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

The North Carolina Department of Environment and Natural Resources (DENR) has made it a priority to comprehensively address climate change in our state, using mitigation and adaptation efforts to increase the resilience of our state's natural resources to these complex changes. The mitigation sector will work on reducing carbon emissions and developing regulations for greenhouse gas emissions, green energy initiatives, and carbon sequestration. The adaptation sector will proactively prepare for changes that cannot be prevented and will address potential impacts to natural resources that the Department is charged with protecting. As part of the adaptation side of this Initiative, the Natural Heritage Program, with input from other conservation agencies, is evaluating the likely effects of climate change on North Carolina's ecosystems and species.

For this analysis, we use the Climate Wizard mid century (2050s) ensemble average model with the medium A1B emission scenario (Maurer *et al.*, 2007) to estimate regional changes in temperature and frequency of droughts, floods, wind damage, and wildfires. We then integrate this information with what we know about ongoing threats, particularly habitat loss and invasion of exotic species. All of these impacts interact with one another, and the goal of our analysis is to provide the predicted climate change effects and possible ecosystem responses to these effects. Once this integrated picture is obtained, we recommend a set of conservation measures that can help offset the combined impacts we predict are likely to occur, and help North Carolina's native species and ecosystems be as resilient as possible for the anticipated effects of climate change.

We conduct this analysis at several levels of biological organization and, where appropriate, over several different regions of the state: the Mountains, Piedmont, and Coastal Plain, including the Sandhills and Tidewater. In all cases, impacts that are identified at the higher levels are believed to translate downward within the organizational hierarchy, although we also expect and identify impacts that are likely to be unique to each separate unit within the levels.

The highest level of our analysis hierarchy is represented by 42 groups of ecosystems that share certain ecological characteristics and are likely to respond to climate change in similar ways. Nested within these Ecosystem Groups are Natural Communities and Landscape/Habitat Indicator Guilds, which comprise groups of plant and animal species associated with finer categories of habitats. Nested within each of these habitat groups are individual species or, in some cases, subspecies or distinctive populations. Species included in this analysis include the majority of federal and state-listed species that occur in North Carolina, although only those which we can assign to a particular Ecosystem Group, Natural Community, or Landscape/Habitat Indicator Guild. Similarly, most of the additional species that are considered Significantly Rare by the Natural Heritage Program are included, as well as the majority of animals identified as Priority Species in the State's Wildlife Action Plan.

Information generated from our analysis is stored in an Access database, which is easily updatable and from which customized reports can be generated as needed. Reports will be produced on a regular basis and sent out to our conservation partners, both within DENR and outside DENR. Comments received will then be fed back into the database: the entire process is iterative and we expect to continue making improvements to our assessments and recommendations as new predictions about the effects of climate change become available or as empirical evidence of the effects begins to accumulate.

**List of Ecosystem Groups used for assessing the
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1.   Blackwater Coastal Plain Floodplains
2.   Brownwater Coastal Plain Floodplains
3.   Coastal Plain Depression Communities
4.   Coastal Plain Large River Communities
5.   Coastal Plain Marl Outcrop
6.   Coastal Plain Nonalluvial Mineral Wetlands
7.   Coastal Plain Stream/Swamp Communities
8.   Dry Longleaf Pine Communities
9.   Estuarine Communities
10.   Freshwater Tidal Wetlands
11.   General Hardwood and Mixed Forests
12.   Granitic Flatrocks
13.   Grass and Heath Balds
14.   High Elevation Rock Outcrops
15.   Low Elevation Cliffs and Rock Outcrops
16.   Mafic Glades and Barrens
17.   Maritime Grasslands
18.   Maritime Upland Forests
19.   Maritime Wetland Forests
20.   Montane Cold Water Stream Communities
21.   Montane Cool Water Stream Communities
22.   Montane Oak Forests
23.   Mountain Bogs and Fens
24.   Mountain Cove Forests
25.   Natural Lake Communities
26.   Northern Hardwood Forests
27.   Peatland Pocosins
28.   Piedmont and Coastal Plain Mesic Forests
29.   Piedmont and Coastal Plain Oak Forests
30.   Piedmont and Mountain Dry Coniferous Woodlands
31.   Piedmont and Mountain Floodplains
32.   Piedmont Headwater Stream Communities
33.   Piedmont Large River Communities
34.   Piedmont Small River Communities
35.   Piedmont Upland Pools and Depressions
36.   Sparsely Settled Mixed Habitats
37.   Spruce Fir Forests
38.   Streamhead Pocosins
39.   Successional and Ruderal Uplands
40.   Successional Wetlands
41.   Upland Seepages and Spray Cliffs
42.   Wet Pine Savannas