

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

DRAFT

Coastal Plain Depression Communities

Ecosystem Group Description:

The natural communities in coastal plain depressions occur in various kinds of small basins in Coastal Plain uplands. The basins, which may be limesink depressions, Carolina bays, or swales between recent or older sand dunes, hold standing water for at least substantial parts of the year. Water levels usually fluctuate over the course of a season and also from year to year. The vegetation is often strongly zoned, with zones reflecting the variation in length of flooding (hydroperiod) along the sloping edges. Basin communities differ in overall hydroperiod, in soil, in slope, and in depth. Vegetation varies widely, perhaps partly because the isolation of individual basin clusters limits dispersal between them. Despite this, however, many plant species are shared with small depression communities from Massachusetts to Florida.

A variety of community types are included in this Ecosystem Group. Interdune Ponds are freshwater ponds on barrier islands. These are geologically young and potentially subject to sand dune movement or salt water flooding, as well as salt spray. Their vegetation varies from open water with aquatic plants, to deep water with sparse swamp black gum or bald cypress trees, to shallow water with beds of tall marsh species. Small Depression Ponds are the wettest of the mainland depression communities, occurring in basins that are essentially permanently flooded at least in the center. Aquatic plants are usually present in the middle, and zones of herbaceous plants and sometimes sparse canopy trees occur around the edge of the water. Cypress Savannas occur in shallow basins that generally dry out by the end of the summer. The ground cover is dominated by a dense grassy herb layer. Unlike the previous two communities, fire is an important natural force during dry periods. Vernal Pools occur in the shallowest basins, which dry up early in the summer. They combine wetland plants with plants more typical of uplands and are naturally subject to fire. Small Depression Pocosins occur in small basins that are filled with organic deposits. The vegetation is a dense thicket of pocosin shrubs often with a pond pine, red maple, or swamp black gum canopy. These communities have much in common with the peatland and streamhead pocosins.

Ecosystem Level Effects:

Predicted Impacts of Climate Change:

Climate Change Factor:	Likelihood:	Effect:	Magnitude:	Comments:
Wind Damage	High	Neg	Med	
Mild Winters	High	Mix	Low	
Fire	Low	Mix	Low	Consumption of woody debris from fires would reduce habitat quality for breeding amphibians.
Drought	High	Neg	Med	

Climate Wizard data (Maurer et al., 2007) for the Onslow/Pender County area show a mid-value average annual temperature increase of 3.3 degrees, with a range among models of 2.28-4.79 degrees. Mid-value average rainfall change is a decrease of 2 inches, but the range of model rainfall predictions range from a decrease of 19 inches to an increase of 18 inches.

General forecasts suggest an increase in severe storms and droughts. Severe storms may cause more wind damage to canopy trees in communities that have them. The effect of drought is less certain. Most communities occur mostly in low-lying areas that are unlikely to become extremely dry even in droughts. However, many species may be excluded from them at present by wetness. Ditches, which are present in many Carolina Bays will exacerbate the effects of drought.

The most important effect of climate change is likely to be its effect on the hydroperiod. Some basins are fed mainly by rainfall, while many reflect the local water table. Depression communities have naturally varying hydroperiods and are well adapted to them, but increased drought may increase the number of years they dry up or the amount of time they spend dry. If droughts are not too long, their effect may be offset by an increase in heavy rainfalls, which would be stored in some basins.

Increased drought conditions and increased thunderstorm intensity may lead to more wild fires. Cypress Savannas and Small Depression Pocosins depend on fire and are often degraded by lack of fire. An increase in wild fires may allow some occurrences to burn in a way that is ecologically beneficial. However, wild fires in drought may introduce fire into ponds and depressions that would normally be unlikely to burn, and might be too intense or extensive and cause harm to some species. If fires consume large woody debris, it would be detrimental to amphibian populations. In basins with organic soils, there is potential for peat fires during droughts, with drastic effects on the community. Because these communities are generally small, they burn in conjunction with the surrounding landscape, which is usually longleaf pine communities. Fire is generally easy to control in these landscapes, but small patches may be completely burned before fires are controlled. Fire fighting often damages wetlands, and this damage could increase. Increased drought might make prescribed burning harder, leading to a decrease in fire in protected examples.

Predicted Ecosystem Responses:

Ecosystem Response:	Likelihood:	Effect:	Magnitude:	Comments:
Exotic species invasion	High	Neg	Med	Warmer temperatures may favor invasive species from the south.
Compositional Change	Low	Mix	Low	Increased drought could allow more species that prefer drier site conditions.
Structural Change	Med	Neg	Low	Wind damage could open canopy

These communities are well adapted to changing water levels and hydroperiods. Many of their plants are able to persist in seed banks until favorable conditions return, or are able to shift within basins to areas with favorable water levels. The same is likely true of many of the invertebrates. Depression communities are often important breeding sites for amphibians. Droughts may cause complete loss of reproduction in some years. Drought conditions in the uplands may also affect the adult stage of their life cycle and reduce overall populations.

If droughts are long enough, species of drier communities that are currently excluded by wet periods may be able to establish in these communities. Loblolly pine invaded a number of Cypress Savannas and some Small Depression Ponds and Vernal Pools in the droughts of the 1980s and 1990s. If wet spells return after drought, some of these plants may drown and the effect may be reversed, but this often does not happen

once they are established.

Coastal Plain Depression Communities and many of their characteristic species span a wide range in latitude, many from New England to Florida. They and their component species are well adapted to warm temperatures, and temperature changes are not likely to have a strong effect on them. It is possible that some species may migrate into them from the south. But many plants in these systems have limited dispersal ability even locally, so any influx of native species is likely to be slow. Even mobile animals are not likely to be able to move. The strong contrast of these environments within the surrounding uplands, the limited number of potential sites in this region, and the fragmented distribution of examples make natural migration difficult.

Increased wind storm damage could affect canopy structure in some communities, creating more open conditions in communities that are forested. However, many of these communities lack tree canopies. Many others are dominated by cypress, which is not very susceptible to wind throw. Only a minority of communities would be very much affected by wind damage.

These systems are not very susceptible to any invasive plants currently, but fire ants are already a serious invader in these systems. Warmer temperatures may allow an increase in their abundance or rate of spread. Red Bay Wilt disease, already a serious problem in South Carolina and Georgia, may spread to North Carolina.

Habitat Level Effects:

Natural Communities:

Third Approximation Name:

Comments:

Interdune Pond

Interdune Ponds occur in the dynamic environment of the barrier islands. They occur in the interior parts of wider, more stable barrier islands. Most are unlikely to be directly affected by coastal erosion or rising sea level, but some basins may be breached and become subject to tidal flooding or salt water intrusion in storms. All will be subject to increased salt spray as the surrounding parts of their islands erode.

Small Depression Pocosin

Small Depression Pocosins generally hold little water. Because of their dense flammable vegetation, they naturally burn during dry periods. Severe drought may allow peat fires to occur, causing major disturbance to the community. These communities often have pine or hardwood canopies, which may be affected by wind storms more than most Coastal Plain Depression Communities.

Small Depression Pond

These are the wettest communities in this theme. Increased drought may dry up examples that have not naturally dried up, which may contain species not adapted to it. Plants are generally good at shifting within basins in response to drought and wet periods. Many ponds are water table windows, and effects of drought on the regional water table may affect them strongly.

Cypress Savanna

These communities are dependent on fire during dry periods. They have proved very susceptible to invasion by loblolly pine and other weedy native species during droughts. Most of their plants are effective at persisting in seed banks when hydrological conditions are unfavorable.

Vernal Pool

These are the driest communities in this theme. Droughts might leave them dry throughout the year. They are very susceptible to invasion by upland species in drought. Fire could offset this effect.

LHI Guilds:

Guilds with Significant Concentration in Ecosystem Group: Comments:

Wet-Xeric Longleaf Pine Woodlands/Ephemeral Pools

The one LHI Guild that has a strong concentration of habitat within this theme covers only those species who occupy terrestrial habitats, at least part of the year. Purely aquatic species associated with isolated pools are currently not well addressed in this analysis, falling between the cracks separating the terrestrial and wetland species covered by the guilds and the primarily lotic species covered by our aquatic species analysis.

Species Level Effects:

<u>Plants</u>	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC	Comments:
Dichanthelium hirstii	G1/S1		Yes	Yes	C/E	Only one location is known to be extant globally; recent searches at both known locations from NC have failed to relocate the species.
Eupatorium paludicola	G2/S2	Yes			/SR-L	Known only from 2 counties in NC and 1 in SC; sites are typically inundated in winter and spring by ground water, and water levels recede below the surface by summer or fall, though soils remain saturated to moist.
Oxypolis canbyi	G2/S1			Yes	E/E	Searches from the only location known from NC have failed to find the species in recent years.
Ludwigia brevipes	G2G3/S1S2				/SR-T	Occurs in Coastal Plain depressions from NJ to FL, but rare throughout its range.
Lindera melissifolia	G2G3/S1			Yes	E/E	Occurs from NC and MO south to FL, but in NC, only 2 sites are extant.
Lobelia boykinii	G2G3/S2				FSC/T	
Hypericum adpressum	G3/SH				FSC/SR-T	
Litsea aestivalis	G3/S2S3				FSC/SR-T	
Ludwigia lanceolata	G3/S1				/SR-P	
Muhlenbergia torreyana	G3/S2				/E	
Myriophyllum laxum	G3/S2				FSC/T	
Rhexia aristosa	G3/S3				FSC/T	
Rhynchospora pleiantha	G3/S2				FSC/T	
Lachnocaulon minus	G3G4/S2				/SR-P	
Persicaria hirsuta	G3G4/S1				/SR-P	
Sphagnum torreyanum	G3G4/S1				/SR-P	
Solidago leavenworthii	G3G4/S1				/SR-P	
Agalinis virgata	G3G4Q/S2				/SR-P	

Ludwigia alata	G3G5/S2	/SR-P	
Vaccinium virgatum	G4/S1	/SR-P	Except for a disjunct population in Indiana, this species reaches the northern limit of its range in NC; widespread and secure throughout the southeast but rare in NC.
Amphicarpum muehlenbergianum	G4/S1	/E	
Drosera filiformis	G4/S2	/SR-P	
Ludwigia linifolia	G4/S2	/SR-P	
Tridens ambiguus	G4/S1	/E	
Rhynchospora tracyi	G4/S2	/SR-P	
Stylisma aquatica	G4/S2	/SR-P	
Sclerolepis uniflora	G4/S2	/SR-T	
Utricularia olivacea	G4/S2	/T	
Scleria reticularis	G4/S2	/SR-O	
Micromitrium synoicum	G4/S1?	/SR-O	
Sclerolepis uniflora	G4/S2	/SR-T	
Potamogeton confervoides	G4/S2	/SR-D	
Sagittaria isoetiformis	G4?/S2	/SR-P	
Cyperus lecontei	G4?/S2	/SR-P	
Rhynchospora harperi	G4?/S2	/SR-P	
Lycopus angustifolius	G4?Q/S1	/SR-P	
Bacopa caroliniana	G4G5/S1	/SR-P	
Utricularia geminiscapa	G4G5/S1	/SR-P	
Eupatorium leptophyllum	G4G5/S2	/SR-P	
Eleocharis cellulosa	G4G5/S2	/SR-P	
Eleocharis cellulosa	G4G5/S2	/SR-P	
Eleocharis atropurpurea	G4G5/S1	/SR-D	
Gratiola ramosa	G4G5/S1	/SR-P	
Eleocharis robbinsii	G4G5/S2	/SR-P	
Utricularia macrorrhiza	G5/S1?	/SR-O	
Boltonia asteroides	G5/S2	/SR-O	
Rhynchospora microcarpa	G5/S2	/SR-P	
Didiplis diandra	G5/S1	/SR-P	
Torreyochloa pallida	G5/S1	/SR-P	
Eleocharis vivipara	G5/S1	/SR-O	
Utricularia cornuta	G5/S1S2	/SR-P	
Hypericum fasciculatum	G5/S1	/SR-D	
Potamogeton nodosus	G5/SH	/SR-D	
Potamogeton illinoensis	G5/S1	/SR-D	
Iva microcephala	G5/S2	/SR-P	
Oldenlandia boscii	G5/S2	/SR-P	
Myriophyllum pinnatum	G5/S1	/SR-T	

Ludwigia sphaerocarpa	G5/S1	/SR-P
Ludwigia suffruticosa	G5/S2	/SR-P
Echinodorus tenellus	G5?/S1	/SR-T
Eleocharis elongata	G5?/S1	/SR-P
Sagittaria chapmanii	G5T3?/S1	/SR-P
Carex canescens ssp. disjuncta	G5T4?/S2	/SR-P
Ceratophyllum australe	G5TNR/S1	/SR-P

Many rare plant species associated with Coastal Plain Depression Communities are at the northern limit of their range in NC, but they are unlikely to move north with warmer temperatures. Limesinks and Depression Pocosins are not likely to expand to the north with the changing climate because the distinctive soils and hydrology do not occur there. Some of these species are rare in NC, but are considered globally secure, as their habitat is widespread throughout the southeastern United States.

Many species associated with this Ecosystem Group are dependent on the combination of wet conditions and frequent fire. Changes in climate that reduce frequency of fire or degree of moisture could cause extinction of the rarest species and extirpation within NC of others.

Terrestrial Animals

Species:	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC/WAP	Comments:
Ambystoma mabeei	G4/S3				/SR/P	
Pseudacris ornata	G5/S3				/SR/P	
Hyla gratiosa	G5/S3S4				//P	
Eurycea quadridigitata	G5/S2				/SC/P	
Deirochelys reticularia	G5/S3				/SR/P	
Ambystoma tigrinum	G5/S2			Yes	/T/P	Populations in North Carolina are currently all small and highly isolated. Increased droughts may have a major impact on the breeding success of this species.

The majority of the animal species associated with this Ecosystem Group are highly vulnerable to the effects of drought, since they require shallow, isolated pools for breeding. While they are adapted to poor reproductive success in occasional dry years, droughts spanning several years in a row are likely to cause extirpation from certain areas, with little opportunity for recovery.

Combined Threats and Synergistic Impacts:

Importance of Climate Change Factors Compared to Other Ecosystem Threats:

Threat:	Rank Order:	Comments:
Development	1	Development has destroyed or degraded many Interdune Ponds, Small Depression Ponds, and Vernal Pools, and threatens many others. Degradation is often indirect, caused by destruction of the surrounding uplands, alteration of ground water levels, destruction of adult habitat for amphibians, and alteration of fire regimes.
Conversion to agriculture/sylvicu	1	Many Cypress Savannas have been planted or invaded by loblolly pines; it is unknown whether conversion continues.
Fire	1	Fire Suppression is a major problem in Cypress Savannas, Vernal Pools, and Small Depression Pocosins.
Climate Change	2	Increases in prolonged droughts -- extending over multiple years -- is likely to have a severe impact on amphibian populations.
Groundwater Depletion	2	Water level in many depression communities of all kinds reflects the water table, and depletion by pumping or drainage reduces or eliminates their hydroperiod. Increases in drought will exacerbate this. In Interdune Ponds, ground water depletion may be accompanied by salt water intrusion.

The greatest threats to this system are due to habitat conversion. Fire suppression is also a major factor affecting the survival of the plant species associated with depression ponds. For amphibians that are highly tied to ephemeral pools for breeding, prolonged droughts, which may potentially increase due to climate change, can have a severe effect on long-term population viability.

Drier basins are destroyed by development or pine plantations, while wetter ones are degraded by these activities on the surrounding uplands. In protected examples, alteration of hydrology and effects of lack of fire are usually the most serious threats. Many depression communities show evidence of becoming drier. Given recent droughts and natural water level fluctuations, it is unclear how much effect drainage and ground water depletion in the surrounding landscape have had. It may be significant. Drought and lack of fire interact, in that invasion by upland trees during drought would be controlled by fire. Destructive use by off-road vehicles has also damaged some examples. The potential for it is also increased by drought.

Climate change is likely to exacerbate these existing effects, increasing the number and severity of droughts and increasing the amount of evaporation even in years of normal rainfall. If increased drought and severe weather reduces the ability to conduct prescribed burning, this may reduce fire even in the few examples that are getting burned.

Recommendations for Action:

Interventive Measures:

Intervention:	Importance:	Feasibility:	Comments:
Restore/Maintain Hydrology	High	Medium	
Restore/Maintain Landscape Connections	Mediu	Medium	

Control Invasive Species	High	Medium
Conduct Prescribed Burns	High	High
Protect/Expand Remaining Examples	High	High

Because so few examples remain, and many rare species are associated with this habitat, protecting remaining examples is crucial with or without climate change. Protection is more critical for complexes with a diversity of community types or basin morphologies. Having more examples and a diversity of different basins will improve the prospects for survival for these rare communities and their species.

Prescribed burning is crucial for the fire-maintained communities in both the present and the expected future climate. Many examples have been invaded by pines in recent droughts, and this problem is likely to increase. It is important in preparing for climate change because excess fuel loads increase the risk of destructive wild fire during droughts. Beginning prescribed burning programs before droughts become severe is important, as reducing fuel loads safely while avoiding ecological damage takes time. Sites that have had regular fire will be safer from wild fire, will represent less of a wild fire hazard to adjacent areas, and will allow prescribed burning to continue into drier conditions. The ash produced by fire in these communities tends to raise the pH in the water, benefitting amphibians. Regular burning will also promote healthy, diverse communities and species, which will allow the best potential for communities to adapt to changing climate. Burns should not be so frequent or intense, however, as to consume the woody debris needed as shelter for the amphibians that depend on these pools as breeding habitat.

Hydrology is very important to these communities, and there appears to be some trend toward drying in many locations. The cause and significance of the current situation are not clear. Additional study is needed to determine the importance of regional drainage and ground water consumption on these systems. This expected changes in the climate will make these problems worse, and create greater urgency to understand and address them.

While these distinctive communities cannot be connected across the landscape, protecting the connection to the uplands around them is important. The amphibians that use these basins need adult habitat and need the ability to migrate to the ponds during breeding season.

Although no invasive exotic plants are a serious problem in these systems now, early detection and control of invasive exotic species (such as Red Bay Wilt) will reduce the ecological damage caused by invasives and the cost of controlling them. Preventative measures such as forbidding sale and transport of invasive species will help reduce the risks and cost. Fire ants are already a serious cause for concern for many of the animal species that inhabit cypress savannas. The development of multi-queen colonies, resulting in greatly increased hive densities, should be regarded as a major threat to savanna ecosystems. High hive densities are already a serious problem along the Gulf Coast and may spread northward aided by decreased winter severity.

Ecosystem Group Summary:

Many Coastal Plain Depressions are likely to be resilient to climate change effects. Most of their component species range well to the south of North Carolina. They are tolerant of fire and wind, but drought may present more problems. Many have broad tolerance of varying moisture and nutrient conditions. However, they have been drastically reduced by conversion to other uses and degraded by lack of fire. This makes them more vulnerable to loss of species and degradation both by climate change and by other threats. Protection of remaining examples and restoration of degraded examples would help the Coastal Plain landscape adapt to future climates, as well as provide benefits under the current climate. Keeping or restoring fire to these systems, through prescribed burning, is crucial to their long term survival in both the present and any future climate.

References:

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.
