coast and are unable to support trees because of heavy salt spray or overwash by salt water during storms. Dune Grass communities occur on the line of foredunes just behind the beach and on unstable sand dunes farther back on barrier islands. The loose, shifting sand with its low water holding capacity and low nutrient reserves makes these environments habitable by only a handful of specialized plant species. Sea oats grass is the dominant plant in most examples, with American beach grass dominating examples in the northern part of the state. Artificial dune stabilization by planting of grasses or placing snow fences modifies the natural dune structure and dynamics. The higher, more continuous artificial dunes are more susceptible to erosion on the front because there are no passages through which seawater can wash.

Maritime Dry Grassland communities occur on more stable sands in the interior of barrier islands. They may be on low, stable, old dunes, but are most typical on sandy flats on low islands that lack continuous foredunes. Seawater overwashes the low islands during severe storms and kills any invading woody vegetation. The characteristic dominant grass in these communities is saltmeadow cordgrass, though seaside little bluestem occurs in a few examples, and overall plant diversity is fairly low. Maritime Wet Grasslands may occur on low sand flats or in dune swales at the water table level. Some examples may even be flooded for substantial periods. Seawater overwash sometimes occurs and Saltmeadow cordgrass is generally dominant but a great diversity of other species is present. The Upper Beach type is not technically a grassland, but is closely related to the other community types. It occurs above the mean high tide line behind the intertidal beach. The environment is very harsh for plants, with almost constant salt spray and with periodic flooding and reworking of sand during storms. A handful of mostly annual, salt-tolerant herbs occur as sparse patches and scattered individuals on the sand. Small mounds of sand may develop around the few perennial plants, such as sea oats and marsh elder, forming the beginnings of dunes.

### **Ecosystem Level Effects:**

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

Climate Change Factor:	Likelihood:	Effect:	Magnitude:	Comments:
Coastal Erosion	High	Neg	High	
Storm Surge	High	Neg	High	Increased overwash.
Mild Winters	High	Mix	Low	May allow new exotic species to invade, or may allow more natural compositional change.
Sea Level Rise -- Salt Intrusion	Med	Neg	Med	
Sea Level Rise -- Inundation	High	Neg	High	

While the climate is expected to be warmer, and rainfall change estimates vary widely, the most important effects on these systems will be rising sea level and an increase in storms. Most Maritime Grasslands occur on the narrower, less stable barrier islands. Riggs (2010 presentation to the Sea Level Rise symposium and personal communication 2010) showed maps indicating that much of the narrower part of the Outer Banks could disappear entirely. Barrier islands in other places can be expected to migrate landward, if allowed to, and could survive if sea level doesn't rise too rapidly. The wider, more stable, generally higher, parts of barrier islands are likely to remain. Much of the area of these portions is occupied by Maritime Upland Forests. Grasslands will likely increase in the more exposed parts of them, and new barrier islands may eventually develop in the long run, but Maritime Grasslands are likely to suffer catastrophic losses.

Grassland communities will also shift and change as the result of increased storm activity and its associated erosion, increased salt spray, overwash, and salt water intrusion. These communities are well adapted to overwash and this may or may not be harmful to them. It may reverse the artificial exclusion of overwash that has altered some examples such as those on parts of Bodie and Hatteras islands and the Currituck Banks.

**Predicted Ecosystem Responses:**

Ecosystem Response:	Likelihood:	Effect:	Magnitude:	Comments:
Latitudinal Change	Med	Mix	Med	
Increased Fragmentation	High	Neg	Med	
Exotic species invasion	Med	Neg	Med	
Elevation Change	High	Neg	Med	
Compositional Change	Med	Mix	Med	Locally substantial but may be negligible in many parts.
Acreeage Change	High	Neg	High	Likely to be substantial. May be drastic.

Because the most extensive examples occur on narrow barrier islands which are most likely to disappear or be substantially altered by erosion, this group will likely shrink drastically. Examples should survive where barrier islands are able to migrate. Examples should survive on larger, more stable, higher islands, and may migrate to higher elevations or expand there at the expense of Maritime Upland Forest and Maritime Wetland Forest.

With the loss of area will come increased fragmentation. Fragmentation is already a problem in smaller examples that are isolated by developed areas. Many of the species in these systems are wide-ranging and may not suffer from fragmentation, but those of diverse wet grasslands and a number of rare species might be affected, particularly the seaside dusted skipper (*Atrytonopsis n. sp. 1*).

Increased natural disturbance and milder temperatures can be expected to change composition. Species native to comparable communities farther south may be able to migrate in. Our species and whole communities may be able to migrate northward into Virginia. However, loss and disruption of barrier islands and the fragmentation caused by development may limit migration. New exotic species may appear or become invasive in the warmer climate, though none are specifically known. Because the harsh physical environment already limits species present, and because the expected changes on surviving islands are mostly increases in processes already active, the degree of compositional change is expected to be limited in most of these communities. Structural changes may be more significant. However the wet grasslands in particular may be more drastically affected.

## Habitat Level Effects:

### Natural Communities:

Third Approximation Name:	Comments:
Upper Beach	These communities are naturally very dynamic and consist of species able to disperse readily. Appropriate environments for them should occur on any barrier islands that survive. However, the increased frequency and intensity of disturbance may affect some species and alter composition.
Maritime Wet Grassland	Many Maritime Wet Grasslands occur in wet dune swales in larger dune systems that are relatively sheltered from overwash and salt spray. Some may be well protected, but others likely are particularly vulnerable to increased exposure created by eroding shorelines. Other examples, such as those on Ocracoke, are low-lying and will quickly become subject to tidal flooding and turn into marshes.
Maritime Dry Grassland	Maritime Dry Grasslands are resilient to salt spray and overwash. Many have suffered from the artificial decrease in these forces caused by dune enhancement. Some may benefit if artificial foredunes are breached. If barrier islands are able to migrate, these communities should be able to establish on newly formed overwash flats. However, many of these communities are low-lying and would be inundated by rapidly rising sea level. Some should be able to migrate to higher elevations on the stable islands.
Dune Grass	Increased erosion of foredunes and possible disappearance of whole barrier islands will substantially reduce acreage. On surviving islands, interior dunes are likely to harbor remnants. If barrier islands are able to migrate, new dunes should form and these communities develop on them. Because these communities, and especially their dominant grasses, are important for stabilizing dunes, it is particularly important to protect the seed sources that will allow them to colonize newly formed dunes.

### LHI Guilds:

Guilds with Significant Concentration in Ecosystem Group:	Comments:
Xeric-Mesic Maritime Mixed Herbaceous Grasslands	

Maritime wet grasslands have been too poorly surveyed for animals to define an LHI guild. The Xeric-Mesic Maritime Mixed Herbaceous Grasslands guild, as currently defined, covers both the typical, fairly depauperate grasslands dominated by sea oats and the more species-rich communities containing significant amounts of seaside little bluestem. Most of the concerns regarding the impacts of sea level rise concern reduction, fragmentation, and degradation of the second type.

## Species Level Effects:

<u>Plants</u>						
Species:	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC	Comments:
Trichostema sp. 1	G2/S2	Yes		Yes	FSC/SR-L	Extremely rare, but adapted for dynamic beach and dune environments. Survival will depend on ability to migrate with the changing habitat.

<i>Amaranthus pumilus</i>	G2/S2		T/T	May be affected by increased storm frequency. This species cannot tolerate much overwash. Storm surges that occur early in the growing season may limit species' ability to produce seeds -- a major problem for this annual plant species.
<i>Dichanthelium caerulescens</i>	G2G3/S1S2		/E	This species also occurs in savannas with calcareous influence.
<i>Polygonum glaucum</i>	G3/S1		/SR-T	
<i>Bulbostylis warei</i>	G3G4/SH		/SR-P	This species is known in NC from only one historical location.
<i>Rhynchospora odorata</i>	G4/S1		/E	
<i>Cyperus tetragonus</i>	G4?/S1		/SR-P	
<i>Yucca gloriosa</i>	G4?/S2?		/SR-P	
<i>Clematis catesbyana</i>	G4G5/S2		/SR-P	
<i>Eleocharis montevidensis</i>	G5/S1		/SR-P	
<i>Hudsonia tomentosa</i>	G5/S2		/SR-P	Peripheral at its southern range limit. Occurs on higher areas in barrier island interiors, a relatively stable setting.
<i>Ipomoea imperati</i>	G5/S1		/SR-P	
<i>Rhynchospora microcarpa</i>	G5/S2		/SR-P	
<i>Scleria verticillata</i>	G5/S2		/SR-P	
<i>Sesuvium maritimum</i>	G5/S1?		/SR-O	
<i>Sesuvium portulacastrum</i>	G5/S1		/SR-P	
<i>Rhynchospora pinetorum</i>	G5?T3?/S2		/SR-T	
<i>Dichanthelium aciculare</i> ssp. <i>neuranthum</i>	G5T3/S1	Yes	/SR-D	
<i>Lechea maritima</i> var. <i>virginica</i>	G5T3Q/S1		/SR-T	
<i>Arenaria lanuginosa</i> var. <i>lanuginosa</i>	G5T4T5/S1		/SR-P	
<i>Solanum pseudogracile</i>	GNR/S1		/SR-T	Also occurs at edge of Brackish Marshes.

Many rare plant species associated with Maritime Grasslands 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. Early-season storm surges may prevent seed production and limit the species' ability to disperse and colonize appropriate areas as they become available. This could have especially devastating impacts on annual species, such as the federally Threatened Seabeach Amaranth (*Amaranthus pumilus*). Habitat fragmentation will also limit species' dispersal ability. These combined forces may cause extirpation within the state for some of these species. As North Carolina is at the edge of the range for many species (northern end of the range of *Bulbostylis warei*, *Cyperus tetragonus*, and *Rhynchospora pinetorum*, and southern end of range of *Hudsonia tomentosa* and *Lechea maritima*), extirpation within NC could significantly reduce the overall ranges of many species.

### **Terrestrial Animals**

Species:	Element Rank:	Endemic	Major Disjunct	Extinction/ Extirpation Prone	Status: US/NC/ WAP	Comments:
<i>Atrytonopsis</i> n. sp. 1	G1Q/S1	Yes		Yes	FSC/SR/	While taxonomic questions remain to

be answered, this skipper is only known from North Carolina barrier islands, from Fort Macon to Bear island. A genetic study indicated that its population is subdivided into three distinct groups, one at Fort Macon and nearby dredge spoil island, one at Emerald Isle, and one at Bear Island. These findings indicate that dispersal may be fairly infrequent across ocean inlets as well as wide strips of maritime forest and development. Sea level rise may have an effect through increased fragmentation of its already restricted range. However, the sites it occupies are among the most stable and likely to persist.

Phyciodes phaon	G5/S3			/W5/
Leucania phragmatidicola	G5/SU	Yes		/W2/
Faronta aleada	GNR/S1S2	Yes	Yes	/SR/

This moth is globally known from only a handful of sites. The population recorded at Fort Macon along with a single individual collected at Rodanthe on the Outer Banks are the only ones known from the Atlantic Slope. The Fort Macon population appears to be associated with the same habitat as the seaside dusted skipper, but its presence on the Outer Banks indicates that it may not necessarily be associated with seaside little bluestem.

The seaside dusted skipper is one of the rarest species in the state. Even if it turns out to be an isolated population of the Loammi skipper, that species is also highly threatened and currently only known to exist in Florida.

## Combined Threats and Synergistic Impacts:

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

Threat:	Rank Order:	Comments:
Development	1	Including artificial foredune build-up.
Climate Change	1	
Invasive Species	2	Feral populations of horses have been documented to have a severe effect on maritime herbaceous communities and particularly on populations of seaside little bluestem.

Housing development has destroyed or severely degraded much of the original expanse of Maritime Grasslands. Ongoing development is the most severe threat to the remaining unprotected examples. However, the sea level rise and increased storm intensity associated with climate change are the most severe threats to the conservation areas where most of the remaining Maritime Grasslands occur.

Artificial building up of foredunes by sand fencing and plantings in the past have altered many Maritime Grasslands, including much of the protected area in Cape Hatteras National Seashore and parts of the

Currituck Banks. Besides altering the structure and sometimes the composition of Dune Grass communities, such past alteration has blocked most overwash. This has resulted in shrub invasion in many low-lying Maritime Grasslands that were maintained by overwash. Increased coastal erosion may breach the foredunes, allowing overwash to occur, partly offsetting this effect. However, such an abrupt return of overwash will represent a catastrophic disturbance to the woody vegetation that has developed in its absence.

Overwash is important for transporting sand to the back of barrier islands, allowing them to migrate landward with rising sea level. Preventing overwash as sea level rises and erosion on the seaward side continues presumably hastens the destruction of the barrier islands.

Maritime grasslands on more stable barrier islands are less likely to be affected by changes in overwash. These communities are even more vulnerable to the effects of development because they are higher. The large expanses on Bogue Banks and Nag's Head have already largely been eliminated.

Grazing by feral horses is a significant threat to some protected areas, such as Shackleford Banks and the Rachel Carson Preserve. Grazing has severely damaged the Maritime Grasslands in these sites. Patches of seaside little bluestem, which support some of the rarest insects in the state, are now almost absent outside of artificial horse exclosures.

## Recommendations for Action:

### Interventive Measures:

Intervention:	Importance:	Feasibility:	Comments:
Restore Extirpated Areas	High	High	Fence off portions of barrier islands where feral horses still occur, allowing recovery of maritime grassland communities.
Control Invasive Species	High	High	
Allow Barrier Islands to Migrate	High	Medium	

Barrier islands will vary in their ability to migrate. Where sand supply is abundant and the substrate is appropriate, restoring overwash processes that carry sand from the seaward to the landward side of the island may allow them to migrate landward and improve their prospects for survival.

Collecting seeds of the rarest plant species associated with Maritime Grasslands (especially annual species) is recommended, to protect genetic diversity and maintain a source of local material that can be used to re-establish populations if species are extirpated or severely impacted within North Carolina.

Beach vitex is the only invasive plant species that is a severe threat at present. Its abundance is limited, and control should be feasible with effort. Additional exotic species are likely to appear with a warmer climate. Those that have shown invasive behavior farther south should be looked for and controlled aggressively as soon as they appear.

Although protected by law in North Carolina, feral horse herds should be restricted from some areas where they currently roam free. Such restriction would be particularly beneficial at Shackleford Banks, allowing restoration of populations of seaside little bluestem -- now almost entirely confined to horse exclosures --

and potentially of associated species such as *Atrytonopsis* n. sp. 1.

## **Ecosystem Group Summary:**

Development and, historically, free-ranging livestock have destroyed much of the original Maritime Grasslands and continue to represent the most severe threats to remaining unprotected examples. However, the sea level rise and increased storm intensity associated with climate change are the most severe threats to the conservation areas where most of the remaining Maritime Grasslands occur. Although massive changes are likely, at least some examples can survive if given sufficient protection and where natural beach cycles are allowed to operate.

## **References:**

Godfrey, P.J., and M.M. Godfrey. 1976. Barrier island ecology of Cape Lookout National Seashore and Vicinity. National Park Service Scientific Monograph Series No. 9.

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.

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