Executive Summary

Understanding the impacts of climate change on fish and wildlife in North Carolina

A review of climate change science, impacts, and planning options for sensitive species and habitats

Conservation Planning Program, Defenders of Wildlife

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Executive Summary: Understanding the impacts of climate change on fish and wildlife in North Carolina.

In 2005, the North Carolina Wildlife Resources Commission developed the State Wildlife Action Plan (NCWRC 2005) as a comprehensive blueprint for the conservation of fish and wildlife. In recognition of the potential impacts of climate change on important North Carolina wildlife species and habitats, the Wildlife Resources Commission is preparing for a revision of its Wildlife Action Plan (NC WAP). However, given the complexity of climate change science and the breadth and depth of stakeholder groups who have been involved in the plan, the Wildlife Resources Commission identified a clear need for a review of the state of climate change science and potential impacts on species and habitats specific to North Carolina.

This report, *Understanding the Impacts of Climate Change on Fish and Wildlife in North Carolina*, provides the most comprehensive and up-to-date review for North Carolina of climate change science, the potential vulnerability of wildlife and their habitats, and response options available through conservation planning. In addition to reviewing the fundamental principles of climate change science in the context of understanding impacts on species and habitats, this report highlights a few key messages:

- Even if all greenhouse gas emissions were stopped today, there will still be unavoidable impacts to humans and wildlife as a result of a rapidly changing climate.
- In North Carolina, average yearly temperatures across the state are projected to increase 3.5 to 4.7°F by mid century, with greatest increases in temperature occurring during the summer months and in mountainous regions of the northern and western portions of the state.
- High elevation communities, reptiles, amphibians, and coldwater aquatic species, are expected to be most impacted by increases in temperature across North Carolina.
- Although shifts in precipitation are more challenging to project, summer and winter droughts as well as increases in the frequency of severe weather events are expected.
- Sensitive maritime forest and shrub communities, as well as coastal wetlands are expected to be significantly impacted by sea level rise.
- Safeguarding fish and wildlife from the impacts of climate change will require careful planning that engages diverse stakeholders and coordinates across multiple sectors.

Defenders of Wildlife is a national, nonprofit, membership organization dedicated to the protection of all native wild animals and plans in their natural communities.

Climate change will cause unavoidable impacts to humans, wildlife, and habitat.

Given current levels of heat-trapping greenhouse gas emissions, we are expected to experience substantial shifts in local, regional, and national climate patterns. These shifts have the potential to disrupt natural processes, and in some areas may cause significant degradation to ecosystem services such as clean and abundant water, protection from flooding, and sustainable timber production or game management. Even if the most rigorous emission reduction strategies were implemented today at the local, regional, and national level, North Carolina will continue to experience the effects of climate change for many years to come.

Climate change will affect the timing of biological processes, breakup of ecological communities, rate of species invasions, and contribute to the loss of additional habitat.

Ecosystem processes are strongly influenced by climate, and changes in climate will affect ecosystem processes, ecological communities, and individual species. The distribution and abundance of plant, invertebrate, and vertebrate species that occur along the latitude and elevation margins of their range are already strongly influenced by climate change (Lenoir et al. 2008). Potential impacts of climate change on ecosystem processes, ecological communities, and individual species include the following:

- The timing of biological processes is changing, altering relationships between species and decoupling critical species interactions (Walther et al. 2002).
- Ecological communities are disaggregating, and as new and often novel communities assemble, warm-adapted and invasive species may be favored (Parmesan 2006, Hellmann et al. 2008).
- Species are losing more habitat due to sea level rise, changes in fire frequency and intensity, changes in water availability, pest outbreaks, and altered weather patterns.
- Species invasions, as well as pest and disease outbreaks, are becoming more prevalent under climate change.

Projections show increases in annual average temperatures of 5 to 6°F in North Carolina by the end of the century.

Climate models project continued warming across the Southeast, with an increasing rate of warming toward the end of the century. Rates of warming are expected to be more than double those experienced in the Southeast since 1975. The greatest temperature increases are projected to come during already hot summer months, and the number of very hot days is projected to rise rapidly. In North Carolina, the areas of highest temperature increase will be in the north and west of the state and in many of the mountainous regions. By the end of the century, projections using the highest emissions scenario show increases in annual average temperatures of 5 to 6°F, again with the greatest increases in the north and west portions of the state (Figure 1). The increase in very hot days will have consequences for human health, drought and wildfires. Increased temperatures will have a direct physiological impact on species and habitats or an indirect impact on community relationships through competition. As temperatures rise, the number of days below freezing will also decrease. A reduction in freezing days can improve survival for disease vectors and pests, alter growing seasons, and reduce the amount of water available from snow pack for spring thaw.

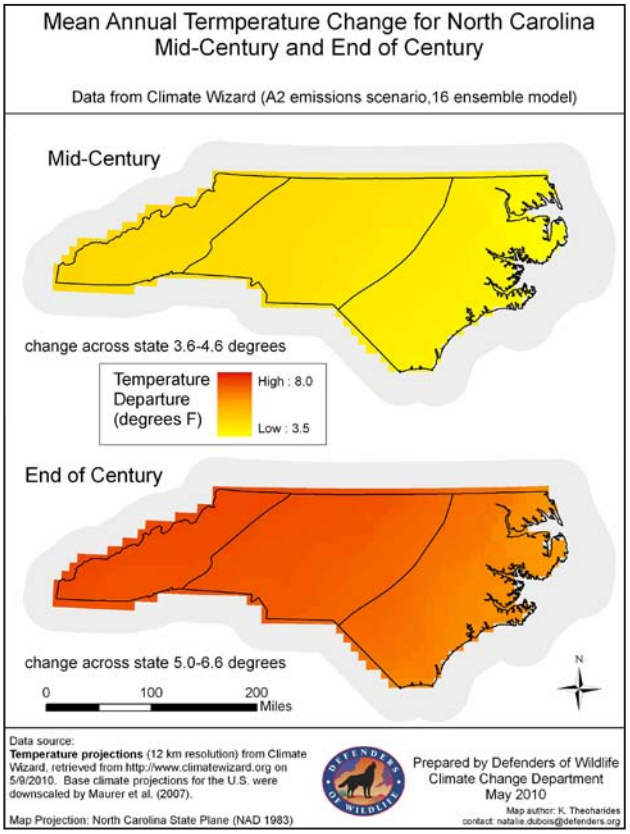

Figure 1. Projected change in mean annual temperature for North Carolina by mid and end of the century. Projections are based on a high emissions scenario (A2) and the ensemble average of 16 GCMs statistically downscaled to 12 km.

Spruce-fir forests are projected to move northward and could be extirpated from North Carolina as temperatures increase.

In North Carolina, high elevation communities may be particularly at risk given projected climate warming in the region. Spruce-fir forests are projected to move northward as physiological tolerances are exceeded across its southern range, which is limited by summer heat and drought. Research from Iverson and Prasad (2001) suggests that spruce-fir habitat could be easily extirpated from the eastern U.S. as temperatures increase. Spruce-fir habitats provide critical habitat for a number of priority birds, including a subspecies of brown creeper (*Certhia americana*) and northern saw-whet owl (*Aegolius acadicus),* that may be endemic to the high peaks of the Southern Blue Ridge Ecoregion.

Recreational fish species and other cold and cool water habitats and species are expected to be significantly impacted by warming climate trends.

The Southeast has the highest aquatic species diversity in the entire United States, including significant diversity of fishes, mollusks, and crayfish. A significant proportion of these groups are already known to be at risk in North Carolina, with 83 fish species, 43 mussel species, 21 crayfish species, and 10 snail species identified as priorities for conservation in the plan. As the availability of cool water habitat contracts, priority species that inhabit cooler headwaters will be more at risk. Recreationally important fisheries, for example those stocked in cold and cool water hatcheries in the state, such as walleye (*Sander vitreus*), muskellunge (*Esox masquinongy*), and trout species, are likely to be affected.

Average autumn precipitation has already increased by 30 percent while summer and winter precipitation has declined by about 10 percent since 1901.

Changes in precipitation have not already occurred in the Southeast. Average autumn precipitation has increased by 30 percent since 1901, while summer and winter precipitation has declined by approximately 10 percent during this same period (Karl et al. 2009). In addition to the differences in the amount of precipitation, the occurrence of heavy downpours has increased in parts of the Southeast. Increased frequency of extreme rainfall events will likely affect processes such as soil erosion, sedimentation, and stream dynamics. At the same time, many parts of the region are experiencing an increasing number of droughts.

A 1 m sea level rise may result in an average shore retreat 288 feet across the state of North Carolina.

Rising seas are perhaps one of the most immediate and possibly devastating impacts of climate change in coastal areas. Several studies have projected up to 1.4 meters of sea level rise by 2100 when ice sheet contributions are included (e.g., Rahmstorf et al. 2007, Pfeffer et al. 2008). Conservative estimates from the Intergovernmental Panel on Climate Change show that coastal North Carolina has over 145,000 acres of land below one meter of elevation (the third largest low-lying region in the U.S. after Louisiana and Florida) and over 1.4 million acres of land in North Carolina are below 1.5 meters (Titus and Richman 2001). There are between 3.1 and 3.9 million acres of wetland in coastal North Carolina, including marshes, swamps, forested wetlands, pocosins, and other wetland habitats (Street et al. 2005).

Loss of barrier islands, maritime forest communities, and coastal wetlands to sea level rise will adversely affect a number of priority species in North Carolina.

North Carolina's coast is primarily composed of wave-dominated barrier islands consisting of long, thin stretches of sand that buffer shallow estuaries or lagoons and are bisected by widely-space tidal inlets (Gutierrez et al. 2009). Overwash, breaching, and storm surge are already a cause of habitat loss on the Outer Banks in North Carolina (Riggs and Ames 2003, Gutierrez et al. 2009). These habitats are important breeding and migration stopover points for many migratory birds and key breeding areas for declining populations of the eastern painted buntings, as well as for several snake species. Any species associated with coastal habitats may be threatened by direct loss of habitat to sea level rise.

Habitat conversion may create barriers to migration, limiting the ability of wildlife populations to shift as a result of climate change.

Urban development, fragmentation, and other land conversions currently threaten many terrestrial habitat types in North Carolina, and species already sensitive to habitat fragmentation are likely to be further impacted by climate change. In some areas, development may have already destroyed or converted remaining natural habitat in these areas, limiting the ability of populations to shift in response to climate change. For example, the limited range of Mabee's salamander (*Ambystoma mabeei*) has been highly impacted by draining of wetlands and conversion of forest into cropland (Petranka 1988 in NatureServe 2009). Like other ambystomids, which require vernal ponds for breeding, sensitivity to precipitation shifts as well as specific habitat requirements and limited movement will make the species particularly vulnerable to climate change.

Significant wind energy potential exists in some of North Carolina's most sensitive biological regions.

However, if expansion of wnd energy is not carefully planned, wildlife and other natural resources may be harmed. In the Southern Blue Ridge Ecoregion, for example, some of the highest areas of wind potential in the state ("outstanding" and "superb") overlap with, or are adjacent to, high priority biodiversity areas. For example, the NC Wildlife Action Plan has identified 46 avian species in this region as species of greatest conservation need, 16 of which have state listing status. Careful planning to avoid sensitive biological communities will be critical to minimize negative impacts to wildlife.

The unsustainable use of forestlands or the conversion of Conservation Reserve Program lands to use for biofuel production may negatively affect wildlife and habitat.

The sustainable development of renewable biofuels and feedstocks will require an understanding of how associated land-use choices may affect important ecological systems (Dale et al. 2010). Biofuels are combustible materials that are derived from biomass (e.g. plants, micro-organisms, or organic waste) and potentially offer an alternative energy. Rich et al. (2007) suggest that North Carolina could meet at least an additional 10% of its energy consumption needs by including forest (6 %), agricultural (1%), and waste (3 %) biomass resources in the state's energy portfolio. The production potential for these resources is distributed throughout the state and could include lands that are currently being used for timber production and agriculture, or lands in the Conservation Reserve Program (CRP). The CRP land is vital part of grassland bird conservation, and also provides important wildlife benefits for reptiles, amphibians, and pollinators (USDA 2010). North Carolina could see a significant decline in grassland habitat if the almost 60% of the current active acreage in CRP will see contracts expire by the end of 2013 is converted back into cropland (USDA 2010)(Figure 2).

Strategic conservation planning that incorporates adaptive management will be critical for maintaining important wildlife populations and habitats.

Strategic conservation planning offers a framework for agencies to organize available data, prioritize species and habitats based on their vulnerability or other values, and identify appropriate management or conservation strategies. If implemented correctly, adaptive management will provide an opportunity for 'learning by doing' and updating conservation strategies, which will be key to managing in the face of uncertainty.

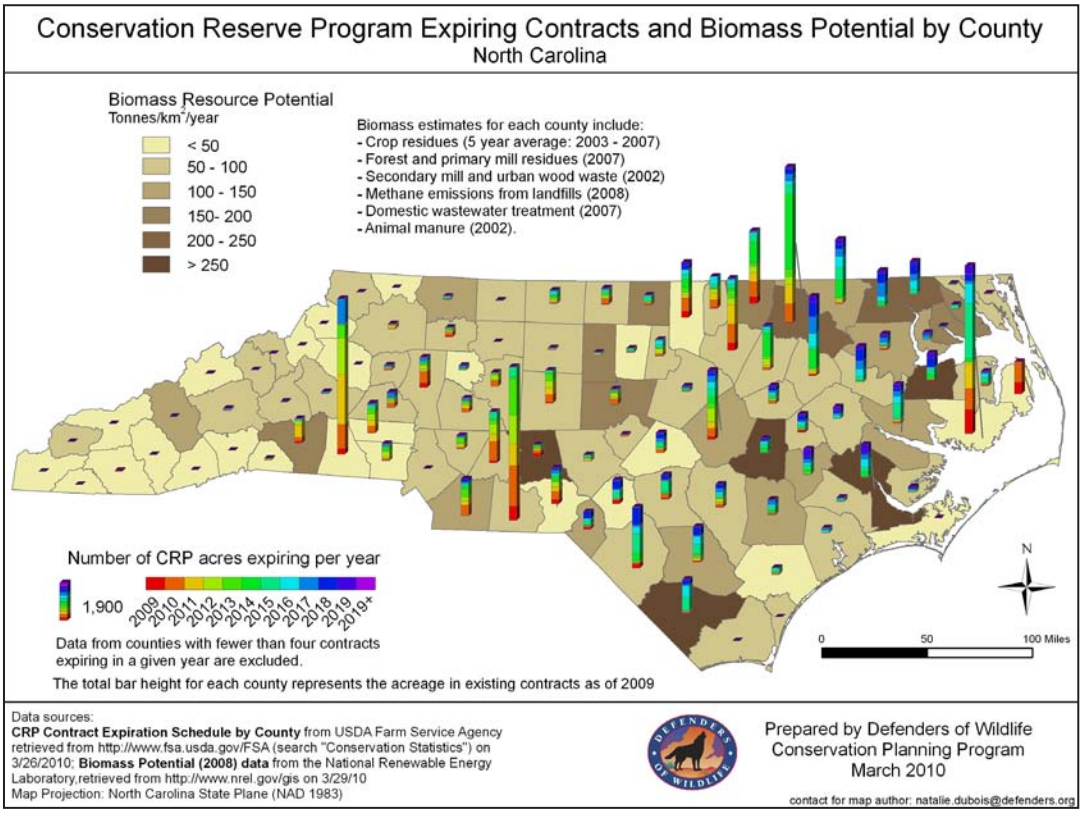

Figure 2. Conservation Reserve Program expiring contracts and biomass potential by county in North Carolina. Dark shaded counties have higher biomass resource potential. The height of the bar in each county indicates the acreage in existing contracts as of 2009 (expiration dates are color coded within the bar).

Planning for climate change adaptation will require wildlife managers to collaborate beyond traditional boundaries.

The term adaptation is currently used to describe adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects. These adjustments moderate harm or exploit beneficial opportunities in response to climate change. Throughout a conservation planning process to develop adaptation strategies, there are a number of over-arching considerations: engaging partners, coordinating across boundaries, recognizing appropriate spatial and temporal scales, addressing uncertainty, incorporating vulnerability assessments, and implementing an adaptive management framework. The maintenance of biological diversity and a fully connected network of habitats across the landscape require conservation planning at multiple spatial scales (Angelstam et al. 2003). In the future, management decisions will need to be coordinated at a species' range-wide scale with a broader ecological, social, and economic landscape context in mind.

Accepting that the future will be different from both the past and the present forces us to manage in new ways.

To date, managers have relied on trends in historical data or sustainability paradigms to identify management goals and objectives (Lackey 1995, Landres et al. 1999 in Millar et al. 2007). However, rapid shifts in climate may make management actions based on past conditions obsolete, or even create new problems where wildlife or habitat are more susceptible to the impacts of climate change (Millar et al. 2007). Understanding the fundamental principles of climate change science as well as the characteristics that make fish, wildlife, and habitat more sensitive to projected climatic shifts, is a critical first step in adaptation planning. Careful consideration of vulnerability assessments, key uncertainties, planning options, and diverse stakeholder engagement will allow the Wildlife Resources Commission to develop a comprehensive approach for safeguarding wildlife from the impact of climate change in North Carolina.

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