

2022 Addendum 2

Plant SGCN



2015 NORTH CAROLINA

WILDLIFE ACTION PLAN

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ADDENDUM 2

1

Chapter 1 Introduction

Road Map to Changes

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1.4 Addendum 2

The most recent version of North Carolina's Wildlife Action Plan (NCWAP, Plan) represents a 10-year comprehensive review and update and was published in 2015. The U.S. Fish & Wildlife Service (Service) has provided guidance to States for making voluntary interim changes to an approved Plan. The guidance allows States to make minor or major revisions to a Plan, as defined below.

- A **Minor Revision** is a change to a Plan that adheres to the methods, criteria, or processes used to address any of the Eight Required Elements in the approved Plan. Note that clarifying edits, corrections to typographical errors, and/or similar revisions to improve readability do not require Service notification or approval. Minor Revisions are voluntary and can occur anytime at the discretion of the State. The 2015 NCWAP was updated by Addendum 1, a minor revision published in 2020.

Addendum 1 updated the Species of Greatest Conservation Need (SGCN) list after Taxa Teams reevaluated selected species for which there is increased knowledge. The revision also added a description and user guide for the online Conservation Opportunity Area (COA) and Threat Risk Assessment (TRA) tool. Addendum 1 was approved by the Service as a minor revision because the information was developed following the methods described in the 2015 Plan; these revisions were also noted in Chapter 8 of the 2015 Plan.

- A **Major Revision** is a significant change to the methods, criteria, or processes used to address any of the Eight Required Elements in an approved Plan, which would require partner and public comment. Major Revisions are voluntary and can occur anytime at the discretion of the State. The 2015 NCWAP is updated by this Addendum 2 major revision to add plants as Species of Greatest Conservation Need (SGCN) and related information to the appendixes.

Addendum 2 is submitted to the Service as a major revision because plant SGCN were not previously included in the 2015 Plan. Adding plant SGCN is a significant change since criteria for identifying plant SGCN represents new processes and methods, and as required by USFWS guidance carries the need for public review and input opportunities. All information in Addendum 2 is new material to be added to the 2015 Plan.

1.4.1 Report Organization and Format

Three chapters and four appendixes are updated by Addendum 2; the remainder of the Plan remains as it was published in 2015 and updated by the 2020 Appendix 1. The following list notes

which chapter and appendixes are included in this major revision. A road map outlining where updates and new text can be found is provided in the next section.

- **Chapter 1 Introduction** provides background information on the State Wildlife Grant program, explains why we have the WAP, outlines the revision process used to update the Plan, and describes the required information that is included in the document. Addendum 2 adds Section 1.4 to provide a description of the major revision process and a roadmap to the changes.
- **Chapter 3 Wildlife** is renamed **Chapter 3 Species** because plants are added to the Plan. Chapter 3 outlines federal and state statutes governing wildlife resources. The chapter focuses on the process for evaluating and ranking species to identify SGCN and others for which there are research and management priorities. Addendum 2 adds Section 3.19 to describe plants as a component of natural communities and introduces the N.C. Department of Agriculture, Plant Conservation Program Scientific Committee’s method for evaluating and designating state listed species. For this major update, plants listed for State protection as Endangered, Threatened, or Special Concern are designated as SGCN. This chapter also introduces new or updated appendixes for plant SGCN—Habitat Associations (new Appendix HA-2), a white paper describing the plant SGCN review and selection method (new Appendix R), and a list of all plant SGCN (new Appendix PA-2).
- **Chapter 4 Habitats** contains descriptions of aquatic, wetland, and terrestrial communities based on four primary ecoregions. These natural communities are considered important wildlife habitat and are a priority for conservation. Community descriptions are provided for 12 aquatic communities, 8 wetland communities, 21 terrestrial communities, and the 17 river basins in the state. The descriptions provide information on SGCNs associated with each community, the problems and threats that affect the communities, anticipated climate change impacts, and provides several recommendations for priority surveys, monitoring, research, conservation, or management actions specific to each community. Addendum 2 adds a natural community description for Piedmont and Coastal Plain Oak Forest to the terrestrial community descriptions.
- **Appendix CA-2** adds a list of key participants and partners involved in developing Addendum 2. Also adds a copy of the N.C. Wildlife Resources Commission’s (WRC, Commission) June 2021 notification letter sent to USFWS about intention to complete a major revision and the 2021 July letter received from the Service acknowledging the major revision.
- **Appendix HA-2 SGCN--Habitat Associations** lists all plant SGCN and shows which natural communities described in Chapter 4 they are associated with. An Excel file is available for this new appendix.

- **Appendix PA-2 SGCN** lists all plant SGCN and provides information on current global and state ranking (NatureServe), federal protection status (ESA), and state protection status (protected species). An Excel file is available for this new appendix.
- **Appendix R Plant SGCN Evaluation Methodology** is a white paper describing the N.C. Department of Agriculture Plant Conservation Program’s Scientific Committee’s evaluation process to designate state listing protection and designates plants as SGCN.

1.4.2 Major Revision Roadmap

The 2015 Plan outlines the requirements and process used for developing the WAP and notes the need for future review and revision (see Chapters 1 and 8). The North Carolina Wildlife Resources Commission (WRC, Commission) notified USFWS in June 2021 of the intent to complete a major revision in accordance with guidance published in 2017. The Service acknowledged the update would be a major revision in July 2021. The following Table A2-1 provides a roadmap to the major revisions provided in this Addendum 2.

Table A2-1 Addendum 2 Revision Road Map

Insert After	2015 NCWAP Chapter/Section	Revision	2022 Addendum 2 Update Documents
Page 7	1.3.	Adds Section 1.4 Addendum 2 Introduction after Section 1.3.4 (added by Addendum 1)	Chapter 1 Introduction Addendum 2
Page 207	3.14	Adds Section 3.15 Plants after Section 3.14 (added by Addendum 1)	Chapter 3 Species Addendum 2, Section 3.15 Plants
Page 494	4.4	Adds Section 4.4.19 Piedmont and Coastal Plain Oak Forest after Section 4.4.18 Sparsely Settled Mixed Habitats	Chapter 4 Habitats Addendum 2, Section 4.4.19 Piedmont and Coastal Plain Oak Forest
Page 901	Appendix C	Adds list of Key Participants and Notification Letters to Appendix C Key Participants and Letters of Support	Appendix CA-2 Key Participants and Notification Letters

Table A2-1 Addendum 2 Revision Road Map

Insert After	2015 NCWAP Chapter/Section	Revision	2022 Addendum 2 Update Documents
Page 1203	Appendix H	Adds plant SGCN and habitat association table	Appendix HA-2 Plant SGCN--Habitat Associations
Page 1298	Appendix P	Adds list of plant SGCN	Appendix PA-2 List of Plant SGCN
End of Document	New Appendix	Adds white paper describing Plant Scientific Council methodology for designating state listed species, which are considered SGCN	Appendix R North Carolina Protected Plant Species Evaluation Methodology-- Plant SGCN
End of Document	New Appendix	Adds a summary list of all comments submitted during the April 20 to May 20, 2022 public review period	Appendix S Public Review Comments

1.4.3 Public Review

Addendum 2 to the 2015 Wildlife Action Plan (WAP, Plan) was available to the public for download and review from April 20 to May 20, 2022. Addendum 2 proposes to add plants to the Species of Greatest Conservation Need (SGCN) list and add a new description for Piedmont and Coastal Plain Oak Forest natural community. The download contained PDF files (most content) and Excel files (some appendixes) available on the NCWRC public website for the Wildlife Action Plan (www.ncwildlife.org/plan). An electronic comment form was provided as part of the public review information on the website.

The online comment form required name, email address, and whether the respondent supports, does not support, or has no preference for adding plant SGCN to the Plan. Two questions allowed for optional responses to explain why they do or do not support the addendum and any additional comments about their response.

Comments were submitted by 168 individuals and overwhelmingly indicate support for adding plants to the SGCN list. Based on responses, 95.83% of the respondents support the addition of plants to the SGCN list, while 2.38% do not support the change and 1.79% have no preference. Several people added comments questioning why plants were not previously included as SGCN

in the Plan. Only one comment was submitted that indicated the person does not support adding plants to the SGCN list but the comment provides no clarifying information about why they don't support the addition.

A summary of all public review responses and optional comments, with a notation added to indicate support, no preference, or against, is provided in Appendix S.

1.4.4 Summary

The 2015 WAP comprehensively addresses the Eight Required Elements and incorporates several of the best practices recommendations published by the Association of Fish and Wildlife Agencies (AFWA). The WRC followed recommendations from the 2009 AFWA guidance on incorporating climate change into State WAPs and worked with a partner to examine how climate change is likely to affect fish and wildlife in North Carolina. An executive summary of the full report (2010 DeWan et al.) is provided in Appendix B of the Plan.

Other best practice recommendations from WAP revision guidance (AFWA 2012) were incorporated during the comprehensive revision, including the following examples.

- WRC developed ranking procedures to identify SGCN, using metrics based on NatureServe's evaluation tool (2012) to quantitatively assess status of fish and wildlife, both range-wide and for populations in North Carolina.
- WRC worked with a partner to develop an online GIS-based tool to identify and spatially depict potential Conservation Opportunity Areas (COAs).
- A classification system using standard descriptions of threats and conservation actions (Salafsky et al. 2008) was incorporated into the 2015 WAP to improve our ability to identify regional concerns outlined in adjacent state Plans.

1.4.5 References

[AFWA] Association of Fish and Wildlife Agencies. 2009. Voluntary guidance for states to incorporate climate change into state Wildlife Action Plans & other management plans. Washington (DC): Teaming With Wildlife Committee and Climate Change Committee. 50 p. https://www.fishwildlife.org/application/files/1916/3361/4991/AFWA-Voluntary_Guidance.pdf.

[AFWA] Association of Fish and Wildlife Agencies. 2012. Best practices for developing state Wildlife Action Plans. Washington (DC): Teaming With Wildlife Committee, State Wildlife Action Plan (SWAP) Best Practices Working Group. 85 p. https://www.fishwildlife.org/application/files/3215/1856/0300/SWAP_Best_Practices_Report_Nov_2012.pdf.

DeWan A, Dubois N, Theoharides K, Boshoven J. 2010. Understanding the impacts of climate change on fish and wildlife in North Carolina. Washington (DC): Defenders of Wildlife. 218 p.

Available online

www.ncwildlife.org/Portals/0/Conserving/documents/ActionPlan/Revisions/FullReportDefendersofWildlifeUnderstandingtheimpactofclimatechangeNC.pdf.

NatureServe. 2012. NatureServe conservation status assessments: rank calculator version 3.1 [Internet]. Arlington (VA): NatureServe. <https://www.natureserve.org/conservation-status-assessment>.

Salafsky N, Salzer D, Stattersfield AJ, Hilton-Taylor C, Neugarten R, Butchart SHM, Collen B, Cox N, Master LL, O'Connor S, et al. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. *Conserv Biol.* 22:897–911. Available online <https://fosonline.org/wp-content/uploads/2010/11/Classification-of-threats-and-actions.pdf>

ADDENDUM 2

3

Chapter 3 Species

Plant SGCN

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3.15 Plants

The term “habitat” is used in this Wildlife Action Plan to describe the natural communities and their components that sustain individual plants and animals, discrete populations, or taxonomic groups. Habitats are considered the sum of all the resources a species needs to survive and persist (Hall et al. 1997) and are made up of many biotic and abiotic components that are too numerous and diverse to describe in this document.

Many, if not most, of the terrestrial natural communities in North Carolina are composed primarily of plants and, depending on the natural community type, composition will include a range of woody trees, shrubs, herbs and forbs, grasses, non-vascular plants, and composite organisms. Further, plants are fundamental elements of wildlife habitat, providing food, shelter, sites for reproduction, structures for resting and hunting, and often much more, depending on the species or taxonomic group. For example, many wildlife species, such as insect pollinators, butterflies, and moths, are adapted to rely on specific host plants to complete their life cycle.

Since plants are rooted within their landscape position, they are at greater risk to direct impacts from threats when compared to wildlife that are better able to move across the landscape to other areas. Considering this, it is important to support conservation of North Carolina’s native plants considered to be Species of Greatest Conservation Need (SGCN) to preserve genetic diversity and seed sources, especially those limited to small, isolated, or fragmented populations.

This Addendum 2 to the 2015 Plan is submitted as a major revision to add plant SGCN as a component of the natural communities described in Chapter 4 Habitats. A new natural community description for Piedmont and Coastal Plain Oak Forests is added to Section 4.4 Terrestrial Communities. This community type has been added to the new Appendix HA-2, which provides habitat associations for plant SGCN.

3.15.1 Introduction

The North Carolina Natural Heritage Program (NCNHP) maintains a statewide inventory of native plant species that are rare, in decline, believed to have been extirpated, or presumed extinct. The inventory is maintained with current data and an updated *Rare Plant List* is published every two years, making it easy to compare the level of current knowledge about a species’ conservation status over a relatively short time frame. The most recent version of the

Rare Plant List (NCNHP 2021) lists over 5,300 native plant species for the state. The majority of these are vascular plants, with the remainder including non-vascular and composite organisms that are lichens, mosses, liverworts, and hornworts. Approximately 18% of the native plant species occurring in NC are tracked by the Natural Heritage Program as state listed Endangered, Threatened, Special Concern, or Significantly Rare, indicating the need for high conservation concern for these rare and at-risk plant species.

In most cases, common names are used throughout this document to identify a species. Exceptions include pest species and species for which there is taxonomic uncertainty or when common practice is to use a form of the scientific name as the common name; in those instances, the scientific name may be used to identify the species. Scientific names for all plant SGCN are provided in Appendix PA-2.

3.15.1.1 Federal Regulations

One of the most important protective measures for conservation is the Endangered Species Act (ESA) of 1973, designed to protect and recover endangered and threatened species of fish, wildlife, and plants within the United States and its territories. Currently, there are 27 plant species known to occur in North Carolina that are listed by the U.S. Fish and Wildlife Service (USFWS) for federal protection under the ESA (USFWS 2021a). Appendix PA-2 provides a list of all SGCN plants and their current NC and federal protection status. All ESA protected plant species found in the state have recovery plans (USFWS 2021b).

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an agreement between international governments to protect wild plants and animals from becoming threatened or endangered from international trade (CITES 1975). The United States is a participating member nation. Protection is afforded through listing of a species in one of three lists, or appendices (CITES 2021).

- Appendix I provides the highest protection, limiting any trade of a species on the list only to exceptional circumstances because they are threatened with extinction.
- Appendix II controls trade of species that are at higher risk when trade could be incompatible with their survival.
- Species included in Appendix III are protected in at least one country that is party to the convention and CITES has been asked for assistance in controlling trade of the species.

There are 15 plants identified as SGCN that are included in CITES Appendix II; four are in the Order *Nepenthales* and 11 are in the Order *Orchidales*. There are no other plants from North Carolina listed in other CITES appendices.

3.15.1.2 State Regulations

The N.C. Nature Preserves Act enacted in 1985 (NCAC 1985: a.2 c.143B §49-§135.273) allows the State to obtain and dedicate land as permanently protected nature preserves. North Carolina's Department of Agriculture and Consumer Services, Plant Conservation Program (PCP) was authorized by the Plant Protection and Conservation Act (NCAC 1979: a.19B c.106 §202.12-§.202.22) to manage plant conservation in the State including adopting a state list of protected plant species, adopting and enforcing regulations that protect, conserve, and enhance those listed species, and developing conservation programs for the benefit of listed species. The PCP is responsible for managing more than 14,500 acres of conservation preserve properties across the state (Friends of Plant Conservation 2021). These preserves provide critical conservation for about 18% of the listed plant species in North Carolina. Additional plant protection is provided by legislation that protects land from criminal trespass (NCAC 2014: a.22 c.14 §126-§159.4) and prohibits taking of certain wild plants from private or public land without a permit issued by the owner.

3.15.2 Evaluation and Identification of Plant SGCN

As noted in Section 3.1.2 in the 2015 NCWAP, conservation priorities need to consider the greatest variety of biological diversity possible to ensure species survival and viable ecosystem services. Similar to methods used by the taxonomic Scientific Councils convened by the Commission's Nongame Wildlife Advisory Committee, the PCP convenes a Scientific Committee to evaluate, identify, and recommend plant species that need protection through state listing. The evaluation process considers the rarity, threats, and short-term trends of every species tracked by the NCNHP. The methodology involves broad participation by species experts and provides opportunities for public input through a 60-day comment period. The species evaluation process and a list of participants involved in developing and implementing the evaluation process are described in a white paper provided in new Appendix R.

3.15.3 Conservation Concerns

Most at-risk plants in North Carolina are endemic species and species with small, isolated populations limited to narrow distributions in insular and highly fragmented habitats (Cartwright 2019). As part of the PCP Scientific Committee's evaluations, a threats analysis is performed for plant species which considers each population as a discrete unit. In this way the viability of each population is considered by the Committee and the overall species' viability is assessed by reviewing the status of the populations within the state. It is understood that some imperiled or rare species in North Carolina might be more common elsewhere; however, each

species' viability within the state is considered at face-value in the interest of maintaining our state's biodiversity.

For species with very small populations, the long-term viability is highly questionable. Small populations tend to suffer from genetic loss which can lower the overall fitness at the population and even species level within a region. By tracking population viability, the NCNHP's database of rare plant populations helps conservationists to prioritize species and populations within species' ranges which are at elevated risk of loss unless population sizes increase. Conservation efforts that support population increases often requires mitigation of more than one threat.

Historical populations of rare species continue to be tracked by NCNHP for two primary reasons. First, historical populations can help us understand the full range and distribution of species as they undergo losses or range changes. Second, it is possible that historical populations can be rediscovered at or near known records during future surveys when environmental conditions are suitable. Most often these rediscoveries occur after appropriate land management is conducted to rehabilitate the habitat at a site, but sometimes a resurvey simply turns up previously undetectable individuals for unknown reasons.

3.15.4 Knowledge Gaps

Beginning in 1982, the NCNHP's county inventory biologists systematically studied the ecology of each county, conducting biological inventories of natural areas and maintaining a database of high-quality natural communities and rare species occurrences. Since the first county inventory was complete (Dare mainland), 97 of North Carolina's 100 counties have been comprehensively inventoried by NCNHP biologists (only Clay, Swain, and Wilkes have not been completed as of 2021). After completion of the initial county inventories, biologists in the NCNHP and partners including Wildlife Resources Commission, Division of Parks and Recreation, and Plant Conservation Program and many others, update the state's natural heritage inventory regularly as new lands are acquired for conservation and through partnership monitoring efforts. However, even with the collaborative efforts of field biologists working across North Carolina, many species and habitats remain under surveyed due to lack of staff resources or difficulty of access. For this reason, some species are considered "data deficient" and were not included in the SGCN priority list. An ongoing need exists for additional surveys and monitoring of species included in the SGCN list to keep the dataset current and complete, as circumstances change due to natural processes and human impacts to the landscape.

Populations that have not been inventoried in more than 30 years (on average) are considered “historical”. Where species occur in rapidly developing urban areas, species may be considered “historical” if they have not been observed in greater than 20 years. This difference is due to the likelihood of local extirpation caused by habitat conversion.

The NCNHP and partners obtain permission from landowners before conducting any biological inventories on private land. In many areas, staff biologists recognize the high likelihood of rare species or natural community occurrences on private land where they are unable to obtain survey permission, these areas represent knowledge gaps in the dataset (data deficiencies).

3.15.5 Threats and Problems

The threat assessment tool used to develop the plant SGCN list helps to assess the conservation needs of an individual species, and also identifies the greatest threats across all the reviewed species. The PCP has identified the following as the top threats to rare plants in North Carolina: natural system modifications (i.e., incompatible land management and hydrological alterations), residential and commercial development (i.e., habitat loss), invasive and other problematic species and genes, and stochasticity. Apart from stochasticity, these threats are defined in Salafsky et al. (2008).

The most important threats relate to habitat loss and habitat degradation. This is not surprising considering the stationary nature of plants, especially relative to most other taxonomic groups. Not surprisingly, these threats are particularly impactful in North Carolina given the state’s long history with agriculture and other land-use intensive industries, as well as its recent and ongoing rapid development and growth. By fragmenting landscapes and damaging natural communities and natural processes, natural areas that are not directly disturbed can face secondary or indirect impacts from nearby habitat losses. Further, habitat fragmentation can disrupt or diminish the connectivity between remaining habitats which can cause populations to be isolated, leading to genetic diversity losses.

Additional noteworthy threats identified for plants in our state include trampling and disturbance caused by recreation activities. Related to this threat are over-collection and exploitation which is an uncommon but a very impactful threat where it occurs. Another concern is climate change and related extreme weather events (e.g., drought, wind damage, flooding, excessive heat, and seasonal norm variations).

Importantly, the worst threats that plants are facing are not easily mitigated by rules or regulations. Instead, habitat conservation, habitat restoration, and population level management are the most important strategies for mitigating threats to plants.

3.15.6 Management Needs

Management needs for rare species are directly linked to the threats faced by those species. In order to address an overarching threat like habitat loss, protection from development (both direct land conversion and indirect encroachment) is key. Habitat degradation is often followed by habitat destruction. Therefore, many of North Carolina's most important plant habitats need protection from land conversion or development. Management activities need to include mitigation of both on-and off-site threats and restoration of previous damages. Thus, it is possible for several rare species living in similar habitats to have similar management needs, while some other species have varying management needs in different parts of their range. In other words, a management prescription depends on the threats and damages being addressed.

Despite habitats varying across North Carolina, land managers will likely find themselves addressing one or more of the following management needs, regardless of their location.

- Fire suppression is one of the largest threats to North Carolina's plant species and thus, prescribed fire is recommended to mitigate woody encroachment and other impacts of fire suppression. Careful planning is needed not only for safety, but also to obtain the best outcomes from each fire. For instance, to reduce competing vegetation, the timing of prescribed burns (season and interval) is important.
- Although prescribed burning is a supported and growing practice in our state, the need for prescribed fires is greater than what can be met with existing resources. Understanding what other management practices can be used as fire surrogates will be increasingly important as these and other constraints limit the use of fire as the primary management tool in areas where fire is needed.
 - Climate change is lengthening the natural wildfire season in our region and elsewhere in the country. The direct and indirect impacts of this longer season result in personnel and resources needed for prescribed burning being deployed to containment and suppression efforts, effectively shortening the prescribed fire window of opportunity due to lack of available resources.
 - Climate change is also leading to more extreme weather which is further reducing the number of "good burning days" available to fire practitioners.
 - Lastly, increasing development, as discussed earlier, is greatly increasing the wildland-urban interface which adds additional safety and sensitivity concerns to

prescribed fire planning in these areas, further limiting the opportunities to conduct effective burns for habitat management.

- Invasive species control is needed in nearly every disturbed site. The various forms of habitat degradation mentioned before each cause inroads for invasive species to colonize, especially in areas where the natural community matrix has been disturbed. Managing invasive species should be equal parts avoidance, control, and eradication of existing infestations.
- Hydrological alterations are also very common forms of habitat degradation but may be the most challenging and least straight-forward threats to address, especially alterations related to climate change such as sea level rise and saltwater intrusion. Understanding the hydrological needs of a species or community is critical to managing for such conditions. In areas with alterations, consider options that restore historic stream flow and capacity for maintaining surface and groundwater levels.
- Right-of-way maintenance is unique compared to natural areas and brings with it a specialized set of management considerations. For one, these areas can simultaneously be highly altered and provide important habitat, especially for sun-loving plant species easily out-competed by surrounding vegetation. Appropriately timed mowing regimes can be highly effective at managing a wide variety of plant habitats in rights-of-way. However, increasingly, rights-of-way are being maintained with herbicide instead of mowing for generalized maintenance focused on human uses (e.g., maintaining visibility in road shoulders and avoiding hazards in powerlines).

3.15.7 Additional Information

There has been a longstanding disconnect between the documented conservation needs for plant species and the disproportionately low funding and support for the recovery of rare, at-risk, and imperiled species. In a review of species listed under the Endangered Species Act, plants vastly exceed all other taxonomic groups in number of species listed but represent the lowest investment per species compared to all other taxonomic groups (Negron-Ortiz 2014). Making additional resources available for conserving these unique and foundational components of our natural world should be a higher priority. With the increase in North Carolina's human population and the rapid pace of land use change over the past 20 years often resulting in habitat destruction and degradation, the need for plant and wildlife habitat conservation and management is more urgent than ever. The need for funding, staff, and public support cannot be overstated.

3.15.8 Recommendations

Surveys. Distributional and status surveys need to focus on plant species believed to be declining or mainly dependent on at-risk or sensitive natural communities. According to the NC Risk Assessment and Resilience Plan (NCDEQ 2020) some habitats considered most at risk – and therefore most in need of monitoring – include:

- Low-lying areas along the coast are vulnerable to sea-level rise impacts including coastal erosion, saltwater intrusion, and storm surge. These habitats include Freshwater Tidal Wetlands, Maritime Wetland Forests, Blackwater Floodplains, and Large River Systems.
- High elevation natural communities are vulnerable to climate change. Even though many of these sites are already in conservation ownership, changes in seasons, extreme heat, drought, and heat waves all affect plants and animals that were adapted to live in conditions unique to the high elevation mountaintops. These changes are most likely to affect High Elevation Cliffs and Rock Outcrops.
- Wetland habitats dependent upon frequent fire are vulnerable to any changes in land use or landscape context that result in fire suppression or changes in hydrology. These threats affect Wet Pine Savannas in the Sandhills and Coastal Plain.
- Freshwater aquatic systems – already impacted by pollution, sedimentation, and obstructions due to dams and culverts – are also vulnerable to climate changes such as changes in water temperature and precipitation amounts as well as flows brought about by heat waves and extreme heat. These threats affect aquatic communities across the state.
- Rare plant and animal species occurring in all the habitats listed above should be routinely surveyed to facilitate early detection of declines due to habitat changes. Management intervention, if feasible, should be considered where needed to avoid local extirpation.

Monitoring. Long-term monitoring is critical to assessing species and ecosystem health over time and gauging the resilience of organisms to a changing climate. Studies should identify population trends, as well as assess impacts from conservation or development activities. These efforts will inform species and habitat management decisions. Long-term monitoring sites need to be identified and monitoring protocols developed for all priority plant species. Monitoring plans should be coordinated with other existing monitoring programs where feasible.

- At the site or population level, monitoring activities should include annual (or regular) observations of area of occupancy with an emphasis on changes in this area (both contractions and expansions), relative vigor (often recorded as the reproductive proportion of the population), and notable concerns such as disease or other impacts.
- At the species level, monitoring activities should help describe or calculate short-term trends for several populations. This level of monitoring often involves demographic data collection and can be very time and resource intensive.

Research. Research topics that facilitate appropriate conservation actions include natural community preferences, fecundity, population dynamics and genetics, propagation and transplant methods for the most imperiled species, and food web dynamics. Increased understanding of life histories and population statuses helps determine the vulnerability of priority species to further imperilment, in addition to identifying possibilities for improved management and conservation. All studies should provide recommendations for mitigation and restoration.

Management Practices. Management practices that reduce impacts and work synergistically with other conservation actions are needed to enhance the resilience of natural resources. Particular needs include preserving biodiversity, protecting native populations and their habitats, maintaining and restoring natural processes such as fire and natural flood regimes, and improving degraded habitats. There is a need for more understanding of how management practices conducted at varying scales impact plant populations. For instance, some practices should be employed in very controlled and isolated applications (i.e., herbicide treatments), whereas other practices are more effective if applied across a larger landscape (i.e., prescribed burns). Factoring in the feasibility of employing the best management practices at the most appropriate scale is a critical component in management planning, especially for rare plant species and sensitive habitats.

Conservation Programs and Partnerships. Conservation programs, incentives, and partnerships should be utilized to the fullest extent to preserve high-quality resources and protect important natural communities. Protective measures that utilize existing regulatory frameworks to protect habitats and species should be incorporated where applicable. Land conservation or preservation can serve numerous purposes in the face of anticipated climate change, but above all, it promotes ecosystem resilience.

North Carolina benefits from a robust conservation community and network of organizations involved in plant conservation. Some partners include North Carolina's Plant Conservation Program and Friends of Plant Conservation, Natural Heritage Program, Botanical Garden,

Division of Parks and Recreation, Forest Service, and Wildlife Resources Commission, as well as federal partners such as the US Forest Service, National Park Service, and Coastal Reserve Program. Universities also collaborate for research and education, especially the University of North Carolina system (Chapel Hill, Asheville, Appalachian State, NC State, Western Carolina, Wilmington), Duke University, and Catawba College. In addition, many land trusts and local governments monitor preserves for rare species and incorporate prescribed fire and wetland restoration into their practices. Groups such as the Plant Conservation Alliance and the Rare Flora Discussion Group play a role in fostering communication and collaboration among these many partners.

3.15.9 References

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. *Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems*. NatureServe, Arlington, Virginia. 83 pp. Available online www.natureserve.org.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). 1975. United Nations Environment Programme, CITES Secretariat. Geneva, Switzerland. Available online <https://cites.org/eng/disc/text.php>.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). 2021. How CITES works. Available online <https://cites.org/eng/disc/how.php>.

Friends of Plant Conservation. 2021. Plant Industry Division, Raleigh, North Carolina. Available online <https://www.ncplantfriends.org/>

Hall L.S, P.R. Krausman, M. L. Morrison. 1997. The habitat concept and a plea for standard terminology. *Wildlife Society Bulletin*. 25(1):173–182.

International Commission on Zoological Nomenclature (ICZN). 2021. *International Code of Zoological Nomenclature, 4th Edition*. Online <https://www.iczn.org/the-code/the-code-online/>.

Negron-Ortiz, V. 2014. Pattern of expenditures for plant conservation under the Endangered Species Act. *Biol. Conserv.* 171: 36-43.

North Carolina Administrative Code (NCAC). 1979. General Statute Article 19B, Chapter 106, Sections 202.12–202.22: Plant Protection and Conservation Act. Available online

https://www.ncleg.net/EnactedLegislation/Statutes/HTML/ByArticle/Chapter_106/Article_19B.html.

North Carolina Administrative Code (NCAC). 1985. General Statute Article 2, Chapter 143B, Sections 49–135.273: Nature Preserves Act. Available online https://www.ncleg.gov/EnactedLegislation/Statutes/HTML/ByArticle/Chapter_143B/Article_2.html.

North Carolina Administrative Code (NCAC). 2014. General Statute Article 22, Chapter 14, Sections 126–159.4: Damages and Other Offenses to Land and Fixtures. Available online https://www.ncleg.gov/EnactedLegislation/Statutes/HTML/ByArticle/Chapter_14/Article_22.html.

North Carolina Department of Environmental Quality (NCDEQ). 2020. North Carolina Climate Risk Assessment and Resilience Plan - Impacts, Vulnerability, Risks, and Preliminary Actions. Available online <https://deq.nc.gov/energy-climate/climate-change/2020-nceq-nc-climate-change-interagency-council/climate-change-clean-energy-plans-and-progress/nc-climate-risk-assessment-and-resilience-plan>.

North Carolina Natural Heritage Program. 2021. List of Rare Plant Species of North Carolina. Department of Natural and Cultural Resources, Raleigh, North Carolina. 194 pp. Available online <https://www.ncnhp.org/publications/nhp-publications/rare-plant-list>.

North Carolina Plant Conservation Program Preserve Steward Manual. 2021. North Carolina Plant Conservation Program and Friends of Plant Conservation. 22 pp. Available online https://www.ncplantfriends.org/uploads/5/7/1/0/57102531/preserve_steward_manual.pdf.

Salafsky, N., D. Salzer, A. Stattersfield, C. Hilton-Taylor, R. Neugarten, S. Butchart, B. Collen, N. Cox, L. Master, S. O'Connor, D. Wilkie. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. *Conserv. Biol.* 22(4): 897-911.

United States Fish & Wildlife Service (USFWS). 2021a. Conservation in North Carolina. Threatened, endangered, and at-risk species. Available online <https://www.fws.gov/southeast/north-carolina/>.

United States Fish & Wildlife Service (USFWS). 2021b. Species with Recovery Plans. Environmental Conservation Online System. Available online <https://ecos.fws.gov/ecp/report/species-with-recovery-plans>.

Weakley, A.S. 2020. Flora of the southeastern United States: North Carolina. University of North Carolina Herbarium, North Carolina Botanical Garden. 1076 pp. Available online <https://ncbg.unc.edu/research/unc-herbarium/flora-request/>.

ADDENDUM 2

4

Chapter 4 Habitats

Piedmont and Coastal Plain Oak Forest

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4.4.19 Piedmont and Coastal Plain Oak Forest

4.4.19.1 Ecosystem Description

Oak forests were once the most common natural community type in the Piedmont, occupying most of the uplands. In the Coastal Plain they were much more limited, especially in areas farther south. They occur primarily in dissected areas such as stream bluffs but may also occur on low upland ridges within large floodplain terraces or swamps. Soils are usually acidic, but on unusual types of rock, such as diabase and gabbro, they may be circumneutral. Piedmont and Coastal Plain oak-hickory forests are generally dominated by white oak in combination with post, red, southern red, or black oak species.

Hickories are generally the second most diverse genus in the canopy, but pines, maples, tulip poplar, or other hardwood species may be abundant. In less acidic examples, ash is often abundant. Large numbers of pine, tulip poplar, sweetgum, or red maple usually indicate a history of severe disturbance. The understory in these forests often consists of red maple, sourwood, black gum, and flowering dogwood. In acidic sites, species of blueberry or huckleberry can form a substantial shrub layer. Herbs are generally sparse and low in diversity at present; they were more abundant and diverse when fire was a regular occurrence.

Natural oak—hickory forests can be categorized into eight community types based on canopy composition, moisture levels, and soil chemistry, as well as biogeography. The first two community types are the most abundant, and some of the others are rare.

- **Dry Oak—Hickory Forests** were once one of the predominant forests of the Piedmont, occurring on drier upper slopes and on the broad upland ridges where acidic soils are present. In the Coastal Plain they are scarce and limited to dry upper slopes of bluff systems. White oak, in combination with post oak or southern red oak, dominates the canopy in more natural examples, and hickories and shortleaf pine are commonly associated. Dry Oak—Hickory Forests were probably once the most extensive forests in the Piedmont. Although they remain one of the most common community types, extensive agriculture and land development on the flat uplands has reduced them by a greater proportion than most other community types. Very mature examples are uncommon, and old-growth examples are unknown. Coastal Plain examples are rare.
- **Dry—Mesic Oak—Hickory Forest** communities occur on slightly more moist areas, on slopes and rolling uplands. They typically have white and red oaks as the primary

associates, with black oak and sometimes scarlet oak present along with hickories and shortleaf pine. They remain one of the most abundant community types in the Piedmont but have been reduced by a great proportion from their past extent. Very mature examples and large unfragmented examples are uncommon. Examples of Dry—Mesic Oak—Hickory Forest are rare in the Coastal Plain, though more abundant than Dry Oak—Hickory Forest.

- **Dry Basic Oak—Hickory Forest** communities occur on rocks such as gabbro and diabase that produce less acidic soils. They occur on upper slopes and upper flats with similar moisture levels as Dry Oak—Hickory Forests. They are dominated by white oak in combination with post or southern red oak, but usually have abundant hickories, including less common species such as shagbark and southern shagbark. Ash is also usually common and shortleaf pine is often a component. Distinctive species of trees, such as redbud and chalk maple, may predominate in the understory, and viburnums, coralberry, or Carolina buckthorn are often more common than blueberries in the shrub layer. These communities have suffered losses from their past extent that are comparable to those of Dry Oak—Hickory Forest, but because their substrates are much less common, remaining examples are scarce.
- **Dry—Mesic Basic Oak Hickory Forest** communities occur on substrates such as gabbro and diabase in settings with moisture levels similar to Dry—Mesic Oak—Hickory Forest. The canopy is dominated by white oak and red oak, in combination with hickories that often include shagbark and southern shagbark, as well as ash, shortleaf pine, and sometimes southern sugar maple. The distinctive understory and shrub species found in Dry Basic Oak—Hickory Forest are often present. Additionally, species typical of mesic and floodplain communities, such as spicebush and dwarf buckeye, as well as a number of herbaceous species, may occur farther uphill in these communities.
- **Piedmont Monadnock Forests** occur on scattered erosional remnant hills that stand above the surrounding uplands because they are more resistant to erosion. The substrate is rocky and soil conditions dry. These communities are dominated by chestnut oak, a species that is common in the mountains but otherwise uncommon in the Piedmont. Shortleaf pine may be codominant. White, post, southern red, and scarlet oaks may be present in small numbers, but often chestnut oak makes up nearly all the canopy. These communities are restricted and are unlikely to migrate. Their extent probably will stay the same, but some aspects of the communities may change.

Monadnock sites tend to be dry. Increased dryness might stress chestnut oaks, but it is unclear how serious this is; they do not appear to be limited by moisture at present. The shortleaf pine component may increase, particularly if there is more fire. Most species will probably persist but those that are confined to monadnocks or other small patches of habitat may be vulnerable to increased perturbations, such as fire, if their entire block of habitat is affected by any one event.

- **Xeric Hardpan Forests** are rare Piedmont communities that are intermediate between oak-hickory forests and glade or barrens habitats. They occur on upland flats where soils high in shrink-swell clays interfere with water penetration and root growth. Most are on diabase or gabbro and have species typical of the less acidic conditions, but an even rarer subtype occurs on acidic shales. The distinctive soil properties produce conditions that appear drier than Dry Oak—Hickory Forest, drier than the climate of North Carolina would suggest. Nevertheless, these communities are often associated with Upland Depression Swamp Forest communities. The canopy is dominated by some of the most drought tolerant species in the state, post oak and blackjack oak, and in mature stands the canopy is somewhat open. With the persistent fire regime that once prevailed across the Piedmont, these forests would be more open, appearing as woodlands or savannas, perhaps with open prairie patches on the most extreme soils. While dense brush is often found beneath the open canopy now, these communities presumably were once open and grassy beneath. Numerous plants that need full sunlight are present in canopy openings and along maintained edges such as roadsides and powerline corridors in areas where Xeric Hardpan Forests occur. Drought will likely shift them to more open structure that resembles their natural condition, perhaps even without increased fire.
- **Mixed Moisture Hardpan Forest** communities are dominated by a mixture of tree species typical of hydric and xeric conditions, occurring on sites with clay-rich soils that have restricted internal drainage or shrink-swell properties. Typically, willow oak is mixed with white oak, post oak, or southern shagbark hickory as the predominant canopy. Mixed Moisture Hardpan Forest is distinguished by the co-occurrence of wetland and upland oak and hickory species, generally including both willow oak and post oak in significant numbers, without segregation into distinct Xeric Hardpan Forest and Upland Depression Swamp communities. The site generally shows evidence of shallow ponding of water but not water flow. Mixed Moisture Hardpan Forests occur on unusually flat upland areas of the Piedmont, generally associated with diabase, gabbro,

or other mafic rock but potentially with clay-rich metasedimentary rocks. Communities with comparable mixtures of wet and dry soil conditions and of wetland and xerophytic plants are found in other parts of the Southeast and are sometimes known by the term “xerohydric.”

- **Swamp Island Evergreen Forests** are rare communities of the Coastal Plain upland ridges on floodplain terraces, where they are generally surrounded by wetlands. They are evergreen hardwood or mixed communities containing species that otherwise, in North Carolina, occur only in the maritime forests of the coast. They are dominated by sand laurel oak, loblolly pine, and often live oak, dwarf live oak, or water oak. Another species typical of maritime conditions is wild olive. Natural isolation from fire is thought to be an important determinant of these communities. All known examples are associated with medium to large blackwater rivers. This community is known only in the southern part of the Coastal Plain, associated with the Lumber, Waccamaw, and Northeast Cape Fear rivers and their large tributaries such as Juniper Creek and Big Swamp.

Three landscape habitat indicator (LHI) guilds have a significant concentration in these ecosystems. These are the Piedmont dry—wet hardwood and mixed forest, Piedmont dry—wet basic hardwood forest, and dry-xeric mixed forests, woodlands, and barrens. Habitat for the dry—xeric mixed forests, woodlands, and barrens LHI guild may increase with higher frequency of drought and fires. Habitat trends for the Piedmont dry—wet hardwood and mixed forests and Piedmont dry—wet basic hardwoods forests LHI guilds are more difficult to predict but given the wide range of moisture conditions they occupy, they are likely to remain fairly common.

4.4.19.2 Location of Habitat

Most Oak—Hickory Forests in the Piedmont are found on upland slopes and ridgetops, while Coastal Plain examples are found on dissected slopes of stream and river bluffs. Xeric Hardpan Forests occur on flat to gently sloping uplands while Piedmont Monadnock Forests occur on isolated higher hills. Basic Oak—Hickory Forests, Xeric Hardpan Forests, Mixed Moisture Hardpan, Swamp Island Evergreen, and Piedmont Monadnock Forests were always minority community types because of their need for specialized sites. The rocky monadnocks escaped impacts from farming, though development, clearcutting, and other alterations have eliminated the natural character of many communities.

Examples of Piedmont and Coastal Plain oak forests can be found on several public lands, including Caswell Game Lands, William B. Umstead State Park, Morrow Mountain State Park, Uwharrie National Forest, and Croatan National Forest.

4.4.19.3 Problems Affecting Habitats

The greatest threats to remaining examples of oak-hickory forests are destruction and degradation associated with development and conversion to successional forests by logging. While all remaining oak-hickory forests regenerated after past logging, present-day harvests often result in regeneration by species other than oaks. Conservation of the best examples and areas important to landscape connectivity is the most important action needed for this habitat.

As with other formerly widespread community types, fragmentation is a concern. Past and ongoing land use changes associated with development not only reduce the extent of habitat but leave remaining oak—hickory communities as isolated patches. While this habitat remains common and most of its component species are widespread, most natural oak-hickory forests are on dissected landscapes comprised of multiple community types and are not extensive. While most component species are abundant and widespread, some species, particularly mammal and bird species, may only be able to persist in large areas or they may be excluded from areas near the forest edge. The chances for some of these animals to survive may be enhanced by protecting forested connections between larger forested blocks.

Fire is believed to have been a natural part of all Piedmont and Coastal Plain oak forests. While its frequency and importance are not precisely known, regular fires give a competitive advantage to oaks, hickories, and shortleaf pine relative to most other tree species. There is now much concern that these species are not regenerating. Other species are much more abundant in forest understories and are increasing in the canopy. Harvests that once resulted in regeneration of oaks now often lead to stands of other species. Fires also lead to more open canopy conditions and greater cover and diversity of herbs. Low intensity fires would be beneficial but intense wildfires can be destructive. Regular fires also reduce fuel loads and reduce the potential for catastrophic canopy-killing fires. The restriction of oak forests in the Coastal Plain to fire-sheltered sites suggests a need for fires to be less frequent than in the longleaf pine communities that occupied the uplands. The Xeric Hardpan Forests appear to have changed most with removal of fire, but fire probably had similar, if less dramatic, effects on the other community types. Most or all rare plants in this group are likely to benefit from fire and the habitat conditions it creates.

The occurrence of invasive and non-native plants is a problem for oak—hickory forests in some places and is likely to continue to spread. Princess tree and tree-of-heaven can invade disturbed areas and occupy canopy gaps in some places. Autumn olive has come to dominate the shrub layer in some forests, and species such as trifoliolate orange represent a potential threat. Several herbaceous exotic plants also invade these forests, particularly those with basic soils. It is unclear if a warmer climate will exacerbate their spread; however, increased canopy disturbance by wind, drought mortality, or severe fire will hasten the spread of invasive species.

Most oak forests are tolerant of drought. Increased occurrence or longer periods of drought may favor oaks relative to weedy mesophytic species, but increased wind damage favors the understory species. If drought leads to severe wildfires, it would be harmful to oak forests, but the ease with which fires may usually be controlled in them makes this unlikely. Increased wind throw would probably favor existing understory maples over the long-lived oaks. Older trees will withstand fire better than younger ones but will be more susceptible to wind. Increased wind throw would reduce the average longevity of trees. The most severe droughts and hot spells of recent record have had only limited effects on oak forests. These forest types occupy the driest places on the Piedmont landscape. In general, the effects of drought, fire, and storm winds are small relative to the effects of development and logging.

4.4.19.4 Climate Change Compared to Other Threats

Climate change is far from the most significant threat to Piedmont and Coastal Plain Oak Forests. Similar oak forests range well to the south of North Carolina where conditions are similar to predicted future climate conditions. Direct effects of the warmer climate on these communities are likely to be limited and may even reduce some of the increase in mesophytic species. If fires increase, this may be beneficial, but an increase in intense fire would be harmful. Most fire that will occur will be from controlled burning, but weather conditions that make burning more difficult will be detrimental as it limits application opportunities. Most or all rare plants in this group are likely to benefit from more canopy openings and more fire.

TABLE 4.43 Comparison of climate change with other threats to Piedmont and Coastal Plain oak forests

Threat	Rank Order	Comments
Development	1	The extensive examples in the Piedmont and the more limited range examples in the Coastal Plain continue to be rapidly destroyed by ongoing urban, suburban, rural, residential, and commercial development. Continued population growth makes this the most severe threat in the current and the future climate. However, the fragmentation and loss of extent will increase the alteration caused by climate change, as isolated communities are unable to migrate, and species are unable to move to more favorable sites.
Extractive Uses/ Timber Harvest	2	Typical past logging practices, both high-grading and clearcutting, have had negative impacts on forest structure and composition, often converting oak forest to other types. Incentives for logging practices geared toward restoration rather than purely short-term financial objectives will reduce (but not eliminate) the negative impacts of logging. While many examples harvested in the past regenerated as oak forests, many harvested at present become dominated by successional pine, maple, or other hardwoods and it is unclear if oak dominance will return. The loss of old trees caused by increased disturbance coupled with future climate conditions will exacerbate impacts caused by timber harvest. Demand for biofuels may reduce timber rotations and may provide incentives to harvest additional areas that have not been commercially viable.
Invasive Species	3	Tree-of-heaven, princess tree, autumn-olive, and other invasive plants are likely to continue to expand regardless of the climate. A number of smaller invasive plants are increasing in disturbed oak forests and pose a risk of increase. Emerald ash borer is a severe threat to the ash component of Dry and Dry—Mesic Basic Oak—Hickory Forest. Exotic diseases, such as the sudden oak death fungus, represent a severe potential threat even under the current climate. Increased drought may make forests more susceptible to other diseases and pests.
Fire Suppression	4	The threat posed by fire regime alteration is less certain in rank. Lack of fire is causing slow changes in composition, including reduced oak regeneration. The growth of dense shade-tolerant understories and the consequent failure of oaks to regenerate is

Threat	Rank Order	Comments
		likely a result of prolonged fire suppression. It is an ongoing problem regardless of climate change. Climate change may exacerbate it; if it makes controlled burning more difficult, but ongoing development and population growth has a much greater effect. Wildfires are likely to remain easy to control in the Piedmont.
Climate Change	5	In the future climate, there may be an increase in natural fires (due to increased drought and higher average temperatures), but landscape fragmentation and fire suppression practices likely will continue to prevent most fires from spreading very far in the Piedmont and in the dissected lands where oak forests occur in the Coastal Plain. Most oak forests are expected to benefit from increased fire frequency, as long as the fire intensity is not too high. Direct effects of the warmer climate on these communities are likely to be limited. Similar oak forests range well to the south of North Carolina. The most severe droughts and hot spells of recent record have had only limited effects on them because they occupy the driest places on the Piedmont landscape.

4.4.19.5 Impacts to Wildlife

Rare species of animals, primarily insects, associated with these natural communities occupy habitats at the dry to xeric extreme, with some occurring only on a few isolated monadnocks in the Piedmont. Species that are confined to monadnocks or other small patches of habitat may be vulnerable to increased perturbations, such as fire, if their entire block of habitat is affected by any one event. Species confined to isolated habitats are unlikely to respond to climate change by migration.

Lists of wildlife SGCN and other priority species for which there are knowledge gaps and management concerns are provided in Appendix G of the 2015 Plan. Plant SGCN that are associated with this habitat type are identified in a new table provided in Appendix HA-2.

4.4.19.6 Recommendations

To reduce the possible impacts from habitat fragmentation, fire suppression, and climate change, conservation or restoration of landscape connections is most important for Piedmont and Coastal Plain Oak Forests. Although oak forest habitat remains abundant and widespread, because of the rapid land development and conversion, the most critical conservation activities revolve around securing land from these activities. Other needs include gathering information about the habitats themselves but also the wildlife species that utilize these habitats, and the unique plants associated with them. Management of these habitats can be better informed by continuing to develop techniques for safe and beneficial controlled burning.

Surveys. Distributional and status surveys need to focus on species believed to be declining or mainly dependent on at-risk or sensitive natural communities.

- Give priority to gathering baseline information regarding the current distribution and status of oak forest-associated species that are rare or declining (e.g., Eastern Fox Squirrel, Timber Rattlesnake, several bat species, Schweinitz's Sunflower, Dwarf-flowered Heartleaf, Georgia Aster).
- Expand surveys to include species for which we know very little about current status and distribution (e.g., Whip-poor-will, weasels, moles, shrews, bats, certain salamanders, and reptile species such as the Eastern Box Turtle).

Monitoring. Long-term monitoring is critical to assessing species and ecosystem health over time and gauging the resilience of organisms to a changing landscape and changing climate. These efforts will inform future decisions on how to manage species and their habitats. Studies should identify population trends and assess impacts from conservation or development activities. Long-term monitoring sites need to be identified and monitoring protocols developed for all priority species. Monitoring plans should be coordinated with other existing monitoring programs where feasible.

- Track oak habitat trends (e.g., rate of loss or conversion of the habitat and disease or pest affects) and consider trends in the development of long-term monitoring strategies for oak forests of the region.
- Track the effects of fire on species in these habitats, especially rare and poorly understood species.

Research. Research topics that facilitate appropriate conservation actions include habitat use and preferences, reproductive behavior, fecundity, population dynamics and genetics, feeding, competition, and food web dynamics. Increased understanding of life histories and status helps assess the vulnerability of priority species to further imperilment. It also aids in identifying possibilities for improved management and conservation.

- Study population responses of plant and wildlife species to habitat restoration and management (large scale prescribed burning, woodland/savanna restoration, etc.).
- Study population responses of plant and wildlife species to habitat fragmentation and degradation to better inform managers and plans.

Management Practices. Management practices that reduce impacts and work synergistically with other conservation actions are needed to enhance the resilience of natural resources. Particular needs include, preserving biodiversity, protecting native populations and their habitats, and improving degraded habitats.

- Foster efforts to understand and implement appropriate management techniques (e.g., prescribed fire or thinning) for the benefit of the broadest array of oak forest-dependent wildlife while considering specific needs of wildlife with more restrictive requirements (Artman and Downhower 2003; Ford et al. 2000).
- Manage existing conservation lands by using prescribed burning to diversify structure and composition of forest understory. Protect older trees, which may become increasingly scarce with increased wind disturbance. Provide an array of age classes by managing for uneven-aged stands rather than a patchwork of even-aged stands.

Conservation Programs and Partnerships. Conservation programs, incentives, and partnerships should be fully utilized to preserve high-quality resources and protect important natural communities. Protective measures that utilize existing regulatory frameworks to protect habitats and species should be incorporated where applicable. Land conservation or preservation can serve numerous purposes in the face of anticipated climate change, but above all, it promotes ecosystem resilience.

- Work with partners including the NC Prescribed Fire Council, the Fire Learning Network, and NC Forest Service to reinstate and increase prescribed burning.

- Support efforts to create wildlife passages along highways and protect undeveloped connections. These provide safer movement between oak—hickory habitats fragmented by highways. Protecting the connections will preserve cover and food resources provided by these habitats.
- Identify and protect strategically important areas, especially in areas that harbor populations of SGCN.

4.4.19.7 References

Artman VL, Downhower JF. 2003. Wood Thrush (*Hylocichla mustelina*) nesting ecology in relation to prescribed burning of mixed-oak forest in Ohio. *The Auk* 120(3):874-882.

Ford WM, Menzel MA, McCay TS, Gassett JW, Laerm J. 2000. Woodland salamander and small mammal responses to alternative silvicultural practices in the southern Appalachians of North Carolina. In *Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies* 54: 241-250 (Vol. 54).

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