

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

DRAFT

Piedmont and Mountain Floodplains

Ecosystem Group Description:

Natural communities of Piedmont and Mountain floodplains are influenced by slight elevation differences created by different sediment deposition patterns. However, relatively steep gradients result in narrow floodplains in the Piedmont and Mountains, so few floodplains contain significant elevation differences. Well developed floodplain landforms are most often lacking. A number of variants can be recognized within the community types in this theme. Variants tend to be determined by the different geologic conditions in different parts of the Piedmont and Mountain regions.

Where floodplain landforms such as natural levees, sloughs, and ridges are poorly developed or too small to affect communities, the forests contain a mixture of bottomland and mesophytic trees. This community type, the Piedmont/Low Mountain Alluvial Forest, is the most common of the Piedmont's floodplain forest community types, although it seldom covers large expanses. Much less common are the differentiated levees, sloughs, and ridges found along the larger Piedmont rivers. Levee forest communities are typically flooded for only brief periods, and may be fairly well drained. Sycamore, river birch, and box elder are the most characteristic tree species and the herb layer is lush and diverse. The bottomlands and sloughs farther from the river are lower and wetter with a sparse herb layer. Several nonforested community types occur in specialized sites on floodplains. Piedmont/Mountain Semipermanent Impoundments occur naturally in beaver ponds and old millponds sometimes provide a similar habitat. These communities have open water in the center and a variety of aquatic and wetland herbs and shrubs along the margins. Floodplain Pools occur in small depressions such as abandoned channels that hold still water for part or all of the year. They usually have few plants, but support aquatic invertebrate communities and are often important amphibian breeding sites. Sand and Mud Bar and Rocky Bar and Shore communities occur along the stream banks where wetness and flooding disturbance prevent development of a forest canopy.

Ecosystem Level Effects:

Predicted Impacts of Climate Change:

Climate Change Factor:	Likelihood:	Effect:	Magnitude:	Comments:
Drought	High	Neg	Med	Droughts are expected to increase, which may cause floodplains to be drier than usual between storm events.
Mild Winters	Med	Neg	Med	May increase exotic species invasion
Flooding	High	Neg	Med	

The most important direct effects of climate change are likely to be changes in the flood regime. The number of high rainfall days is expected to increase, which will increase the frequency and magnitude of

floods. Flooding is of short duration in these floodplains and is likely to remain so. The main effect of increased flooding will be increased scouring and bank erosion. Channel incision may increase, causing reduced flooding and drying in some floodplains. Bars are a minor part of these floodplains, but may increase. Mortality of individual plants near the channel or in sloughs may increase. It is possible that floodplains may expand, but because terraces are few and most floodplains are bounded by distinct upland slopes, this effect is likely to be small. If stream downcutting were to increase, more floodplains could become isolated from their creeks, or have reduced flooding.

Invasion by exotic species is already a severe problem in these floodplains and is increasing irrespective of climate change. *Murdannia*, *Microstegium*, *Lonicera*, *Ligustrum*, and *Reynoutria* are likely to continue expanding if not controlled. Increased disturbance by flooding and wind would increase their ability to invade communities. Warmer temperatures may allow the invasion of additional species (perhaps *Triadica*).

The effect of drought is uncertain. Only small patches of these floodplains are wet for long periods. Some floodplains are well enough drained that moisture stress is possible in droughts. Invasion by upland species because of decreased wetness is a possibility but is uncertain.

In addition to the direct effects, major indirect effects on these habitats are likely to result from increased construction of impoundments. Increased droughts, along with increases in the human population, will inevitably spur the creation of more water supply reservoirs. Increased severity of flooding will increase the demand for flood control structures. Increased development of non-carbon-based energy is also likely to include construction of new hydro-power dams.

Predicted Ecosystem Responses:

Ecosystem Response:	Likelihood:	Effect:	Magnitude:	Comments:
Exotic Species Invasion	High	Neg	Med	Already-severe invasion will increase as more exotic species invade from the south.
Structural Change	Med	Neg	Med	
Compositional Change	Med	Neg	Low	
Acreage Change	Low	Pos	Low	Small increases in floodplain extent may occur with deeper floods.

This Ecosystem Group may be one of the least susceptible to ecosystem change in response to climate change. Nevertheless, some significant changes can be expected, especially caused by increased wind damage and increases in invasive species. In addition, small and isolated populations of some rare species will be more vulnerable to extirpation if the frequency or magnitude of disturbance increases.

Increased wind storm events would decrease average tree age and increase number of gaps. These changes are likely to be fairly limited, and less in magnitude than the effects of past and ongoing logging.

New invasive exotic species may appear, and existing ones may spread more rapidly with increased natural disturbance. These systems already suffer from more invasive species and more severe invasions than any other, and climate change will exacerbate this problem.

Most of the species in these systems range well to the south and are unlikely to disappear with a warmer climate. Mild winters may allow some southern species to expand northward. The appearance of species native to comparable communities farther south should not be regarded as negative. The high stream

density in the Piedmont and short distances between streams in different watersheds should facilitate migration of species that can live in small floodplains. Larger floodplains are farther apart, and species confined to them will have more difficulty migrating. The large reservoirs present on many Piedmont and Mountain rivers may be significant barriers to migration.

Habitat Level Effects:

Natural Communities:

Third Approximation Name:	Comments:
Floodplain Pool	
Piedmont/Mountain Semipermanent Impoundment	These communities are increasing in abundance and extent under the current climate, as beavers reestablish themselves in their former range. This is likely to continue regardless of climate change.
Rocky Bar and Shore	Rocky bar and shore communities tend to be frequently disturbed already. Expected increases in disturbance will likely have only limited effect.
Sand and Mud Bar	Piedmont and Mountain bars tend to be unstable and frequently disturbed already. Increased flood intensity or disturbance may make them less stable, but probably will not change their character much.
Montane Alluvial Forest	
Piedmont/Low Mountain Alluvial Forest	
Piedmont/Mountain Bottomland Forest	
Piedmont/Mountain Swamp Forest	Might be subject to invasion by drier-site species if droughts become longer and more frequent. However, if wet conditions return, these species likely will not persist.
Piedmont/Mountain Levee Forest	Effects of increased flood scouring and channel migration would be concentrated in these communities. Severe effects likely will still be small in area.

LHI Guilds:

Guilds with Significant Concentration in Ecosystem Group:	Comments:
Wet-Mesic Hardwood Forests	
Piedmont Wet-Mesic Hardwood Forests	
Piedmont Wet Hardwood Forests	
Piedmont Freshwater Marshes	
Montane Floodplain Hardwood and Mixed Forests	

Species Level Effects:

<u>Plants</u>	Element Rank:	Endemic	Major Disjunct	Extinction/Extirpation Prone	Status: US/NC	Comments:
Isoetes virginica	G1/S1	Yes			FSC/SR-L	
Spiraea virginiana	G2/S2	Yes		Yes	T/E	Many populations have been invaded by exotic species. Excessive scour may damage populations.

<i>Ptilimnium nodosum</i>	G2/S1		Yes	Yes	E/E	Very vulnerable to changes in hydrology that would cause drying of habitat or excessive scouring.
<i>Cardamine micranthera</i>	G2/S1	Yes		Yes	E/E	Very vulnerable to changes in hydrology that would cause drying of the habitat.
<i>Silphium connatum</i>	G3G4Q/S2				/SR-T	
<i>Cryphaea nervosa</i>	G4?/S1?				/SR-T	
<i>Carex cherokeensis</i>	G4G5/S1				/SR-P	
<i>Carex projecta</i>	G5/S1				/SR-P	
<i>Carya laciniosa</i>	G5/S1		Yes		/SR-P	Occurs as a small, disjunct population that may be particularly vulnerable.
<i>Pedicularis lanceolata</i>	G5/S1				/SR-P	
<i>Cardamine douglassii</i>	G5/S2				/SR-P	
<i>Plagiochila ludoviciana</i>	G5/S1				/SR-P	
<i>Silphium perfoliatum</i>	G5/S1				/SR-P	
<i>Enemion biternatum</i>	G5/S2				/SR-P	Some populations have already been invaded by exotic species, but the early flowering, ephemeral nature of this species limits competition from invasives.
<i>Asclepias purpurascens</i>	G5?/S1?				/SR-T	
<i>Cleistocarpidium palustre</i>	G5?/S1		Yes		/SR-D	
<i>Stachys</i> sp. 1	GNR/S1	Yes			/SR-T	

Most plant species occurring in Piedmont and Mountain floodplains are relatively common and widespread. However, the rarest species in Piedmont and Mountain floodplains are very vulnerable to changes in hydrology that would increase scour or sediment deposition, including Harperella (*Ptilimnium nodosum*), and Small-anthered Bittercress (*Cardamine micranthera*). If climate change brings increased flooding and scouring, this could lead to the extirpation of these species in North Carolina. Small-anthered Bittercress is one of the plant species in NC most vulnerable to extinction, and both drought and increased flood intensity may be threats to it. Many plant species in these systems already compete with a wide array of invasive exotic plants, which have seriously degraded natural habitat.

Terrestrial Animals

Species:	Element Rank:	Endemic	Major Disjunct	Extinction/ Extirpation Prone	Status: US/NC/ WAP	Comments:
<i>Hypomecis longipectinaria</i>	G2G4/S3S4				/W3/	
<i>Hypomecis longipectinaria</i>	G2G4/S3S4				/W3/	
<i>Argillophora furcilla</i>	G3G4/S2S3				/W3/	
<i>Argillophora furcilla</i>	G3G4/S2S3				/W3/	
<i>Catocala marmorata</i>	G3G4/S1S3				/SR/	
<i>Amblyscirtes reversa</i>	G3G4/S3				/SR/	
<i>Corynorhinus rafinesquii rafinesquii</i>	G3G4TNR/S2				FSC/T/	
<i>Cordulegaster erronea</i>	G4/S3?				/W2/	
<i>Autochton cellus</i>	G4/S2				/SR/	
<i>Cisthene kentuckiensis</i>	G4/SU				/W3/	

<i>Rallus elegans</i>	G4/S3B,S3N	Yes	/W1,W3/P	Probably once more widespread in the Piedmont, now extremely rare in this region as a nesting species.
<i>Dasychira atrivenosa</i>	G4/S3?		/W3/	
<i>Papaipema</i> sp. 3	G4/S3S4		/W3/	Known in the Piedmont only from one Wake County specimen. Fairly common in the Outer Coastal Plain and Sandhills.
<i>Cisthene kentuckiensis</i>	G4/SU		/W3/	
<i>Dendroica cerulea</i>	G4/S2B		FSC/SR/P	
<i>Hemidactylum scutatum</i>	G5/S3		/SC/P	
<i>Hemidactylum scutatum</i>	G5/S3		/SC/P	
<i>Ixobrychus exilis</i>	G5/S3B	Yes	/SR/P	Probably once widespread in the Piedmont, but now very scarce as a breeding species.
<i>Oporornis formosus</i>	G5/S4B		//P	
<i>Poanes viator zizaniae</i>	G5/S5	Yes	//	Sole Piedmont population is located near the confluence of the Deep and Haw Rivers.
<i>Hemidactylum scutatum</i>	G5/S3		/SC/P	
<i>Ambystoma opacum</i>	G5/S5		//P	
<i>Ambystoma maculatum</i>	G5/S5		//P	
<i>Eurycea guttolineata</i>	G5/S5		//P	
<i>Ambystoma maculatum</i>	G5/S5		//P	
<i>Ambystoma opacum</i>	G5/S5		//P	
<i>Ambystoma talpoideum</i>	G5/S2	Yes	/SC/P	Populations in the Piedmont of North Carolina are all widely disjunct.
<i>Oporornis formosus</i>	G5/S4B		//P	
Apameine, New Genus 1, Species 2	GNR/SH	Yes	/SR/	Only a single, historic record exists for North Carolina from Highlands. Other populations are located west of the Appalachians.
Apameine, New Genus nr. <i>Oligia</i>	GNR/S2S3	Yes	/W2/	Recently discovered species known only from the North Carolina side of the Great Smoky Mountains National Park and possibly also from Highlands
Apameine, New Genus 2, Species 4	GU/S2S3	Yes	/W2/	Appears to be endemic to the Southern Appalachians
Apameine, New Genus 2, Species 5	GU/S1S2	Yes	/W2/	Only North Carolina records is from the Dan River at Hanging Rock State Park. Known primarily from the Midwest

Two cane-feeding moths are endemic to the Southern Appalachians and two others are major disjuncts from west of the Appalachians. Several species associated with marshy habitats are found only at widely disjunct sites in the Piedmont and mountains, possibly representing beaver-ecosystem relicts.

Combined Threats and Synergistic Impacts:

Importance of Climate Change Factors Compared to Other Ecosystem Threats:

Threat:	Rank Order:	Comments:
Logging/Exploitation	1	Construction of reservoirs and interbasin transfers of water are likely to be spurred by climate change
Development	2	
Invasive Species	3	
Flood Regime Alteration	4	
Groundwater Depletion	5	
Climate Change	6	The direct effects are comparatively minor compared to other types of impacts. However, climate change is also likely to increase the severity of all other factors, with the possible exception of development, whose rate of increase may or may not be affected by climate change.

This is one of the systems that is currently, and will be in the future, so heavily impacted by humans that climate change appears a comparatively minor threat. Extensive ongoing logging alters structure and composition of vegetation. The drier, seldom flooded portions of floodplain are often subject to development. Though reservoir construction has slowed, it may increase in a warmer, drier climate. Invasive species are rampant already in these floodplains, and will continue to spread even under the current climate. Chinese and Japanese privet, Japanese honeysuckle, *Microstegium*, and Japanese knotweed, etc., are already locally abundant, and are expected to continue to proliferate, along with some other exotic species.

Beavers are likely to play an increasing role in these systems, and may cause more change than altered climate in the coming decades. Because beavers are a native species returning to presumed former abundance, such changes should generally not be regarded as negative, although they can have severe impacts on local populations of rare species. Increasing beaver populations will provide more open water for wildlife species but at the same time reduce closed-canopy forest for shade-loving species of bottomlands. For at least several species of marsh, sedge-mire, and other species associated with open wetlands, on the other hand, the return of beavers is likely to have a strongly positive effect.

Much more damaging than beaver impoundments are man-made reservoirs, which are likely to become increasingly important due to increases in the human population and to the effects of climate change. Such reservoirs permanently destroy vast amounts of riverine and riparian habitats due to the direct effects of inundation. They can also severely alter the flood regimes downstream, particularly where used for hydro-power generation. Such alterations, in turn, can have major effects on the structure and composition of floodplain ecosystems.

In the Piedmont, floodplains are often the only remaining forested landscape connections. The loss of these connections is exacerbated if development occurs around reservoirs. Where unrestricted, shoreline development can completely obliterate upland habitats adjoining the reservoirs. At the landscape level, the combined loss of both floodplain and upland habitats directly reduces or eliminates some of the last remaining large blocks of habitat in the state -- particularly in the Piedmont -- and also creates major barriers to movements along what have previously been some of the last remaining connections between various regions of the state.

Recommendations for Action:

Interventive Measures:

Intervention:	Importance:	Feasibility:	Comments:
Control Invasive Species	High	Medium	
Protect/Expand Remaining Examples	High	High	
Restore/Maintain Hydrology	Medium	Medium	
Restore/Maintain Landscape Connections	High	Medium	Designing bridge crossings that allow wildlife movements is a critical and viable need. Maintaining strips of undeveloped lands bordering reservoirs will benefit water quality for human uses and maintain landscape connectivity across broad areas of the state.

Maintaining or restoring floodplain habitats will play an increasingly important role in offsetting the effects of climate change, both direct and indirect. Natural floodplain communities serve essential roles in maintaining the integrity of the floodplains themselves, acting to buffer the effects of severe flood events and to maintain flow during times of drought. As the largest remaining expanses of natural habitats and native species' populations in the Piedmont, they provide enough space and connectivity to allow recovery from major ecological perturbations, which are expected to become much more frequent due to climate change. By spanning vast areas of the landscape, in several cases making connections from the Coastal Plain all the way to the Mountains, they provide avenues for populations to move in response to altered environments. In all of these roles, natural floodplain habitats serve not only the needs of species that are restricted to those habitats, but also to a large number of species that inhabit the adjoining uplands.

Additionally, as some of the largest tracts of forests and marshlands in the state, floodplain habitats are some of our most important sources of carbon sequestration. Cutting floodplain forests, particularly for energy production (e.g., as biofuels), and draining of marshlands not only works against carbon sequestration, but will actually release more carbon and other greenhouse gasses into the atmosphere.

As some of the last remaining undeveloped but potentially exploitable lands in the state, floodplain forests and other habitat types will come under increasing pressure for exploitation, particularly for the development of new reservoirs but also potentially as a source for biofuels. In order to make good decisions about alternative uses, the value of natural floodplain habitats in maintaining healthy ecosystems, including allowing for adaptation to climate change as well as mitigating those impacts, must be emphasized. Whenever adverse impacts to those ecosystems are deemed unavoidable, then every effort should be made to either minimize or compensate for those impacts. Examples include acquiring or otherwise protecting upland buffers around all new reservoirs and constructing or retro-fitting all bridge crossings to facilitate, or at the very least, not impede, the movements of species along riparian corridors.

Due to their great importance to the state's biodiversity, acquisition or other forms of conservation protection, including consistent application of Best Management Practices, need to be increased for floodplain systems. Emphasis should be given to certain types of communities, such as Montane Alluvial Forests, that are already quite rare. In some cases, however, the ecological values of floodplain ecosystems are so important that they should be protected even where the natural communities or their species are not yet rare enough to merit identification as Natural Heritage Program Elements or Element Occurrences.

Even where protected, action needs to be taken to combat the effects of exotic, invasive species. This Ecosystem Group currently suffers the most impact from invasive plants of any in the state and the increased disturbance related to climate change is only likely to exacerbate it. Beaver management is a related issue, even though beavers are not an exotic species, nor is restoration of their populations across the continent a true "invasion" (although it often appears to produce the same effects). In the long run, the return of beavers to their natural range is likely to enhance native ecosystems, restoring their former species and community composition and contributing to floodplain stability. However, they can, in the short term, have severe impacts on species whose populations have become reduced and isolated as a consequence of their absence or that have moved into former beaver-dominated habitats opportunistically. Where these species are of major conservation concern, control of beaver populations or their impounding or foraging activities may be warranted. In all other cases, however, the return of beavers should be regarded as ecologically beneficial.

Ecosystem Group Summary:

The direct impacts of climate change on Piedmont and Mountain floodplains may be fairly limited compared to other threats. Indirectly, however, changes in rainfall patterns, including increases in severe flooding, are likely to spur construction of more reservoirs, both to secure water supplies and serve for flood control and power generation. Reservoir construction (which will also be spurred by ever-increasing human populations) results both in significant losses of floodplain habitats and in severe fragmentation of entire river basins. Increased flooding and scouring are likely to have an adverse effect on some of the states rarest plant species, which occupy the unstable mud and gravel bars in Piedmont and Mountain rivers. Given that floodplains provide some of the most important remaining dispersal corridors for both upland and bottomland species, any further losses in acreage will have impacts far beyond the limits of the floodplains themselves.

References:

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