

**Michaux's Sumac (*Rhus michauxii*)**

**5-Year Review:  
Summary and Evaluation**



USFWS photo, D. Suiter

**U.S. Fish and Wildlife Service  
Southeast Region  
Raleigh Ecological Services Field Office  
Raleigh, North Carolina**

**5-YEAR REVIEW**  
**Michaux's Sumac (*Rhus michauxii*)**

**I. GENERAL INFORMATION**

**A. Methodology used to complete the review**

The information used to prepare this report was gathered from peer reviewed scientific publications, monitoring reports (Boyer 1996, 2011), Willis (2008), data from the Georgia Natural Heritage Program (GNHP), North Carolina Natural Heritage Program (NCNHP) and Virginia Natural Heritage Program (VNHP), correspondence from botanists who are knowledgeable of the species and personal field observations. The review was completed by the lead recovery biologist for *Rhus michauxii* in the Raleigh, North Carolina Ecological Services Field Office. The recommendations resulting from this review are a result of thoroughly assessing the best available information on *R. michauxii*. Comments and suggestions regarding the review were received from peer reviews within and outside the U.S. Fish and Wildlife Service (Service). A detailed summary of the peer review process is provided in Appendix A. No part of the review was contracted to an outside party. Public notice of this review was provided in the *Federal Register* on July 29, 2008, and a 60-day public comment period was opened (73 FR 43947). No comments were received.

**B. Reviewers**

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**C. Background**

**1. FR Notice citation announcing initiation of this review:**

July 29, 2008 (73 FR 43947)

**2. Species status:**

A status survey for this species has never been conducted, although the NC Plant Conservation Program did conduct some monitoring of populations in North Carolina (NC) between 1992 and 1996 (Boyer 1996). Willis (2008) visited 42 occurrences in 2006 and conducted stem counts at each site. Boyer (2011)

conducted the last comprehensive field review of *R. michauxii*, visiting 20 NC populations populations in 2010 and 2011.

In 2013, we believe the status of *R. michauxii* is likely stable since it occurs in three states and each of these states has several populations that are managed with prescribed fire or manual control of adjacent woody vegetation. We continue to work with partners to gather data, initiate long-term monitoring, and gain a greater understanding of each population.

**3. Recovery achieved**

*R. michauxii* = 2 (26% - 50% of species recovery objectives achieved)

**4. Listing history**

Original Listing

FR notice: 54 FR 39850

Date listed: September 28, 1989

Entity listed: species

Classification: endangered

**5. Associated rulemakings:**

There are no associated rulemakings.

**6. Review History:**

*R. michauxii* was listed as endangered in 1989, and the recovery plan was completed in 1993.

Five Year Review: November 6, 1991.

In this review (56 FR 56882), different species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors as they pertained to the different species' recovery. In particular, no changes were proposed for the status of this plant.

The last comprehensive field review of *Rhus michauxii* populations in NC was conducted in 2010 and 2011 by Boyer (2011).

**7. Species' Recovery Priority Number at start of review (48 FR 43098):**

*R. michauxii* has been assigned a recovery priority number of 2, indicating a high degree of threat, a high potential for recovery, and a taxonomic status of species.

**8. Recovery Plan**

The *R. michauxii* Recovery Plan was approved on April 30, 1993.

## II. REVIEW ANALYSIS

### A. Application of the 1996 Distinct Population Segment (DPS) policy

The Endangered Species Act (Act) defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing DPS to only vertebrate species of fish and wildlife. Because the species under review is a plant and the DPS policy is not applicable, it is not addressed further in this review.

### B. Recovery Criteria

1. **Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes, delisting criteria.

2. **Adequacy of recovery criteria**

a. **Do the recovery criteria reflect the best available (i.e., most up-to-date) information on the biology of the species and its habitat?** Yes.

b. **Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?** The recovery criteria do take into account any threats to this species in association with the five listing factors, since the assurance that populations are self-sustaining and secure from any foreseeable threats, is part of the criteria.

3. **Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes

*R. michauxii* will be considered for removal from the Federal list when the following criteria are met:

1. It has been documented that at least 19 self-sustaining populations exist and that necessary management actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival.

Progress: Partially complete

The recovery plan defines “self-sustaining” as one that is clonally expanding or sexually reproducing and demographically and genetically viable (enabling it to survive and successfully respond to natural habitat changes). It seems reasonable to predict which populations are self-sustaining based on the Natural Heritage Program’s ranking criteria. A-ranked populations are considered to have excellent viability and B-ranked populations are considered to have good viability. According to NCNHP (2012) records, there are 18 A-, B- or AB-ranked parent populations in NC. Similarly, Boyer (2011) surveyed 20 populations of *R. michauxii* in NC and identified 14 as either stable or increasing. Three of the six populations in Virginia are very large and are likely to be self-sustaining. One of the Georgia populations has a rank of B. Based on the criteria explained above, 22 parent populations (which includes a greater number of subpopulations) may

be self-sustaining. However, regular monitoring using standardized monitoring protocols is necessary to determine if populations are truly self-sustaining.

The recovery plan states that the recovery populations should be distributed throughout the species' historic range. With the discovery of large, healthy populations in Virginia, the range of *R. michauxii* is actually greater now than when the species was listed. It seems reasonable to believe that this criterion will likely be met as long as populations across the range of the species are determined to be self-sustaining.

2. All of the above (self-sustaining) populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations.

Progress: Partially complete

All of the potentially 22 self-sustaining parent populations mentioned above have some level of protection. A more detailed review of their ownership and management would be necessary to determine if their level of protection meets the requirements of the recovery plan. We need to work with each land manager to document what measures are in place for protection and long-term viability.

## **C. Updated Information and Current Species Status**

### **1. Biology and Habitat**

#### **a. Abundance, population trends, demographic features, or demographic trends:**

The NC Plant Conservation Program conducted surveys and monitoring for this species between 1992 and 1996 (Boyer 1996). Irregular monitoring has occurred since 1996. In 2006, Willis (2008) conducted stem count monitoring at 42 occurrences. According to Amy Haynes, Biologist at Fort Pickett, VA (pers. comm.), biologists will map and delineate the boundary of the populations there on an annual basis and they conduct density and frequency counts every three years. The two populations in GA are regularly monitored by the GA NHP.

Despite recent visits to many of the known subpopulations, they have not been monitored in enough detail or with sufficient frequency nor has enough detailed data been collected to predict long-term population trends. Due to the rhizomatous growth habit of this species, it is difficult to determine how many individual plants occur at any particular site. Surveys usually consist of stem counts, but multiple above ground stems may only represent one individual plant.

**b. Genetics, genetic variation, or trends in genetic variation:**

As mentioned in the recovery plan, Sherman-Broyles et al. (1992), using starch gel electrophoresis, found that *R. michauxii* has considerably less genetic variation than the more widespread congeners *Rhus glabra* and *Rhus copallina*.

Hardin and Phillips (1985) mention that, in 1895, W.W. Ashe named an intermediate between *R. michauxii* and *Rhus glabra* as *Rhus caroliniana*. The current name for this hybrid is *x Rhus ashei*. They conducted experimental crosses between the two and had 20% success with viable seeds. Electrophoresis work by Burke and Hamrick (2002) confirmed five Fort Pickett, Virginia (VA) populations of *Rhus* as hybrids between *Rhus michauxii* and *Rhus glabra*. Four of these populations were putative hybrids and one was believed to be *R. michauxii*.

**c. Taxonomic classification or changes in nomenclature:**

Andre Michaux discovered this species on July 20, 1794 in Mecklenburg County, NC (the area is now part of Union County). He named the species *Rhus pumila* in 1803; however, since the specific epithet *pumila* had already been used for another species, Sargent assigned the name *R. michauxii* in 1895 (Barden and Matthews 2004).

There have been no changes to the taxonomic classification or nomenclature since *Rhus michauxii* was listed as endangered in 1989.

**d. Spatial distribution, trends in spatial distribution, or historic range:**

When the recovery plan was completed in 1993, *R. michauxii* was believed extant at 21 sites in NC and GA. No populations were known from VA at that time. *R. michauxii* was believed to be extinct at 20 sites in the coastal plain and piedmont of NC, South Carolina (SC), GA and Florida (FL). Since listing, additional occurrences have been found in GA, NC and VA. As of 2014, there are 43 parent populations, range-wide. The GANHP database currently lists four extant occurrences of *R. michauxii* and two additional subpopulations are considered historical or extirpated. NCNHP records currently indicate a total of 33 extant populations. An additional 13 sites in NC are now considered historical, extirpated or failed to find. The VANHP database indicates that there are six occurrences extant within the state with no known historical or extirpated populations. This information is summarized in Table 1 and additional information about each element occurrence (EO) is included in Appendix C. Following current NatureServe methodology, some of these sites are now considered sub-populations or sub-sets of larger populations

or principal EOs. See Table 1 for an additional explanation of this methodology.

Several populations of *R. michauxii* are now considered historical or extinct, including all previously known sites in FL and SC. *Rhus michauxii* was collected in Alachua County, FL in 1961. Attempts to relocate this population in 2006 (and prior to 2006) were unsuccessful (Herring 2006). Three sites known from SC (one site each in Florence, Kershaw and Oconee counties) were considered extirpated before the species was federally listed as endangered in 1989.

Table 1. Number of extant populations (principal element occurrences) and sub-populations of *Rhus michauxii* at the time of listing (1989), preparation of recovery plan (1993) and current (2011).

	GA	NC	VA	Total
No. extant populations at listing (1989)	1	15	0	16
No. extant populations* at in 1993 (completion of recovery plan)	1	20	0	21
No. extant populations (principal EOs) in 2014	4	33	6	43
No. historical, extirpated for failed to find populations in 2014	2	13	0	15

\* Please note that data between States is not necessarily comparable. While some states (GA) consider each distinct site as a population or “element occurrence; EO” and assign that site a unique identifying number, other states (NC and VA) use NatureServe’s Habitat-based Plant Element Occurrence Delimitation Guidance to determine what constitutes a population. The result is that some occurrences that are in close proximity to each other are merged into principal EOs and considered part of a single population. Since NatureServe has not developed Specific Population / Occurrence Delineation for *Rhus michauxii*, the default is that all sites within 2 km of each other are considered part of one population as long as there is not an area of unsuitable habitat greater than 1 km wide or another separation barrier present. NatureServe’s Habitat-based Plant Element Occurrence Delimitation Guidance is online at [http://www.natureserve.org/explorer/decision\\_tree.htm](http://www.natureserve.org/explorer/decision_tree.htm).

**e. Habitat:**

According to the recovery plan, *R. michauxii* grows in sandy or rocky open woods on sandy or sandy loam soils with low cation exchange capacities and appears to depend on some form of disturbance to maintain the open quality of its habitat. This disturbance may be in the form of fire, wind throws, or openings created by roads, railroads and utility rights of way.

**f. Other relevant information about the species (propagation, etc.):**

Although it is generally accepted that the flowers are dioecious and that each population is typically male or female, recent observations by various botanists indicate that individual flowers are perfect, or have both male and female parts.

The NC Botanical Garden is the designated Center for Plant Conservation repository for *R. michauxii*. Seeds from five NC populations (Natural Heritage Program EOs 211, 16, 20, 54, 56) are stored there for long-term preservation of genetic material and to be used for research and reintroduction. The NC Botanical Garden hopes to increase seed accessions and conduct research on seed production, seed ecology, storage and germination as funds become available (Michael Kunz, Conservation Ecologist, NC Botanical Garden, pers. comm.). The NC Botanical Garden has several plants of *R. michauxii* on display in the rare plant garden and in cultivation at the research area of the garden.

The NC Botanical Garden sent *R. michauxii* seeds from NCNHP EOs 11 and 54 to Bryan Connolly of the University of Connecticut Department of Plant Science, for germination protocol testing in 2008. Seeds were sanded, boiled or otherwise stratified, but none germinated (Bryan Connolly, State Botanist, Massachusetts Natural Heritage and Endangered Species Program, pers. comm.).

Mary Frazer (Environmental Biologist, NC Department of Transportation, pers. comm.) and Steve Mitchell (NCDOT) have successfully germinated *R. michauxii* seeds using two different stratification methods. Results are preliminary, but it appears that the highest germination rate is with seeds that were soaked in concentrated sulfuric acid (12 normal) for 45 minutes, rinsed in tap water, dried and refrigerated for approximately six weeks, then planted. Seeds that were soaked in hot (nearly boiling) water for two minutes, then dried and refrigerated for approximately six weeks before planting have also germinated. Bolin et al. (2011) also found that germination increased when seeds were scarified with sulfuric acid.

According to Heather Alley (Botanist, State Botanical Garden of Georgia, pers. comm.) the State Botanical Garden of Georgia has several stems of *R. michauxii* in their rare plant garden. In addition, the Atlanta Botanical Garden cultivates *R. michauxii* in their conservation garden (Ron Determann, Horticulturist, Atlanta Botanical Garden, pers. comm.).

Woodlanders Nursery in Aiken, SC has *R. michauxii* material from several populations in cultivation at their nursery. Plants grown from material collected at the Covington, GA water tower site in Newton County, GA were used to reintroduce the species back to where it originally occurred

(Robert McCartney, Owner, Woodlanders Nursery, Aiken, SC, pers. comm.).

Thrush (2002) looked at the effects of adjacent vegetation, light intensity and soils when choosing introduction sites for *R. michauxii*.

At the University of Florida, *R. michauxii* has been used in ongoing research of biological control studies of the exotic, invasive plant Brazilian Peppertree (*Schinus terebinthifolius*). Plants in this study are subjected to stem-attacking thrips (small black winged bugs that suck plant sap) (*Pseudophilothrips ichini*) or a sawfly (*Heteroperryia hubrichi*) and ultimately destroyed in an autoclave. Propagated *R. michauxii* plants have been obtained from NCSU and the NC Botanical Garden. There was initial concern that the release of these insects could negatively affect *R. michauxii* in the wild. Release of any biological control species into the wild are being withheld pending the results of the effects on *R. michauxii*.

In summary, despite recent visits to many of the known *R. michauxii* sites, this species has not been monitored in sufficient detail to predict long-term population trends. Electrophoretic work indicates that *R. michauxii* has considerably less genetic variation than the more widespread congeners *Rhus glabra* and *Rhus copallina*. Electrophoresis work confirmed five Fort Pickett, VA populations of *Rhus* as hybrids between *R. michauxii* and *Rhus glabra*. Hybrids between *R. michauxii* and *Rhus glabra* are sometimes referred to as x *Rhus ashei*.

When the recovery plan was written in 1993, *R. michauxii* was known from 21 sites in NC and GA. Since that time, additional occurrences have been found in NC, GA and VA. Records provided by respective Natural Heritage Programs indicate a total of 43 extant populations including four introduced/created populations in NC, VA and GA. An additional 15 populations are considered extinct, historical or failed to find, indication that no plants were observed at those populations during the last visit to the site by a competent botanist during the appropriate season (one of these populations was introduced/created).

## 2. Five-Factor Analysis

### **a. Present or threatened destruction, modification or curtailment of its habitat or range:**

Several populations and parts of populations (subpopulations) of *R. michauxii* have suffered from habitat modification and/or destruction. This species is threatened by fire suppression and the ecological succession (competition and/or shading by woody species) that occurs in areas that are not burned on a regular basis. Forested populations are threatened by timber operations. Logging activities can crush plants and

or compact the soil where they grow. Sites located within utility rights-of-way are threatened by herbicide use, mowing during critical growth periods, and ground disturbing activities. Habitat destruction, the result of development or land conversion, also threatens this species (Boyer 1996).

Braham and Suiter (2000) noticed that the reduction and control of trees and vines at *R. michauxii* sites is critical to the species' long-term survival, especially at roadside "encapsulated" populations. They recommended a two step vegetation control plan that involves cutting the competing vegetation back and immediately treating cut stems with herbicides. The maintenance phase would involve prescribed fire every two to three years.

Emrick and Jones (2008) found that competition for light by adjacent woody vegetation negatively correlated with stem density at Fort Pickett, VA. Their research showed that the impact of woody competition differed substantially depending on the type of competition and the sex of the *R. michauxii* colony. Competition in the 2 to 5 meter strata negatively correlated with female flowering. The authors suggest that reducing woody competition in this strata would improve habitat conditions for sexual reproduction.

Many populations of *R. michauxii* occur on lands that are regularly managed for conservation purposes. Many of the NC populations occur on Fort Bragg Army Base and Camp Mackall (Sandhills Game Land) and receive protection and appropriate management, especially through the use of prescribed fire to reduce shade and competition. At least 29 extant populations in NC are partially or fully on protected/conservation lands. In VA, five populations occur on protected lands at Fort Pickett National Guard Training Center and on private conservation lands. Two GA populations are in conservation management at the Broad River Wildlife Management Area and the Covington Water Tower Preserve (Mincy Moffitt, GNHP, pers. comm.). In addition, there are two "safeguarding sites" for *R. michauxii* in GA at Panola Mountain State Park and Chattahoochee Nature Center.

Habitat modification, fire suppression, ecological succession and forestry practices all have the potential to negatively impact *R. michauxii*. Woody competition negatively affects the viability of *R. michauxii* populations. A total of 22 self-sustaining populations occur on lands that receive some level of protection and conservation management.

**b. Overutilization for commercial, recreational, scientific, or educational purposes:**

There is currently no evidence to suggest that *R. michauxii* is being overutilized for commercial, recreational, scientific or educational purposes.

**c. Disease or predation:**

No signs of predation have been observed in this species; however, it seems reasonable to believe that herbivores may eat the leaves or flowering stems of this plant while grazing on adjacent vegetation.

While it appears to be reasonably easy to propagate this species in a greenhouse or nursery setting from root cuttings, plants produced in this manner frequently succumb to powdery mildew (Richard Braham, Professor of Forestry, NC State University, Raleigh, NC, pers. comm.).

No signs of predation or disease have been observed in this species in nature.

**d. Inadequacy of existing regulatory mechanisms:**

Because of its federal endangered status, *R. michauxii* is protected on Federal lands such as Department of Defense property at Fort Bragg and Camp Mackall in NC and Fort Pickett in VA. Even though the species is federally listed as endangered, populations that occur on private land receive little protection.

*Rhus michauxii* is also listed as state endangered by NC under the Plant Protection and Conservation Act of 1979, but this protection is largely limited to the regulation of collecting and trade (North Carolina Department of Agriculture 02 NCAC 48F .0301). The Act authorizes the NC Plant Conservation Program to establish nature preserves for protected species and their habitat. One population of *R. michauxii* was recently found on an existing NC Plant Conservation Program preserve. *R. michauxii* is also listed as State Endangered in GA. Georgia has laws protecting rare plants (Ga. Code Ann. Secs. 27-3-130 et seq.). Violations constitute a misdemeanor. In addition, the GA Environmental Policy Act requires the assessment of major proposed agency impacts on biological resources (Ga. Code Ann. Sec. 12-16-1 et seq.) (Center for Wildlife Law, <http://wildlifelaw.unm.edu/statbio/georgia.html>). *R. michauxii* is listed as threatened in VA (Townsend 2009). The Endangered Plant and Insect Species Act of Virginia prevents listed species from being taken from someone's property by another without a permit from the Virginia Department of Agriculture and Consumer Services. Legal harvest and export may be permitted by the VDACS under an approved management plan.

We have conducted formal consultation with the Federal Highway Administration / NC Department of Transportation because of project related impacts to this species. In 1998, rhizomes were removed from a population found in the corridor of the proposed I-540 north of Raleigh, NC and planted at Umstead State Park (Wake County, NC) and NCSU's

Hill Forest (Durham County) (Amoroso 1998). We have also conducted intra-service consultation regarding the issuance of a permit to ship specimens to Brazil for research involving insects that may be useful in the treatment of the invasive Brazilian pepper (*Schinus terebinthifolia*). Since Brazilian pepper is also in the same family as *R. michauxii* (Anacardiaceae) and it historically occurred in FL where Brazilian pepper is so problematic, it is important to test the susceptibility of *R. michauxii* to potential harm by any biological control that may be released in areas where the species may occur.

Many populations of *R. michauxii* are protected because they occur on federal lands in NC and VA, while other populations receive protection from projects that are federally funded or permitted. This species is also listed as state endangered in NC and GA and state threatened in VA.

**e. Other natural or manmade factors affecting its continued existence:**

*R. michauxii* populations are generally small and often consist completely of male or female plants. *R. michauxii* is a clonal species. It is believed that many populations consist of multiple stems that are all connected by underground rhizomes, so therefore, they likely contain only one plant. Single plant populations or single sex populations do not produce seeds. Limited genetic variation within populations may contribute to the observed low rates of seed production in natural populations. In addition, it appears that seed viability is extremely low (Bolin et al. 2011; Mary Frazer, Environmental Biologist, NC Department of Transportation, pers. comm.).

The effects of climate change on this species are unknown at this time. However, since this species occurs on dry soils in fire maintained habitat, it seems reasonable to believe that it will not be negatively affected by the predicted increase in droughts and wildfires.

No other natural or manmade factors affecting the continued existence of *R. michauxii* are known at this time.

Single sex populations that are clonal in nature prohibit sexual reproduction and seed production in this species. In populations where seeds are produced, it appears that seed germination is very low.

**Summary**

In summary, the most important factors that justify its endangered status are related to its extreme rarity due to habitat loss from fire suppression and subsequent ecological succession, forestry practices and development due to the inadequate regulatory mechanisms to protect listed plants on private lands. *R. michauxii* sites located within utility rights-of-way are threatened by herbicide use or mowing during critical growth periods.

Most protected sites in NC are regularly managed with prescribed fire and they currently appear to receive minimal competition from other woody species. However, few management plans formally prescribe long-term plans for management with fire.

Although no rigorous monitoring has been conducted, multiple observations suggest that limited seed production continues to be a problem at most populations, including at protected sites. Without seed production and seedling recruitment, populations are expected to have reduced ability to adapt to selection pressures and may have an increased long-term risk of extinction. Monitoring programs are needed to determine whether low seed production is indeed a factor at protected sites.

There is currently no evidence to suggest that *R. michauxii* is being overutilized for commercial, recreational, scientific or educational purposes. No signs of predation or disease have been observed in this species. *R. michauxii* is listed as state endangered in NC and GA and state threatened in VA.

#### **D. Synthesis**

In summary, despite recent visits to approximately half of the known subpopulations, *R. michauxii* sites have not been monitored in sufficient detail to predict long-term population trends. Little genetics research has been done on this species.

In 1989 when *R. michauxii* was listed as endangered, there were 16 sites (or what are now considered subpopulations) in NC and GA. By 1993, when the recovery plan was written, it was known from 21 sites in NC and GA. Since that time, additional occurrences have been found in NC, GA and VA. Records provided by respective Natural Heritage Programs indicate a total of 43 populations in NC, VA and GA. An additional 15 populations are considered extinct or historical and no plants were observed at two more subpopulations during the last visit to the site (by a competent botanist during the appropriate season).

There is currently no evidence to suggest that *R. michauxii* is being overutilized for commercial, recreational, scientific or educational purposes. No signs of predation or disease have been observed in this species. *R. michauxii* is also state listed in NC, GA and VA. Limited genetic variation within populations and the prevalence of unisexual populations may contribute to the observed low rates of seed production in natural populations.

The principal threat to this plant is habitat destruction, modification, fragmentation due to lack of fire management, ecological succession, timber

operations, maintenance at right of ways, etc. In addition, *R. michauxii* is threatened because despite having 43 extant populations, many of them remain small and may be unisex or single plants with multiple stems. We believe *R. michauxii* continues to meet the definition of endangered due to habitat threats, small population size.

### III. RESULTS

#### A. Recommended Classification:

**No change is needed**

### IV. RECOMMENDATIONS FOR FUTURE ACTIONS

Recommendations for future actions that will contribute to the recovery of *R. michauxii* include:

- revisit known populations that have not been visited in the past three years; monitor the habitat condition of each site including threats and fire regime; monitor population size and evidence of reproduction (sexual, asexual and seed viability); discuss conservation options with landowners where appropriate; update Natural Heritage Program files with this information,
- search for additional populations throughout the range of the species,
- prioritize known sites for protection,
- protect additional populations through fee simple acquisition, conservation easements, etc.,
- develop management plans including the use of prescribed fire for all protected populations,
- develop standardized monitoring protocols, initiate long-term population monitoring and determine the criteria for sustaining populations,
- reinstate monitoring that was initiated in the early 1990s by Boyer (1996),
- conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship),
- compare, genetically, the populations of questionable taxonomy in VA with those known from NC and GA (especially populations suspected of hybridizing with other species of *Rhus*),
- work with NC Botanical Garden to conserve seeds and germplasm, and develop propagation protocols, and
- consider augmenting populations to increase genetic variation.

### V. REFERENCES

Amoroso, J. 1998. Michaux's sumac restored at Umstead State Park. *The Steward* 12(5):7.

Barden, L.S. and J.F. Matthews. 2004. Andre Michaux's sumac – *Rhus michauxii* Sargent: Why did Sargent rename it and where did Michaux find it? *Castanea* 69(2):109-115.

- Bolin, J.F., M.E. Jones, and L. J. Musselman. 2011. Germination of the federally endangered Michaux's sumac (*Rhus michauxii*). *Native Plants* 12(2):119-122.
- Boyer, M. 2011. Monitoring *Ptilimnium nodosum* and *Rhus michauxii* in North Carolina (2010 – 2011). Final Report in Fulfillment of U.S. Fish and Wildlife Service Grant 40181AG138. Rougemont, NC.
- Boyer, M. 1996. Final report on *Rhus michauxii* Monitoring and Management 1992-1996. Unpublished report to NC Plant Conservation Program and U.S. Fish and Wildlife Service. 26 pp + maps.
- Braham, R. and D. Suiter. 2000. Status and management of encapsulated Michaux's sumac populations in North Carolina. Unpublished report. 15 pp.
- Burke, J.M. and J.L. Hamrick. 2002. Genetic variation and evidence of hybridization in the genus *Rhus* (Anacardiaceae). *The Journal of Heredity* 93(1):37-41.
- Emrick, V. and J. Jones. 2008. Influence of Competition on the Density of the Federally Endangered Michaux's Sumac (*Rhus michauxii*) at Fort Pickett, Virginia. *Southeastern Naturalist* 7(1):61-68.
- Hardin, J.W. and L.L. Phillips. 1985. Hybridization in Eastern North American *Rhus* (Anacardiaceae). *ASB Bulletin* 32(3):99-106.
- Herring, B. 2006. A status survey for Michaux's sumac (*Rhus michauxii*) in Alachua County, Florida. Unpublished report submitted to the Florida Department of Agriculture and Consumer Services Division of Administration (FDACS)/Division of Forestry. Florida Natural Areas Inventory, Tallahassee, FL.
- N.C. Natural Heritage Program. 2012. North Carolina Natural Heritage Program Biotics Database *Rhus michauxii* Element Subnational Tracking Record and Element Occurrence Records. Office of Land and Water Stewardship, NCDENR, Raleigh, NC.
- Sherman-Broyles, S.L., J.P. Gibson, J.L. Hamrick, M.A. Bucher and M.J. Gibson. 1992. Comparisons of allozyme diversity among rare and widespread *Rhus* species. *Systematic Botany* 17(4):551-559.
- Townsend, J.F. 2009. Natural Heritage Resources of Virginia: Rare Plants. Virginia Department of Conservation and Recreation. Richmond, VA. 66 pp.
- Willis, M.S. 2008. Status and Soil Requirements of *Rhus michauxii* in North Carolina. M.S. Thesis. Department of Forestry, NC State University, Raleigh, NC. 43 pp.
- Thrush, L.E. 2002. Planting Site Determination Techniques for *Rhus michauxii*. M.S. Thesis. Department of Forestry, NC State University, Raleigh, NC. 52 pp.

**U.S. FISH AND WILDLIFE SERVICE  
5-YEAR REVIEW OF MICHAUX'S SUMAC (RHUS MICHAUXII)**

Current Classification: Endangered  
Recommendation resulting from the 5-Year Review:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change is needed

Review Conducted By: Dale Suiter, Fish and Wildlife Biologist, Raleigh Field Office

**FIELD OFFICE APPROVAL:**

Pete Benjamin, Lead Field Supervisor, Fish and Wildlife Service

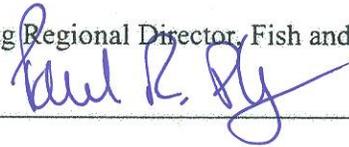
Approve  Date 6/3/14

**REGIONAL OFFICE APPROVAL:**

Lead Regional Director, Fish and Wildlife Service

For Approve  Date 7/23/14

Cooperating Regional Director, Fish and Wildlife Service

Approve  Date 8/1/14

**APPENDIX A**  
**Summary of peer review for the 5-year review of**  
**Michaux's sumac (*Rhus michauxii*)**

**A. Peer Review Method:**

In early July, a draft copy of the five year review was emailed to botanists with the NC Plant Conservation Program (Lesley Starke), NC Natural Heritage Program (Misty Buchanan), NC Botanical Garden (Michael Kunz), NC Department of Transportation (Mary Frazer) and the GA Natural Heritage Program (Mincey Moffitt). Since *R. michauxii* occurs within the work area of two other Service Ecological Services Field Offices, the Athens, GA (James Rickard) and Gloucester, VA (Sumalee Hoskin) Field Offices were asked to review this document as well. Reviewers provided comments by email, modifications to the original document and/or in “track changes.” All of the peer reviewers used know the listed species and are familiar with the habitats where the species occurs and the threats to its long-term survival.

**B. Peer Review Charge:**

Peer reviewers were asked to provide written comments on the information presented in our analysis of the status of the *R. michauxii* and to provide comments on the validity of the data. Peer reviewers were asked not to provide recommendations on the legal status of the species.

**C. Summary of Peer Review Comments/Report:**

One peer reviewer from the NCNHP provided additional information about *R. michauxii* populations that occur in managed areas in NC and she also provided information about updated element occurrence ranks, changes that were made to their database since the data were originally acquired in January 2009. The reviewer from the NC Plant Conservation Program provided information about the use of *R. michauxii* in research dealing with potential predators for the Brazilian peppertree. The reviewer from NC Department of Transportation provided information about their experiences with seed germination as well as additional information about some of the roadside populations of this species. All peer reviewers suggested some changes in wording throughout that greatly improved the quality of the document.

**D. Response to Peer Review:**

The Service evaluated all the comments provided by the peer reviewers and incorporated them as appropriate into the final document.

**APPENDIX B**  
**Bibliography of documents mentioning *Rhus michauxii***

- Amoroso, J. 1998a. Michaux's sumac restored at Umstead State Park. *The Steward* 12(5):7.
- Amoroso, J. 1998b. Michaux's sumac restored at Umstead State Park. *The Umstead Coalition Newsletter* Fall 1998, p. 5.
- Barden, L.S. and J.F. Matthews. 2004. Andre Michaux's sumac – *Rhus michauxii* Sargent: Why did Sargent rename it and where did Michaux find it? *Castanea* 69(2):109-115.
- Bolin, J.F., M.E. Jones, and L.J. Musselman. 2011. Germination of the federally endangered Michaux's sumac (*Rhus michauxii*). *Native Plants* 12(2):119-122.
- Boyer, M. 1996. Final report on *Rhus michauxii* Monitoring and Management 1992-1996. Unpublished report to NC Plant Conservation Program and U.S. Fish and Wildlife Service. 26 pp. + maps.
- Boyer, M. 2011. Monitoring *Ptilimnium nodosum* and *Rhus michauxii* in North Carolina (2010 – 2011). Final Report in fulfillment of U.S. Fish and Wildlife Service Grant 40181AG138. Rougemont, NC.
- Braham, R.R. 1999. Enhancing populations of Michaux's sumac in North Carolina. First annual report. Unpublished report. 11 pp. + appendices.
- Braham, R. and D. Suiter. 2000. Status and management of encapsulated Michaux's sumac populations in North Carolina. Unpublished report. 15 pp.
- Braham, R., C. Murray and M. Boyer. 2006. Mitigating impacts to Michaux's sumac (*Rhus michauxii* Sarg): a case study of transplanting an endangered shrub. *Castanea* 71(4):265-271.
- Buchanan, M.F. and J.T. Finnegan. 2008. Natural Heritage Program List of the Rare Plant Species of North Carolina. NC Natural Heritage Program, Raleigh, NC.
- Burke, J.M. and J.L. Hamrick. 2002. Genetic variation and evidence of hybridization in the genus *Rhus* (Anacardiaceae). *The Journal of Heredity* 93(1):37-41.
- Carolina Country. 2004. Vegetation Management Program – Responsible and Effective. *Carolina Country* 36(6):22.
- Coile, N.C. 2000. Notes on Florida's endangered and threatened plants. Bureau of Entomology, Nematology, and Plant Pathology – Botany Section, No. 38, 4<sup>th</sup> ed. Florida Department of Agriculture and Consumer Services, Gainesville, FL.

- Coile, N.C. and M.A. Garland. 2003. Notes on Florida's endangered and threatened plants. Bureau of Entomology, Nematology, and Plant Pathology – Botany Contribution, No. 38, 4<sup>th</sup> ed. Florida Department of Agriculture and Consumer Services, Gainesville, FL.
- Cooper, J.E.; Robinson, S.S.; Funderburg, J.B. 1977. Endangered and threatened plants and animals of North Carolina. Raleigh, NC. North Carolina State Museum Natural History. 444 pp.
- Cuda, J.P., J.C. Medal, M.D. Virorino and D.H. Habeck. 2005. Supplementary host specificity testing of the sawfly *Heteroperryia hubrichi*, a candidate for classical biological control of Brazilian peppertree, *Schinus terebinthifolius*, in the USA. *BioControl* 50:195-201.
- Deese, J., O. Hutchins, K. Kerecman, J. Mason, J. Maples, C. Olekson, S. Savin, T. Snow, K. Sweaney and L. Bardin. 2001. The reintroduction of *Rhus michauxii* into Mecklenburg County, North Carolina. Conservation Biology Laboratory, University of North Carolina – Charlotte. Unpublished report.
- Emrick, V. 2009. Preliminary Report: Reproductive Status of Michaux's sumac (*Rhus michauxii* Sarg.) on Fort Bragg and Camp Mackall, NC. Unpublished report to Fort Bragg Peaks to Prairies Ecological Services.
- Emrick, V. and J. Jones. 2008. Influence of competition on the density of the federally endangered Michaux's sumac (*Rhus michauxii*) at Fort Pickett, Virginia. *Southeastern Naturalist* 7:61-68.
- Emrick, V. and A. Hill. 1997. Density of *Rhus michauxii* stems at Fort Pickett Military Reservation, Virginia. Springfield, VA: US Army Corps of Engineers, Construction Engineering Research Laboratories. 16 pp.
- Emrick, V. and A. Hill. 1998. Plant community composition of *Rhus michauxii* colonies at Fort Pickett military Reservation, Virginia. U.S. Army Corps of Engineers Resarch Lab., USACERL Technical Report. Champaign, IL. 98/49. 27 pp.
- Emrick, V. and J. Jones. 2008. Influence of Competition on the Density of the Federally Endangered Michaux's Sumac (*Rhus michauxii*) at Fort Pickett, Virginia. *Southeastern Naturalist* 7(1):61-68.
- Emrick, V.R., R.J. Proffitt, T. O. Southall, and L.M. Boyette. 1995. The community ecology of Michaux's sumac (*Rhus michauxii* Sargent), a globally endangered species occurring at Fort Pickett, Virginia. *ASB Bulletin* 42(2):123.
- Fleming, G.P., J.C. Ludwig. 1996. Noteworthy collections; Virginia. *Castanea* 61:89-94.
- Hardin, J.W. and L.L. Phillips. 1985a. Atlas of foliar surface features in woody plants, VII. *Rhus* subg. *Rhus* (Anacardiaceae) of North America. *Bull. Torrey Bot. Club* 112(1):1-10.

- Hardin, J.W. and L.L. Phillips. 1985b. Hybridization in Eastern North American *Rhus* (Anacardiaceae). *ASB Bulletin* 32(3):99-106.
- Henderson, M, R. Braham and F. Isik. 2011. Status of Michaux's Sumac (*Rhus michauxii* Sarg.) in North Carolina. Draft for publication.
- Henderson, B. 2001. Native plant life from 1700s returned to Mecklenburg. *Charlotte Observer* November 29, 2001.
- Herring, B. 2006. A status survey for Michaux's sumac (*Rhus michauxii*) in Alachua County, Florida. Unpublished report submitted to the Florida Department of Agriculture and Consumer Services Division of Administration (FDACS)/Division of Forestry. Florida Natural Areas Inventory, Tallahassee, FL.
- Kartesz, J.T. 1999. A synonymized checklist of the vascular flora of the U.S., Canada, and Greenland. In: Kartesz, J.T. and Meacham, C.A., editors. *Synthesis of the North American Flora, Version 1.0*. North Carolina Botanical Garden. Chapel Hill, NC.
- Legrand, H., Jr. 1992. Heritage staff member finds more rare species in the Sandhills Game Land. *Natural Diversity*, Summer 1992 pp. 4-5.
- Murray, C.A., R. Braham and S. Burlison. Undated. Development and implementation of mitigation plans to off-set impacts to Michaux's sumac from roadway construction in North Carolina. Unpublished report. NC Department of Transportation and NC State University.
- The Nature Conservancy. 1993. Rare and endangered plant survey and natural area inventory of Fort Bragg and Camp MacKall military reservations, North Carolina. Sandhills Field Office: Final report by The Nature Conservancy.
- North Carolina Department of Agriculture. 1997. Endangered native sumac to be reintroduced. NCDA Press Release, February 21, 1997. Raleigh, NC.
- North Carolina Division of Parks and Recreation. 1993. CP&L, Heritage Program enter management agreement. *The Steward* 7(4):4-5.
- Patrick, T.S., J.R. Allison and G.A. Krakow. 1995. Protected Plants of Georgia, An informational manual on plants designated by the State of Georgia as endangered, threatened, rare or unusual. Georgia Department of Natural Resources, Wildlife Resources Division, Georgia Natural Heritage Program, Social Circle, GA.
- Pokorski, B. and V. Emrick. 2007. Current status of the federally endangered Michaux's sumac (*Rhus michauxii*). Conservation Management Institute – Military Lands Division College of Natural Resources, Virginia Polytechnic Institute and State University. CMI-MLD-2007-R-58.

- Radford, A.E., H.E. Ahles and C.R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill, N.C.
- Rees, M.D. 1989. Final Listing Rules approved for 13 Species. Endangered Species Technical Bulletin. 14, 9-10:8-9.
- Sargent, C.S. 1895. New or little-known plants – *Rhus michauxii*. Garden and Forest 8(398):404-405.
- Savage, S., M. Bucher, C. Mayes, J. Moore and R. Sutter. 1991. Preliminary results of a demographic and genetic analysis of *Rhus michauxii*. Unpublished report. 8 pp.
- Schafale, M. and A. Weakley. 1990. Classification of natural Communities of North Carolina. NC Natural Heritage Program, Raleigh, NC. 325 pp.
- Sherman-Broyles, S.L., J.P. Gibson, J.L. Hamrick, M.A. Bucher and M.J. Gibson. 1992. Comparisons of allozyme diversity among rare and widespread *Rhus* species. *Systematic Botany*, Vol. 17(4):551-559.
- Sherfy, Mark H. 1997. Working together for sumac recovery. Endangered Species Bulletin 22(1):20-21.
- Schiffer, J.E. 1999. The sumac rescue mission. Raleigh News and Observer January 17, 1999.
- Sorrie, B.A., B. VanEerden and M. J. Russo. 1997. Noteworthy Plants from Fort Bragg and Camp MacKall, North Carolina. *Castanea* 62(4):239-259.
- Stanton, T. 2009. Management Plan for the Recovery of Michaux's sumac (*Rhus michauxii* Sarg.) At Big Shoe Hill Preserve Conservation Area Scotland County, North Carolina. A report to U.S. Fish and Wildlife Service, Raleigh, NC. 18 pp.
- Thrush, L.E. 2002. Planting Site Determination Techniques for *Rhus michauxii*. M.S. Thesis. Department of Forestry, NC State University, Raleigh, NC. 52 pp.
- Townsend, J.F. 2009. Natural Heritage Resources of Virginia: Rare Plants. Virginia Department of Conservation and Recreation. Richmond, VA. 66 pp.
- USFWS . 1993. Michaux's Sumac Recovery Plan. Atlanta, Georgia: 30 pp.
- Uttall, L.J. 1984. The type localities of the Flora boreali-americana of Andre Michaux. *Rhodora* 86:1-65.
- Van Alstine, N.E. and A. Belden, Jr. 2004. An inventory for *Rhus michauxii* Sarg. (Michaux's sumac) in the southern Piedmont of Virginia. Natural Heritage Technical Report 05-02. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA.

- Van Alstine, N.E. and A. Belden, Jr. 1995. Distribution of *Rhus michauxii* of Fort Pickett, Virginia. Natural Heritage Technical Report 95-15. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA.
- Virginia Natural Heritage Program. 2011. New Michaux's sumac population. Virginia Natural Heritage E-News Summer 2011. 7 pp.
- Warren, L.E. 1910. *Rhus michauxii* – A non-poisonous plant. The American Journal of Pharmacy.
- Weakley, A. 2012. Flora of the Carolinas, Virginia, Georgia and surrounding areas. University of North Carolina, Chapel Hill.
- Willis, M.S. 2008. Status and Soil Requirements of *Rhus michauxii* in North Carolina. M.S. Thesis. Department of Forestry, NC State University, Raleigh, NC. 43 pp.
- Wilkinson, C.A., H.A. DeMarco and L.J. Jones. 1996. Report to the United States Department of the Army: Viability, germination, and propagation of *Rhus michauxii* at Fort Pickett. Blackstone (VA): Virginia Tech Southern Piedmont Agricultural Research Station.
- Yi, T.S., Miller, A.J. and Wen, J. 2004. The phylogeny and biogeographic diversification of *Rhus* (Anacardiaceae) in the Northern Hemisphere. *Molecular Phylogenetics and Evolution* 33(3):861-879.
- Yi, T.S., Miller, A.J. and Wen, J. 2007. The phylogeny of *Rhus* (Anacardiaceae) based on sequences of nuclear NIA-i3 intron and chloroplast trnC-D suggests reticulate evolution. *Systematic Botany* 32:379-391.

**APPENDIX C**  
**Summary of populations of *Rhus michauxii* (USFWS 2012).**

Parent EO No.	Previous EO No.	County	Survey Site Name	Last Observed Date	EO Rank	Owner
<b>GEORGIA</b>						
1	1	Newton	Covington Water Tower (females)	2009-06	B	City of Covington, GA
2	2	Elbert	Broad River WMA (males)	2009-06	E	USACE, leased as GA WMA
5	5	Muscogee/Chattahoochee	Columbus/Ft. Benning (historic)	1845-10	H	
6	6	Henry	Panola Mtn State Park (Safeguarding - females)	2008-02-20	E	GA State Parks
7	7	Fulton	Chattahoochee Nature Center (Safeguarding - females)	3/24/2009	E	Chattahoochee Nature Center - private
9	4	Fulton	Chattahoochee River/Fulton Co. (historic)	1900-05-28	H	
<b>NORTH CAROLINA</b>						
1	1	Franklin	Franklin Co., Norris Creek Plant Site	9/21/2006	C	
2	2	Orange	Efland, NC.	10/17/1964	X	
3	3	Wake	William B Umstead State Park.	6/23/1942	X	NC State Parks
4	4	Wilson	Bailey, NC.	1958-06	X	
5	5	Davie	Pudding Ridge Road, Farmington.	7/18/2006	D	
9	9	Robeson	Southeast of Red Springs, NC.	5/12/1993	F	
10	10	Robeson	Pretty Pond Bay.	9/11/1982	Cr	TNC
16	16	Wake	Walnut Creek Sumac Site: Barwell Road, Raleigh	6/7/2008	D	City of Raleigh
18	18	Durham	Upper Flat River/Hill Forest Macrosite, Hill Forest.	7/22/1949	Xi?	
19	19	Hoke	Fort Bragg: Southern Rockfish Creek Natural Area	7/14/1998	D	DOD
21	21	Moore	Aberdeen, NC [Not Mapped]	6/12/1901	H	
22	22	Lincoln	Lincoln County, NC [Not Mapped]	1917-PRE	H	
23	23	Franklin	Franklin Co., Southwest of Bunn.	1914-09	H	
24	24	Johnston	Johnston Co., Wayne or Bear Creek [Not Mapped]	1833-07	X	
29	29	Hoke	Fort Bragg: Piney Bottom Creek	6/2/1993	B	DOD
30	30	Hoke	Fort Bragg: Gum Branch Natural Area.	7/15/1998	C	DOD
31	31	Moore	Fort Bragg: Little River Corridor Macrosite, Northern Training Area I	9/23/1999	C	DOD
32	32	Hoke	Fort Bragg: Juniper Creek	7/22/1998	B	DOD
33	33	Hoke	Fort Bragg: Mot Commel Restoration Area	8/16/2006	AB	DOD
34	34	Hoke	Fort Bragg: Holland Drop Zone	7/22/1998	A?	DOD

Parent EO No.	Previous EO No.	County	Survey Site Name	Last Observed Date	EO Rank	Owner
			Area			
40	40	Union	Union County, NC	1794-07-21	H	
41	41	Wake	Perry Creek Forests	7/10/1997	X?	
42	42	Cumberland	Overhills Little River Terrace, Overhills Estate	5/30/1997	D	
53	53	Wake	Longleaf Restoration Area Of The Harris Research Tract	5/30/2003	Br	Progress Energy
56	56	Richmond	Hoffman Powerline / Camp Mackall Auxiliary Airfield Buffer: Parent EO	9/30/2007	A	DOD
56.14	14	Richmond	Hoffman Powerline / Camp Mackall Auxiliary Airfield Buffer: US-1, 2 miles north of Hoffman (Sub EO of Parent EO 056)	7/10/1990	D	DOD
56.15	15	Richmond	Hoffman Powerline / Camp Mackall Auxiliary Airfield Buffer: Michaux's Sumac SMA (Sub EO of EO 56).	8/17/1999	A	DOD
56.51	51	Richmond	Hoffman Powerline / Camp Mackall Auxiliary Airfield Buffer: Camp Mackall (Sub EO of EO 56)	6/30/1999	A	DOD
56.52	52	Richmond	Hoffman Powerline / Camp Mackall Auxiliary Airfield Buffer: Camp Mackall (Sub EO of EO 56)	8/24/1999	D	DOD
56.55	55	Richmond	Hoffman Powerline / Camp Mackall Auxiliary Airfield Buffer: Hoffman Powerline (Sub EO of EO 56); all plants have been removed for a NCDOT project.	9/30/2007	X	DOD
57	57	Moore	Weymouth Woods State Natural Area	8/24/2004	D	NC State Parks
59	59	Richmond	Marston Area: Parent EO	2/28/2007	B	
59.11	11	Richmond	Marston Area: Sandhills Game Land Block T, Marston Pond and Uplands (Sub EO of EO 059)	9/23/2006	B	NCWRC
59.54	54	Richmond	Marston Area: Marston Post Office (Sub EO of EO 059)	2/28/2007	B	
60	60	Wake	Schenck Memorial Forest Reintroduction Site.	2/3/2006	Dr	NCSU
61	61	Wake	William B. Umstead State Park Reintroduction Site.	2005-09	Br	NC State Parks
62	62	Durham	Hill Demonstration Forest Reintroduction Site.	2005-09	B'i	NCSU
63	63	Mecklenburg	Mecklenburg County: Latta Prairie	6/14/2005	Xi	Mecklenburg County
64	64	Mecklenburg	Mecklenburg County: Shuffletown	2006	Fi	Mecklenburg County
66	66	Scotland	Sandhills Game Land & Camp Mackall: Parent EO	9/23/2006	A	DOD, NCWRC
66.26	26	Scotland	Sandhills Game Land & Camp Mackall: Naomi Church Sandhills	9/23/2006	D	DOD, NCWRC

Parent EO No.	Previous EO No.	County	Survey Site Name	Last Observed Date	EO Rank	Owner
			(Sub EO of EO 066)			
66.27	27	Scotland	Sandhills Game Land & Camp Mackall: Beaver Dam Creek/Little Muddy Creek Natural Area (Sub EO of EO 066)	9/23/2006	AB	DOD, NCWRC
66.28	28	Scotland	Sandhills Game Land & Camp Mackall: Pea Swales (Sub EO of EO 066)	8/17/2006	D	DOD, NCWRC
66.36	36	Scotland	Sandhills Game Land & Camp Mackall: US 15-501 South of Drowning Creek Bridge (Sub EO of EO 066)	8/17/2006	AB	DOD, NCWRC
66.7	7	Scotland	Sandhills Game Land & Camp Mackall: Beaver Dam Creek/Little Muddy Creek Natural Area (Sub EO of EO 066)	7/15/1990	A	DOD, NCWRC
67	67	Scotland	Big Shoe Heel Creek Preserve	2/22/2007	Ci	NC Herp. Soc.
68	68	Scotland	Sandhills Game Land: Juniper Creek Cedar Swamps, Site I	9/14/2006	Bi	NCWRC
69	69	Scotland	Sandhills Game Land: Watery Branch Sandhills, Site F	9/14/2006	Ci	NCWRC
70	70	Wake	Marks Creek Floodplain	10/31/2007	C	Wake County Parks and Rec.
71	71	Wake	Knightdale - Milburnie Lake Headwaters	10/31/2007	C	Private
73	73	Hoke	Antioch & Vicinity: Parent EO	11/5/2005	B	
73.17	17	Hoke	Antioch & Vicinity: Antioch Bay Complex (Sub EO of EO 073)	11/13/1991	X	
73.6	6	Hoke	Antioch & Vicinity: Near Antioch, NC (Sub EO of EO 073)	11/13/1991	X?	
73.8	8	Hoke	Antioch & Vicinity: Antioch Bay Complex, Plum Thicket (Sub EO of EO 073)	11/5/2005	B	
74	74	Moore	Sandhills Game Land Block Y: Parent EO	11/8/2005	C	NCWRC
74.25	25	Moore	Sandhills Game Land Block Y: Hoffman Road (Sub EO of EO 074)	11/8/2005	D	NCWRC
74.50	50	Moore	Sandhills Game Land Block Y: North of Thunder Road (Sub EO of 074)	9/4/1997	CD	NCWRC
75	75	Richmond	Sandhills Game Land Block A, West of SR-1003: Parent EO	9/3/2008	A	NCWRC
75.20	20	Richmond	Sandhills Game Land Block A, West of SR-1003: Ellerbe Tower Lane (Sub EO of EO 075)	9/12/2006	Dr	NCWRC
75.43	43	Richmond	Sandhills Game Land Block A, West of SR-1003: Nursery Land Streamheads (Sub EO of EO 075)	9/12/2006	A?	NCWRC

<b>Parent EO No.</b>	<b>Previous EO No.</b>	<b>County</b>	<b>Survey Site Name</b>	<b>Last Observed Date</b>	<b>EO Rank</b>	<b>Owner</b>
75.44	44	Richmond	Sandhills Game Land Block A, West of SR-1003: Naked Creek Lane/Deatons Lane (Sub EO of EO 075)	5/24/2007	C	NCWRC
75.45	45	Richmond	Sandhills Game Land Block A, West of SR-1003: Naked Creek Lane (Sub EO of EO 075)	9/12/2006	CDr	NCWRC
75.45	46	Richmond	Sandhills Game Land Block A, West of SR-1003: Naked Creek Lane/Bagget Lake Lane (Sub EO of EO 075)	1998-Pre	X	NCWRC
75.48	48	Richmond	Sandhills Game Land Block A, West of SR-1003: Tower Lane/Bagget Lake Lane (Sub EO of EO 075)	9/12/2006	B	NCWRC
75.49	49	Richmond	Sandhills Game Land Block A, West of SR-1003: Bagget Lake Lane/Deatons Lane (Sub EO of EO 075)	10/29/2007	A	NCWRC
75.58	58	Richmond	Sandhills Game Land Block A, West of SR-1003: Thrower Lane (Sub EO of EO 075)	9/12/2006	B	NCWRC
75.72	72	Richmond	Sandhills Game Land Block A, West of SR-1003: Naked Creek Lane (Sub EO of EO 075)	9/3/2008	AB	NCWRC
75.82	82	Richmond	Sandhills Game Land, Block A, Bagget Lake	10/12/2011	B	NCWRC
75.83	83	Richmond	Deaton's Lane and Six Points	8/1/2012	C	NCWRC
76	76	Richmond	Sandhills Game Land Block A, East of SR-1003: Parent EO	9/12/2006	B	NCWRC
76.13	13	Richmond	Sandhills Game Land Block A, East of SR-1003: Drowning Creek (Sub EO of EO 076)	9/12/2006	B	NCWRC
76.47	47	Richmond	Sandhills Game Land Block A, East of SR-1003: Myers Lane (Sub EO of EO 076)	9/12/2006	D	NCWRC
77	77	Richmond, Scotland	Sandhills Game Land Block C: Parent EO	9/23/2006	B	NCWRC
77.12	12	Scotland	Sandhills Game Land Block C: Currie Road/Crawford Lake Road Sandhills (Sub EO of EO 077)	9/23/2006	B	NCWRC
77.35	35	Richmond	Sandhills Game Land Block C: SR 1605 Southeast of SR 1609 Junction (Sub EO of EO 077)	9/23/2006	C	NCWRC
77.37	37	Richmond, Scotland	Sandhills Game Land Block C: Crawford Lake Natural Area (Sub EO of EO 077)	9/23/2006	C	NCWRC
77.85	85	Scotland	Sandhills Game Land, Block C	8/25/2012	B	NCWRC

Parent EO No.	Previous EO No.	County	Survey Site Name	Last Observed Date	EO Rank	Owner
78	78	Scotland	Sandhills Game Land Block B, East of Hoffman Road: Parent EO	8/17/2006	B	NCWRC
78.38	38	Scotland	Sandhills Game Land Block B, East of Hoffman Road: George Drop Zone and George Drop Zone Natural Area (Sub EO of EO 078)	8/17/2006	Br	NCWRC
78.39	39	Scotland	Sandhills Game Land Block B, East of Hoffman Road: Gardner Farm Lane Woodland (Sub EO of EO 078)	8/17/2006	C	NCWRC
81	81	Nash	Middlesex Hospital Grounds	10/22/2009	C	private
86	86	Durham	Eno River Diabase Sill Plant Conservation Preserve	5/20/2014	C	NCPCP
<b>VIRGINIA</b>						
1	2,4,6	Brunswick/ Dinwiddie/ Nottoway	Fort Pickett Impact Area, Nottoway Basin	01/2003	A	DOD
3	5	Brunswick/ Nottoway	Fort Pickett Dove Field # 6, Nottoway Basin	2004	CD	DOD
7	7	Brunswick	Lake Rawlings	10/16/2003	C	railroad
8	8	Nottoway	Fort Pickett Dove Field # 6	2004	U	DOD
9	9	Brunswick	Deepwater (WBF)	2011	A	private, conservation
10	10	Dinwiddie	Turkey Egg Creek	10/11/2013	B	private, conservation

**Definitions:**

Principal EO - Principal Element Occurrence number, as assigned by the respective state Natural Heritage Program

Old EO - Element Occurrence number, as assigned by the respective state Natural Heritage Program

County – Name of the county where the occurrence is located

Survey Site Name – Name of the site, as assigned by the respective state Natural Heritage Program

EO Rank – Element Occurrence rank, as assigned by the respective state Natural Heritage Program; Definitions for EO Ranks follow NatureServe methodology (NatureServe, <http://www.natureserve.org/prodServices/eodraft/5.pdf>).

**EO Rank - Description**

A - Excellent estimated viability/ecological integrity

A? - Possibly excellent estimated viability/ecological integrity

AB - Excellent or good estimated viability/ecological integrity

AC - Excellent, good, or fair estimated viability/ecological integrity

B - Good estimated viability/ecological integrity

B? - Possibly good estimated viability/ecological integrity

BC - Good or fair estimated viability/ecological integrity  
BD - Good, fair, or poor estimated viability/ecological integrity  
C - Fair estimated viability/ecological integrity  
C? - Possibly fair estimated viability/ecological integrity  
CD - Fair or poor estimated viability/ecological integrity  
D - Poor estimated viability/ecological integrity  
D? - Possibly poor estimated viability/ecological integrity  
E - Verified extant (viability/ecological integrity not assessed)  
F - Failed to find  
F? - Possibly failed to find  
H - Historical  
H? - Possibly historical  
X - Extirpated  
X? - Possibly extirpated  
U - Unrankable  
NR - Not ranked

**EO Origin Subrank - Description**

i – introduced  
i? - possibly introduced  
r – reintroduced/restored  
r? - possibly reintroduced/restored

Last Observed Date – the date the species was last observed at this site