

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

DRAFT

Piedmont Upland Pools and Depressions

Ecosystem Group Description:

These communities occur in shallow depressions which hold water in wetter parts of the year. They generally dry up by the end of summer, but are flooded long enough into the growing season to contain wetland vegetation that contrasts with the surrounding uplands. Most occur in the Piedmont, where they are associated with mafic rocks or shales, but a couple of Upland Pools are known from the Mountain region, where they occur on quartzite.

Upland Depression Swamp Forests occur in shallower depressions than Upland Pools, and are flooded for shorter periods. They have a closed canopy of wetland trees. Understory, shrubs, and ground cover are usually sparse. Upland Pools occur in wetter sites, where the water is deep enough or long-standing enough to prevent development of a closed tree canopy. The vegetation varies widely, and it is likely that this type could be split into several community types. Trees of the Upland Depression Swamp Forest community type may occur around the edges.

Both of these community types often have abundant amphibians. Because the pools do not support fish, which eat amphibian eggs and larvae, they are excellent amphibian breeding sites. Other important amphibian breeding sites in the Piedmont are pools located on higher, infrequently flooded riparian terraces. In most years, these pools are also fish-free and support good amphibian breeding success. During heavy storm events, however, fish can be swept in by overbank flooding, reducing the suitability of these pools for amphibian breeding until they dry out again.

Ecosystem Level Effects:

Predicted Impacts of Climate Change:

Climate Change Factor:	Likelihood:	Effect:	Magnitude:	Comments:
Wind Damage	Med	Neg	Med	
Increased Temperature	High	Neg	Low	
Drought	High	Neg	Med	

The Climate Wizard mid model temperature increase is about 4 degrees by 2050, in the Asheboro area (Maurer et al., 2007). The cmd model predicts an increase of 4.5 degrees. The mid value rainfall forecast is for a slight increase, but there is substantial variation among the models: anywhere from a decrease of 13 inches to an increase of 18 inches per year. Some models predict that rainfall will be concentrated during the fall, and there will be increased droughts in the spring and summer. This may reflect an expectation of increased hurricane activity rather than well-distributed rainfall. There is also a general expectation that

both droughts and extreme rainfall events will become more common.

These systems are perched wetlands that are fed mostly by rainwater, with little surface input. All of them dry up in in the course of most growing seasons. Higher temperatures will increase evaporation and will lead to somewhat shorter hydroperiods. Effects of short-lived droughts may be offset by water persisting from rainy periods. More prolonged drought would further reduce the flooded period.

Most of these systems are forested, and their trees are particularly susceptible to wind throw because of the wet soil and shallow rooting depth. Examples have suffered disproportionate damage in recent hurricanes. An increase in severe storms is likely to intensify their effect.

Predicted Ecosystem Responses:

Ecosystem Response:	Likelihood:	Effect:	Magnitude:	Comments:
Structural Change	High	Neg	Med	
Acreage Change	Med	Neg	Low	
Compositional Change	Low	Mix	Low	

These communities are isolated and contrast strongly with the surrounding uplands. They will be unable to migrate. However, most of their component species range well to the south, and the change in temperature is not expected to have a major effect on them. The change in hydroperiod may be more important. These communities are important breeding sites for amphibians, and it is possible that reduced duration of flooding would leave too little time for larvae to mature in some years. Warmer water temperatures may have uncertain effects on amphibian development as well.

Shallower marginal depressions and edges of larger depressions may be dried enough that they are invaded by upland species and lose their identity. This will cause a loss of acreage, but this loss is not likely to be extreme.

An increase in wind throw may occur if severe storms become more frequent. These communities are already disproportionately affected by severe storms, but normally have supported closed canopies of large trees. More frequent storms will lead to more open canopies, possibly causing some Upland Depression Swamps to more resemble the more open Upland Pools. The more open canopy may allow less shade-tolerant plants to establish, changing the composition of the communities in ways that would not be detrimental. The loss of evapotranspiration from the trees may possibly offset the increased evaporation caused by higher temperatures. Increased wind throws may benefit amphibians by creating deeper pools that hold water longer into the season or that offer at least some breeding opportunities when the rest of the pool is dry.

Habitat Level Effects:

Natural Communities:

Third Approximation Name:	Comments:
Upland Pool	These communities are rare. The effect of climate change is not clear. Faster drying may allow trees to invade, effectively turning them into Upland Depression Swamps. Conversely, increased wind throw in Upland Depression Swamps might cause them to resemble the open Upland Pools more.

LHI Guilds:

Guilds with Significant Concentration in Ecosystem Group: Comments:

(Piedmont Ephemeral Pools)

Currently, the Piedmont Ephemeral Pools guild may be provisionally carved out of the other two guilds associated with this theme, including only species with strong associations with isolated, temporary pools.

In the LHI analysis, upland pools and seepage areas are treated as sub-communities within two larger categories of hardwood forests. With respect to climate change, however, upland pools and their associated species are likely to respond differently from the surrounding forests and are grouped into a separate guild of their own. This guild, however, includes floodplain pools that rarely flood, in addition to upland pools that are located on ridges or other inter-basin sites.

Species Level Effects:**Plants**

Species:	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC	Comments:
Isoetes virginica	G1/S1	Yes		Yes	FSC/SR-L	Endemic to Virginia and North Carolina where known from only five recent occurrences.

Few rare plant species are associated with this Ecosystem Group. The ecological requirements of *Isoetes virginica* are not well understood. In NC, only one of five historical locations has been seen in recent years. Changes in hydrology would likely negatively impact the species. Because of the isolated populations and small patches of suitable habitat, this species is not likely to migrate much to colonize new sites.

Terrestrial Animals

Species:	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC/WAP	Comments:
Hemidactylum scutatum	G5/S3				/SC/P	
Ambystoma talpoideum	G5/S2				/SC/P	
Ambystoma opacum	G5/S5				//P	
Ambystoma maculatum	G5/S5				//P	

Members of this provisional guild all make use of upland pools for breeding, but make use of floodplain pools as well, at least where they are fairly well isolated from frequent overbank flooding. Wind throw pits may also be used and *Hemidactylum scutatum*, in particular, makes frequent use of seepage habitats.

All are likely to be strongly affected, particularly upland populations, by increases in prolonged droughts associated with climate change. Increased drawdown of groundwater levels, also the result of prolonged drought as well as increased human utilization, particularly in times of surface water scarcity, is another major threat for populations associated with floodplain pools or seeps. Floodplain pool populations are additionally

likely to be adversely affected by increases in overbank floods that carry fish into their breeding sites. These impacts may be offset to some extent, however, by increases in the number of wind throw pits resulting from heavier storm damage.

Combined Threats and Synergistic Impacts:

Importance of Climate Change Factors Compared to Other Ecosystem Threats:

Threat:	Rank Order:	Comments:
Logging/Exploitation	1	
Development	1	
Climate Change	2	
Flood Regime Alteration	3	
Invasive Species	3	

The greatest threats to these systems come from land use changes and ongoing exploitation. Shallower examples may be destroyed by development or heavily altered by logging. Logging when the ground is wet creates permanent ruts as well as altering canopy structure and composition. Wetter examples often are excluded, but are degraded by development of surrounding areas. Amphibians in these communities depend on the surrounding uplands, and are lost or much reduced if the surrounding habitat is destroyed or altered. Drainage ditches have affected some examples, and alteration of drainage by roads has altered some other examples.

Climate change represents a moderate threat, with potential to reduce acreage and destroy some examples and to somewhat alter the others. The threat of climate change is greatest in drier examples, the same examples that are most likely to be destroyed by the more severe threats. However, pools located in floodplain terraces that now rarely flood may experience greater flooding in the future due to more frequent severe storms. Pool-breeding amphibians that make use of these pools may potentially be as adversely affected by these changes as those associated with upland pools are by increased frequency of drought.

Invasive species are not a significant problem in these systems at present. Increased canopy opening and shortened hydroperiod will make them more susceptible to invasion by Japanese honeysuckle (*Lonicera japonica*), Japanese stilt grass (*Microstegium vimineum*), and possibly Asian dayflower (*Murdannia keisak*). Fire ants, which are not abundant in the Piedmont at present, are likely to increase with warmer temperatures. They represent a threat to these communities, and may represent an additional indirect threat if they harm amphibians in the uplands.

Recommendations for Action:

Interventive Measures:

Intervention:	Importance:	Feasibility:	Comments:
Restore/Maintain Hydrology	Mediu	High	Very important in the minority of examples where hydrology has been significantly altered. Some existing drainage which is not significant now may become so if the future climate makes sites more marginal.
Restore/Maintain Landscape Connections	High	Medium	It is particularly important to protect the surrounding uplands for these communities
Protect/Expand Remaining Examples	High	High	

The most important actions needed for these communities is to protect unprotected examples and to protect or restore the surrounding uplands for as many as possible. In some cases where ditches are affecting the hydrology of the pools, plugging the ditches or other hydrological restoration methods should be employed.

It is particularly important to protect the larger and wetter examples, which are more likely to persist in drier conditions. As more examples are lost, the remaining ones will become increasingly important for the survival of amphibian populations. With more extreme weather, species populations in individual basins may become less stable and more dependent on metapopulation dynamics for their long-term survival. Where they can be protected or established, connections between examples will become even more important than at present.

Ecosystem Group Summary:

The greatest threats to Piedmont Upland Pools and Depressions come from land use changes and ongoing exploitation, however, climate change also represents a significant threat. The drier Upland Depression Swamp Forests, also most threatened by development and logging, will likely be most affected by drought and wind throw from severe storms. These habitats are important amphibian breeding sites. Amphibian populations that make use of ephemeral pools in these environments may potentially be as adversely affected by increased flooding from severe storms as they are by increased frequency of drought. The most important conservation actions needed for these communities is to protect remaining sites, including the surrounding uplands, to ensure resiliency against climate change impacts and to allow for landscape connections between habitats.

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.