

Mohr's Barbara's Buttons
(Marshallia mohrii)

5-Year Review:
Summary and Evaluation



Photos by and courtesy of John Gwaltney, Southeasternflora.com.

July 2016

U.S. Fish and Wildlife Service
Southeast Region
Mississippi Field Office
Jackson, Mississippi

5-YEAR REVIEW

Mohr's Barbara's Buttons (*Marshallia mohrii*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on the best available information pertaining to historical and contemporary distributions, life histories, genetics, habitats, disturbances, and potential threats of this species. We announced initiation of this review and requested information in a published *Federal Register* notice with a 60-day comment period (75 FR 18233). In an effort to acquire the most current information available, various sources were solicited, including data housed at State natural heritage programs, internet searches, and knowledgeable individuals associated with academia, and Federal, State, and non-governmental conservation organizations. Specific sources included the final rule listing this species under the Endangered Species Act; the Recovery Plan; peer reviewed scientific publications; unpublished field observations by Federal, State, and other experienced biologists; unpublished studies and survey reports; and notes and communications from other qualified individuals. The completed draft review was sent to affected U.S. Fish and Wildlife Service field offices and three peer reviewers for review. Comments were evaluated and incorporated into this final document as appropriate (see Appendix A). We did not receive any public comments during the 60-day open comment period.

B. Reviewers

Lead Region: Southeast Region, Kelly Bibb, (404) 679-7132

Lead Field Office: Mississippi Ecological Services Field Office, M. Scott Wiggers, (601) 364-6910

Cooperating Field Offices: Daphne Ecological Services Field Office, Shannon Holbrook, (251) 441-5837; Georgia Ecological Services Field Office, Don Imm, (706) 613-9493.

C. Background:

- 1. Federal Register Notice citation announcing initiation of this review:** April 9, 2010. 75 FR 18233.
- 2. Species status:** Stable. Overall, extant populations in Alabama and Georgia are considered stable with some local populations likely increasing, while others are likely declining; however, inconsistent and infrequent monitoring range-wide hinders a detailed assessment of all sites. Further monitoring is needed at sites range-wide to better assess these trends. Similarly, while new populations and sites have been discovered in recent years—leading to an expanded range and greater number of populations than previously known—some have also been extirpated or are now considered historic.
- 3. Recovery achieved:** 1 (1–25% species recovery objectives achieved). Partial success towards achieving recovery objectives through: (a) searches for and

discoveries of new populations and colonies; (b) Federal, State, and non-profit acquisition, protection, and management of land containing Mohr's Barbara's buttons; (c) some management of the species on conservation lands; (d) limited genetic research; and (e) limited *ex situ* preservation of genetic stock.

4. Listing history

Original Listing

FR notice: 53 FR 34698

Date listed: September 7, 1988

Entity listed: Species

Classification: Threatened

5. Associated rulemakings: None.

6. Review History:

Recovery Plan: 1991

Each year, the U.S. Fish and Wildlife Service (Service) reviews and updates listed species information to benefit the required Recovery Report to Congress. Through 2013, we did a recovery data call that included showing status recommendations, such as "Stable" for this plant. We continue to show that species status recommendation in 5-year reviews. The most recent evaluation for Mohr's Barbara's Buttons was completed in 2015.

Five-year review: November 6, 1991 (56 FR 56882)

In the 1991 review, multiple species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors or threats as they pertained to each species' recovery. The notices listed these species and stated that no changes in the designation of these species were warranted at that time, including no changes to the status of Mohr's Barbara's buttons.

7. Species' Recovery Priority Number at start of review (48 FR 43098): 14

Degree of Threat: Low

Recovery Potential: High

Taxonomy: Species

8. Recovery Plan

Name of Plan: Recovery Plan for Mohr's Barbara's Buttons

Date Issued: November 26, 1991

II. REVIEW ANALYSIS

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

The Endangered Species Act (ESA) 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 DPSs to only vertebrate species of fish and wildlife. Because the species under review is a plant, the DPS policy is not applicable.

B. Recovery Criteria

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

2. Adequacy of recovery criteria.

a. Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat? No. Habitats that Mohr's Barbara's buttons occupies have been more fully described since the recovery plan was completed. Additionally, rationale for the number of protected populations required for delisting is not provided in the recovery plan; however, little progress has been made investigating the species' life history, genetics, ecology, and management requirements, thus limiting our ability to determine the minimum number of protected populations required to maintain genetic diversity and continued survival of Mohr's Barbara's buttons.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? Yes. The recovery criteria adequately address habitat destruction and degradation (via inadequate or incompatible management and encroachment of invasive species), and population loss, which continue to threaten this species.

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

The stated Recovery Objective is to delist Mohr's Barbara's buttons. Recovery criterion for considering delisting is the protection of 15 viable populations from present and foreseeable threats. At least three of these populations should be located within each of the two physiographic regions (Cumberland Plateau, Ridge and Valley) within the species' historical range. In addition, at least three of these protected populations should be within Alabama and another three in Georgia. Viability of populations will be assessed through periodic monitoring for at least a 15-year period.

The number of individuals necessary and the quantity and quality of habitat needed to meet these criteria will be determined as one of the recovery tasks. A viable population is a reproducing population that is of sufficient size and genetic variability to enable it to survive and respond to natural habitat changes (stable or increasing). These original recovery criteria were identified as preliminary and could be revised on the basis of new information.

These criteria have not been met. Progress has been made locating and protecting populations in both Alabama and Georgia, but opportunities to enhance protection and management of plants on these conservation lands still remain to be achieved.

Currently, only eight extant populations (5 entire populations and 3 partial populations) receive some protections on Federal, State, or non-governmental conservation organization lands. All of these populations occur in the Ridge and Valley (also known as, Valley and Ridge) physiographic region. No populations within the Cumberland Plateau physiographic region are known to be protected. Various other populations are located along highway and utility rights-of-way and receive some conservation considerations pursuant to sections 7 and 9 of the Endangered Species Act, but are otherwise unprotected.

Range-wide, regular monitoring of populations is inconsistent, hampering assessment of long-term population trends. Furthermore, limited progress has been made toward determining the factors required to define and sustain viable populations of this species. Some genetics work has begun to elucidate the evolutionary and phylogenetic history of the species, but little research into the life history, ecology, and management of this species has been conducted—these studies are vital to successful long-term conservation of this species. Similarly, no known demographic studies have been conducted on this species. Lack of information coupled with inconsistent and irregular monitoring limits our ability to determine the viability of any populations of Mohr's Barbara's buttons at this time.

C. Updated Information and Current Species Status

1. Biology and Habitat

The Service reviewed information on the biology and habitat of Mohr's Barbara's buttons in the species' recovery plan (Service 1991). Relevant information from the recovery plan has been included in this review.

a. New information on the species' biology and life history:

Mohr's Barbara's buttons' biology and life history remain poorly understood. However, a small-scale germination study for this species has been completed by staff of the Missouri Botanical Garden (M. Albrecht pers. comm. 2015a, b, Q. Long pers. comm. 2015a). Results of this study are not currently available. An informal study found that 90 day cold treatment is effective for germination (A. Highland pers. comm. 2015). Chafin and Owers (2010) have suggested that the species' pollinators are small insects, such as beetles and butterflies, and have further suggested that its seeds may be dispersed by small animals, such as birds; however, no studies are known that confirm the identity or importance of any of these potential pollinators or dispersal agents.

b. Abundance, population trends, demographic features, or demographic trends:

Populations

Relatively little is known about the population ecology and dynamics of Mohr's Barbara's buttons. Accordingly, it is not currently known what constitutes an ecologically discrete or viable population of this species. However, given this

lack of information, an attempt has been made to consistently define populations for the purposes of this review. Accordingly, a provisional population definition based on foraging distances of small insect pollinators—such as bees (e.g., Gathmann and Tscharntke 2002, Greenleaf *et al.* 2007)—is used herein, which are thought to be the primary pollinators of Mohr’s Barbara’s buttons. A population is defined as a plant or group of plants separated from their nearest neighbor by at least 1 mile (1.6 kilometers), which is presumed sufficiently distant to limit gene flow via pollen dispersal between these plants. This provisional population definition does not incorporate seed dispersal distance, which is poorly understood for this species. Each population may be composed of one or more local populations that are referred to as “sites” or “occurrences”, herein. The terms “occurrence” and “site”, as used herein, are used in the general sense of localized groups of plants (e.g., plants located within a single glade).

Mohr’s Barbara’s buttons is known from 28 populations, with 22 found in Alabama, 5 located in Georgia, and 1 population shared by both states. Of these 28 known populations, 19 are extant, 8 have not been relocated and are considered historical, and one is confirmed extirpated. In addition, portions of six populations have been locally extirpated or are historical. Table 1 summarizes the population distribution and status for Mohr’s Barbara’s buttons. Table 2 summarizes populations occurring on conservation lands. Figure 1 depicts the distribution of counties with Mohr’s Barbara’s buttons populations in Alabama and Georgia.

The most recent range-wide assessment of Mohr’s Barbara’s buttons was completed in 2014, following fieldwork during 2012 to 2014, by Al Schotz, botanist with the Alabama Natural Heritage Program (Schotz 2014). The survey sought to relocate and assess 47 Mohr’s Barbara’s buttons sites (together representing 24 populations) in Alabama and Georgia. Plants were only found at 34 sites (14 populations). Of the remaining 13 sites, where plants were not found, 3 sites were likely extirpated, 1 site had largely been converted to a pine plantation, 2 sites have not been observed in decades, and 1 site had been recently mowed—which may have limited Schotz’s ability to find plants there. In addition, Schotz noted that suitable habitat appears to remain in the vicinity of 6 sites where plants were not observed. Schotz ranked the extant sites as *A* (excellent), *B* (good), *C* (marginal), or *D* (poor) based on population quality, condition, viability, and defensibility (a qualitative assessment of the presumed ability for a given site to be protected from “extrinsic human factors” [Schotz 2014]). Of these extant sites, only one (approximately 3%) was assigned the rank of *A* (which occurs on lands owned and managed by The Nature Conservancy [TNC] in Bibb County, Alabama), seven (21%) received *B* ranks, 18 (53%) were ranked as *C*, and eight (24%) were ranked as *D*. Of the 4 populations not included in Schotz’s survey, 1 was discovered in 2012 (A. Schotz pers. comm. 2015), 2 were discovered in 2014 (Tennessee Valley Authority [TVA] 2015), and 1 was identified in 2009 (Alabama Army National Guard [AANG] 2015). All of these populations are considered extant.

Schotz (2014) estimated the total range-wide population to be up to 6,740 individuals. Additional recent survey data from some of these sites and other sites not visited by Schotz in Alabama (e.g., AANG 2015, TVA 2015) suggests that this estimate is low; however, 2015 surveys by Malcolm Hodges (pers. comm. 2015) did not relocate plants at three small sites in Georgia where Schotz had previously found them. Together, this recent survey data suggests that the range-wide Mohr's Barbara's buttons population size may approach 10,000 plants (Schotz 2014, AANG 2015, M. Hodges pers. comm. 2015, TVA 2015). Individual sites may range from fewer than 20 plants to well over 1,000 (Schotz 2014, AANG 2015, TVA 2015); although, most (27 [79%]) of the 34 extant sites surveyed by Schotz support 200 or fewer plants. Furthermore, two-thirds of the plants encountered during Schotz's surveys were found at only seven sites. Additionally, Schotz noted that at a given site, plants may be clustered in areas of approximately 50 square feet or can be scattered across several acres, which is similar to observations made by others (i.e., AANG 2015, TVA 2015).

Accurate assessment of Mohr's Barbara's buttons populations is hindered by inadequate monitoring, which is inconsistent and infrequent across its range, and, to a lesser extent, is complicated by the use of inconsistent terms to describe local populations. Various terms have been used to describe populations, including "plants", "individuals", and "clumps" (e.g., Allison 1993, 1995, Schotz 2014, TVA 2015). The definition of "plants" and "individuals" is ambiguous in these sources and may refer to stems, basal rosettes, or some other entity, such as flower heads. At least one source (AANG 2015, L. Nerem Storino pers. comm. 2015b) equates numbers of flower heads with numbers of plants, which complicates assessments of the actual population sizes for these monitored sites due to the likely presence of multiple flower heads on individual plants (typically 2–5, but up to 10 flower heads per plant) (cf. Kral 1983, Watson 2006). While it is not certain what "clumps" refers to, it is presumed that the term likely refers to clusters or groups of stems. Standardization of terminology used to describe and monitor populations should eliminate or minimize potential future confusion, while facilitating assessment and comparison of populations.

State Population Summaries

Alabama

Five populations of Mohr's Barbara's buttons have been found in Bibb County and support more than 2,800 plants (Schotz 2014). Most of the sites in the County where location data is available are apparently still in existence; however, some sites, which represent portions of three populations, have not been observed in over 20 years and are considered historical (Allison 1993, Schotz 2014, C. Hansen pers. comm. 2015). Most of Bibb County's known sites occur on private property with no known formal protections. However, portions of two populations are found on conservation lands owned and managed by TNC (Kathy Stiles Freeland Bibb County Glades Preserve) and by the Service (Cahaba River National Wildlife Refuge [NWR]), which, together protect over 1,500 plants (Schotz 2014). One of these two

populations extends onto both TNC's Preserve and the Service's NWR, but both populations also extend onto unprotected properties.

While six populations of Mohr's Barbara's buttons have been found in Cherokee County, only three are considered to be extant. Additionally, a portion of one these extant populations has not been relocated since it was discovered. The easternmost population within Cherokee County is part of a larger population that traverses the Alabama–Georgia state line into neighboring Floyd County, Georgia (2012 collection by D. Estes No. 11621 stored at Austin Peay State University Herbarium, Clarksville, Tennessee; Schotz 2014, C. Hansen pers. comm. 2015).

Three populations of Mohr's Barbara's buttons occur in Calhoun County, where it is only known from the AANG Ft. McClellan Army National Guard Training Center (Ft. McClellan). The species was originally discovered on the installation in 1993 along the margins of an ephemeral stream, but several additional sites have since been discovered (AANG 2011). Most of the known plants on the installation are scattered along wet to dry roadsides (Schotz 2014). Management and protection of the species on Ft. McClellan is detailed in AANG's Integrated Resource Management Plan (INRMP) (AANG 2011) and Endangered Species Management Plan (ESMP) (AMEC Earth and Environmental, Inc. 2002). Some sites with Mohr's Barbara's buttons have been designated Special Interest Natural Areas (SINA) and receive additional protections (e.g., signage, restricted vehicle access) and management considerations. Management of most sites involves a restricted mowing schedule and/or application of prescribed fire. Additionally, most sites are monitored annually (via flower head counts) as they are discovered, but access restrictions due to the presence of unexploded ordnance at one site have prevented monitoring for over 10 years (AANG 2011, L. Nerem Storino pers. comm. 2015a). Given such access restrictions and the limitations of flower head counts for estimating population size, Ft. McClellan may have supported at least 1,480 plants in 2014 (assuming 5,181 flower heads [AANG 2015] and 3.5 heads per plant). Overall, this flower head count data (which acts as a rough proxy for actual population size) indicates that the Mohr's Barbara's buttons populations are likely stable to increasing at Ft. McClellan because of protective management measures that have been put in place there.

In 2014, Mohr's Barbara's buttons was discovered in Jefferson County along a Tennessee Valley Authority (TVA) electrical transmission right-of-way (Schotz 2014, TVA 2015). Three populations (each separated by at least a mile) are found spread along nearly 4 miles of this right-of-way. Together, these TVA populations may support around 2,000 Mohr's Barbara's buttons plants; however, no definition of "plants" was provided by TVA 2015.

The species was also rediscovered in Walker County in 2012 at a previously unknown site (A. Schotz pers. comm. 2015), which represents the one extant population known for this County. Two other populations within the County

have not been relocated since their discoveries in the 1970s and 1980s (Schotz 2014) and they are now considered to be historical occurrences.

Three counties within the state previously had documented populations of Mohr's Barbara's buttons—Cullman, Blount, and Etowah—but repeated searches have been unable to relocate these populations and all are considered historical. In particular, the species has not been found in Cullman County since the late 1800s and has not been relocated in Blount County since 1998 (Schotz 2014, C. Hansen pers. comm. 2015). One population in Etowah County, discovered in 1994, is thought to have been extirpated by logging operations (Schotz 2014, D. Spaulding pers. comm. 2015).

Georgia

In Georgia, Mohr's Barbara's buttons is currently only found in Floyd County (Schotz 2014). Six populations have been found in Floyd County, one of which crosses into neighboring Cherokee County, Alabama. One of the County's populations has not been relocated in recent years and is considered historical. Together, the five extant populations have a total estimated population of nearly 4,000 plants (Schotz 2014, M. Hodges pers. comm. 2015). Malcolm Hodges (pers. comm. 2015) was unable to relocate plants at three of the sites visited by Schotz (2014), but also located three additional sites not reported by Schotz. It is unknown why plants at some sites were not relocated, but Hodges suggested revisiting them following fire. Most of these populations were discovered in the 1990s (e.g., Allison 1995, Govus 1999, Ware 1999).

Of Floyd County's known Mohr's Barbara's populations, several are located on state-owned and managed properties or on privately owned conservation lands. Conservation lands in Floyd County include Berry College WMA (home to two extant and one historical population) and a conservation easement on timber lands held by TNC, which protects part of one larger population (Schotz 2014, M. Hodges pers. comm. 2015). Together, these conservation lands afford protection to nearly 4,000 plants (Schotz 2014, M. Hodges pers. comm. 2015).

c. Genetics, genetic variation, or trends in genetic variation:

Genetics of Mohr's Barbara's buttons has received limited attention. Much of the genetics work that has been completed to date on the species has been conducted primarily to elucidate the phylogenetic relationships of species within the genus *Marshallia* and the family Asteraceae (e.g., Watson and Estes 1990, Watson *et al.* 1991, Goertzen and Hansen 2014, Hansen and Goertzen 2014, Melton 2015). A recent genetic study by Hansen and Goertzen (2014) found a close affinity between *M. mohrii* and *M. trinervia* (broadleaf Barbara's buttons), which supports Watson *et al.*'s (1991) earlier hypothesis that *M. mohrii* may have derived from *M. trinervia* and *M. grandiflora* (large-flowered Barbara's buttons). Melton (2015) found similar evidence to support this hypothesis, but noted that *M. mohrii*

also has a variety of unique alleles not found in either of these putative parent species. Watson's (2006) later suggestion that *M. mohrii* derived from *M. grandiflora* and *M. graminifolia* ssp. *tenuifolia* (grassleaf Barbara's buttons) does not appear to be supported by these more recent studies, however. Goertzen and Hansen's (2014) recent studies provide important insights into the genetics of *M. mohrii* and its close relatives and, as the researchers note, much yet remains to be gleaned from this dataset. Despite these recent studies, conservation genetics of this species remains poorly understood and much work in this area remains to be done. Such genetic work is needed to, among other things, determine genetic diversity of the species and of individual populations, determine effective population sizes, and better assess the potential risks of small population sizes on population persistence and viability of Mohr's Barbara's buttons.

d. Taxonomic classification or changes in nomenclature:

The taxonomy of *Marshallia mohrii* was reviewed by the Service for both the listing document (53 FR 34698) and recovery plan (Service 1991). The taxon is currently recognized as valid by the Integrated Taxonomic Information System (ITIS) (ITIS 2015), as well as national and regional floras (e.g., *Flora of North America* [Watson 2006] and *Flora of the Southern and Mid-Atlantic States* [Weakley 2015]).

While the taxonomic status of this species is not affected, some authors use the alternate common name Coosa Barbara's-buttons (e.g., Noss 2012, Spaulding 2013, Weakley 2015) rather than Mohr's Barbara's buttons used by the Service and others (e.g., Chafin 2007, ITIS 2015, NatureServe 2015).

e. Spatial distribution, trends in spatial distribution, or historic range:

The species' confirmed range spans approximately 150 miles from central Alabama's Bibb County to northwestern Georgia's Floyd County (see Fig. 1 and Table 1). In Alabama, the species is known historically from eight counties (Bibb, Blount, Calhoun, Cherokee, Cullman, Etowah, Jefferson, and Walker), but has not been observed in Blount, Cullman, or Etowah Counties since the initial discoveries of these populations (Schotz 2014, pers. comm. 2015, C. Hansen pers. comm. 2015). Georgia's only confirmed populations occur in Floyd County (Patrick *et al.* 1995, Schotz 2014) and continued searches have discovered previously unknown occurrences within the county, extending the species' range further northeast (Allison 1995, Govus 1999, Ware 1999).

Mohr's Barbara's buttons was reputedly collected in Walker County, Georgia, during the late 1800s, but further investigation has shown this record to be erroneous (Allison 1995, Patrick *et al.* 1995). Similarly, both NatureServe (2015) and U.S. Department of Agriculture's (USDA) PLANTS Database (USDA 2015) indicate that Mohr's Barbara's buttons occurs or has occurred in Florida, but these accounts are erroneous (A. Jenkins pers. comm. 2015).

f. Habitat or ecosystem conditions:

Mohr's Barbara's buttons is often found within open to partially shaded graminoid-dominated (grasses and grass-like species [e.g., sedges]) habitats within the Ridge and Valley (alternatively referred to as "Valley and Ridge") and Cumberland Plateau physiographic regions (Fig. 1). The species can be found along a variety of roadsides and utility rights-of-way, along stream margins, and within open woodlands, prairies, and barrens in Alabama and Georgia. Habitats where the species occurs typically have mesic to moist soils, but some tend to be comparatively dry (Schotz 2014). Additionally, the U.S. Army Corps of Engineers (USACE) (2014) *National Wetland Plant List* designates Mohr's Barbara's buttons as a Facultative Wetland (FACW), which indicates that the species "[u]sually occur[s] in wetlands, but may occur in non-wetlands" (Lichvar *et al.* 2012).

Two habitats supporting Mohr's Barbara's buttons have received increased attention in recent years: Ketona Dolomite Glades and Coosa Valley prairies.

Ketona Dolomite Glades

In Bibb County, Alabama, Mohr's Barbara's buttons' colonies are typically associated with Ketona dolomite glade habitats, an exceedingly rare habitat—found nowhere else—that support a diverse assemblage of plants (Allison 1993, Allison and Stevens 2001) and have been variously described as a "botanical lost world" (Allison 1994), "magic rock garden" (Mohlenbrock 2009), and "botanical discovery of the century" (Garland 2008). Additionally, Ketona dolomite glades are home to numerous rare, imperiled, and endemic plant species (Allison 1994, Allison and Stevens 2001, Garland 2008, Mohlenbrock 2009, Diggs 2013).

Ketona dolomite glades are characterized by dry, shallow soils derived from the weathering of Ketona dolomite (dolostone) bedrock, which is a magnesium-rich sedimentary rock similar to limestone (Allison 1994, Lacefield 2013). High magnesium and calcium contents of these bedrocks have resulted in moderately alkaline soils (pH 7.4–7.6) (Allison 1994, Garland 2008). Allison and Stevens (2001) noted that Ketona dolomite glades are similar to cedar glades found elsewhere in the southeastern U.S.; whereas, Lawless *et al.* (2006) have suggested that these glades are a subclass of "xeric limestone prairies".

Observations by Dr. Quinn Long (pers. comm. 2015a) indicate that Mohr's Barbara's buttons is often found in deeper soils along the margins of these glades or in small "pockets" of deeper soils within the glades. These observations are similar to those of Diggs (2013), who noted the species growing in deeper soils of a glade's downslope end. These deeper soils may ameliorate the otherwise harsh conditions (e.g., high temperatures and low soil moisture) associated with these habitats. Indeed, glade temperature monitoring data near one of these occurrences indicate that soil temperatures can reach 122°F (50°C) near the surface (preliminary data provided by

Missouri Botanical Garden's Dr. Adam Smith [pers. comm. 2015]). Additional study is needed to investigate this putative relationship.

Both the Service and TNC recognized the need to protect Bibb County's rare habitats and have established the Cahaba River NWR (Service 2007) and Kathy Stiles Freeland Bibb County Glades Preserve (TNC 2012, 2015), which together protect portions of two Mohr's Barbara's buttons populations. Remaining populations within the county occur on private lands.

Coosa Valley Prairies

Mohr's Barbara's buttons can be found in Coosa Valley prairies of Georgia. These prairies are calcareous, grass-dominated habitats growing within the Coosa River Valley and are home to a variety rare plant species (Noss 2012, Duncan 2013, Edwards *et al.* 2013). This rare ecosystem was only recently described and was once more prevalent within the Coosa River Valley—occurring in both Alabama and Georgia—however, prairies were apparently destroyed during the early 1800s and the habitat is now restricted to Floyd County, Georgia (Duncan 2013). Within this ecosystem, Mohr's Barbara's buttons tends to be found in the wetter prairies (Edwards *et al.* 2013). Today, TNC holds a conservation easement on commercial timber lands that protects nearly 1,000 acres of this rare habitat in Floyd County, Georgia, which affords protection to a portion of one the County's populations (Duncan 2013, Schotz 2014).

Associated Species

Mohr's Barbara's buttons has been found in association with numerous species, including various locally rare or uncommon plant species, including: *Coreopsis delphiniifolia* (larkspur tickseed), *Prenanthes barbata* (barbed rattlesnakeroot), *Rhynchospora thornei* (Thorne's beakrush or beaksedge), *Schoenolirion croceum* (yellow sunnybell), and *Silene regia* (royal catchfly), as well as the federally listed, endangered *Xyris tennesseensis* (Tennessee yellow-eyed grass) and *Helianthus verticillatus* (whorled sunflower) (Allison 1993, Moffett 2008, Schotz 2014, TVA 2015).

Fire

Fire may help maintain the open conditions favored by this species in some habitats (Kral 1983, Patrick *et al.* 1995, Schotz 2014). Indeed, Allison (1995) suggested that historical fire suppression contributed to the species' decline in Georgia. A small study by Duncan *et al.* (2008) in Ketona dolomite glades of Bibb County, Alabama, found no effect of fire on Mohr's Barbara's buttons densities, but did find a decline in tree populations following experimental fires. These results imply that fire limits encroachment of woody species into these systems. Therefore, fires may not directly benefit this species; rather, it is fire's ability to maintain open habitats that likely indirectly benefits Mohr's Barbara's buttons, as has been suggested by others (e.g., Patrick *et al.* 1995, Schotz 2014).

In the absence of fire, frequent mowing can also maintain similarly favorable conditions, such as within utility and road rights-of-way (e.g., Schotz 2014, TVA 2015).

g. Other:

Ex Situ Conservation Efforts

Various botanic gardens and arboretums in the southeastern U.S. maintain Mohr's Barbara's buttons plants in *ex situ* (off-site) cultivation as part of safeguarding and/or educational efforts (e.g., Atlanta Botanical Garden [R. Determann pers. comm. 2015], Auburn University's Donald E. Davis Arboretum [P. Thompson pers. comm. 2015], Chattahoochee Nature Center [H. von Schmeling pers. comm. 2015], State Botanical Garden of Georgia [J. Ceska pers. comm. 2015]). At least two gardens outside of the Southeast are also participating in *ex situ* conservation of this species: Missouri Botanical Garden in St. Louis, Missouri maintains a small seed bank and live plant collection (M. Albrecht pers. comm. 2015a, Q. Long pers. comm. 2015b) and Mt. Cuba Center in Delaware maintains a small live plant collection (A. Highland pers. comm. 2015). Most of these *ex situ* collections are limited in scope and represent only one or a few populations and are predominantly represented by plant material from Bibb County, Alabama and Floyd County, Georgia.

2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

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

Destruction and Degradation of Habitat

Clearing, conversion, and agricultural activities remain persistent threats to various Mohr's Barbara's buttons' occurrences (Schotz 2014). Nearly one-third (11 of 34) of extant sites Schotz (2014) surveyed have been converted to pine plantations and/or had been impacted by recent timber harvests. In addition, logging is thought to have extirpated Etowah County, Alabama's only known population (Schotz 2014, D. Spaulding pers. comm. 2015), while conversion to row crop agricultural field has likely extirpated one population in Cherokee County, Alabama (Schotz 2014).

Suitable habitat for Mohr's Barbara's buttons remains vulnerable to loss. As described above, most Coosa Valley prairies are thought to have been lost since the early 1800s with the only known remnants of this habitat currently located in Floyd County, Georgia (Duncan 2013). Similarly, Bibb County, Alabama's Ketona dolomite glades are unique and exceedingly rare habitats and are vulnerable to damage by recreational uses and adjacent logging activities. Schotz (2014) noted damage to two glades by recreational traffic (e.g., ATV use) and logging damage or vulnerability of two others. Construction of a borrow pit is thought to have reduced available habitat for one site in Floyd County, Georgia

(Schotz 2014). Furthermore, development and associated habitat destruction are projected to continue for decades to come throughout the southeastern United States (Stein *et al.* 2010), which could further encroach upon and limit habitat suitable for Mohr's Barbara's buttons.

Inadequate/Incompatible Habitat Management

An important threat to Mohr's Barbara's buttons' continued survival is incompatible and inadequate land management. While the species is apparently able to survive certain types of forestry practices (e.g., limited timber harvesting that opens up the canopy), its apparent inability to tolerate heavy shading likely increases its susceptibility to practices that promote vegetation succession and encroachment of invasive species (e.g., fire suppression). Fire may be an important mechanism for maintaining the open character of some of Mohr's Barbara's buttons habitats. Inadequate fire regimes threaten some occurrences by allowing competing vegetation—particularly hardwoods—to grow unchecked, thereby encroaching upon available habitat for Mohr's Barbara's buttons and reducing availability of resources (e.g., light) that the species requires to survive and thrive (Patrick *et al.* 1995, Schotz 2014). Fire exclusion was noted as a primary threat to 24% of sites surveyed by Schotz (2014), whereas succession was considered a threat to 29%.

Highway and utility rights-of-way are currently home to various Mohr's Barbara's buttons sites. The known extent of three extant populations are restricted to a TVA utility right-of-way (in Jefferson County, Alabama), whereas portions of at least six other populations occur in either utility or road rights-of-way (Allison 1993, Schotz 2014, M. Hodges pers. comm. 2015). As such, these sites are heavily dependent upon compatible management regimes to maintain healthy populations (e.g., Schotz 2014, AANG 2015, TVA 2015). Mohr's Barbara's buttons is particularly vulnerable to herbicides and incompatible mowing regimes within its habitats; however, appropriate mowing regimes may also serve as valuable conservation tools in these areas (Schotz 2014). Schotz (2014) noted that nearly one-third of all sites surveyed were vulnerable to incompatible management regimes within rights-of-way throughout the species' range. Furthermore, at least one site along a road right-of-way in Cherokee County, Alabama is thought to have been extirpated by incompatible management (Schotz 2014). Additional emphasis on reintroducing fire or fire surrogates (e.g., mowing) is needed to promote healthy populations and maintain open conditions that this species requires.

- b. Overutilization for commercial, recreational, scientific, or educational purposes:** Not known to threaten this species. However, the species is attractive and collection for horticultural trade may pose a future threat, which needs to be monitored.
- c. Disease or predation:** Not known to threaten this species.

- d. Inadequacy of existing regulatory mechanisms:** Mohr's Barbara's buttons is a State threatened plant in Georgia (Patrick *et al.* 1995) and, therefore, receives State protection from non-permitted collection and sale; however, State law does not provide protection against habitat destruction in Georgia. Collection of this species on public lands without a permit is prohibited in Georgia under the Georgia Wildflower Preservation Act of 1973, O.C.G.A. 12-6-170. No such provisions are afforded to plants found on privately owned lands in the State. The species does not receive any specific legal protections from State laws or regulations in Alabama.
- e. Other natural or manmade factors affecting its continued existence:**

Invasive Species

During the most recent range-wide survey, Schotz (2014) noted that invasive species are a potential threat to some Mohr's Barbara's buttons populations. Indeed, Schotz (2014) observed encroachment of exotic invasive plants species at 14 Mohr's Barbara's buttons sites. These species—predominantly Chinese privet (*Ligustrum sinense*)—left unchecked have the potential to degrade habitat quality and out-compete Mohr's Barbara's buttons for resources (e.g., moisture, nutrients, light, and recruitment sites). Currently, threats posed from invasive plants at most sites appears to be minimal (Schotz 2014); however, habitat management (e.g., fire, mechanical or hand thinning, etc.) may be required to control invasive species where they threaten Mohr's Barbara's buttons.

Small Population Size

Most extant populations of Mohr's Barbara's buttons are comprised of a number of small, fragmented occurrences. While population sizes (i.e., number of plants obtained from counts or estimates) are not available for all sites/populations of Mohr's Barbara's buttons, the most recent range-wide status assessment by Schotz (2014) found that most sites had small local population sizes and that most of the range-wide population was contained in only a few sites with comparatively large local populations. Indeed, Schotz found that 53% (18 of 34) of extant sites had local populations of ≤ 100 individuals and 79% (27 of 34) of these sites had ≤ 200 individuals. Together, sites with ≤ 200 individuals accounted for about one-third of the total population evaluated by Schotz. By contrast, only three sites evaluated were found to have 500 or more plants, which accounted for nearly half of the entire population evaluated range-wide. Small population sizes increase the vulnerability of individual sites to environmental and anthropogenic perturbations and chance events. In addition, small population sizes increase the risks posed by inbreeding and genetic drift, which may limit the species' adaptive capacity and ability to cope with future stressors (Ellstrand and Elam 1993).

Climate Change

The precise magnitude and impacts of climate change on the southeastern United States are uncertain, but models have projected that climate change in the region

may include increased temperatures of 2 to 4°C (3.6 to 7.2°F) accompanied by reduced average annual precipitation by the end of the century (Joyce *et al.* 2011). Specific impacts of climate change on populations of Mohr's Barbara's buttons are poorly understood; however, a variety of impacts are possible. Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins *et al.* 2008). Davenport (2007) suggested that Mohr's Barbara's buttons may be negatively impacted by climate change within Alabama as available habitat becomes constricted. In addition, climate change may disrupt plant-pollinator interactions via phenological shifts in flowering and/or pollinator activity (Memmott *et al.* 2007, Hawkins *et al.* 2008), which may thereby reduce sexual reproduction of Mohr's Barbara's buttons. While disease is not currently known to threaten Mohr's Barbara's buttons, climate change has the potential to promote the spread of infectious diseases among plants, particularly if arthropod vectors become more widespread and abundant (Anderson *et al.* 2004, Garrett *et al.* 2006, Hawkins *et al.* 2008). Given the variety and complexity of climate change's potential effects (cf. Hawkins *et al.* 2008, Walther 2010), more research is needed to assess its potential long-term impacts on Mohr's Barbara's buttons populations and habitats.

D. Synthesis

Many of the threats to Mohr's Barbara's buttons when the species was listed still remain. In particular, inadequate land management and associated encroachment of competing vegetation threaten the species by degrading habitat suitability. Additionally, at least one population has been extirpated by incompatible silvicultural activities in recent years. The most recent range-wide status assessment ranked over three-quarters of extant sites evaluated to be of marginal to poor overall status and also found that most (79% extant sites) of these local populations were small (≤ 200 individuals).

New populations have been discovered in Alabama and Georgia since the Mohr's Barbara's buttons was listed, increasing the number of known populations and expanding the species' known range. Of the species' 28 known populations, 19 (68%) are extant and 9 (32%) are historical (8) or extirpated (1). In addition, portions of 6 extant populations (or 32% of extant populations) have been locally extirpated or are historical. Individual sites have been extirpated by timber harvesting, conversion to row crop agriculture, and incompatible habitat management.

Most occurrences of Mohr's Barbara's buttons receive no protections or conservation considerations. Currently, only 8 extant populations and portions of populations receive some protections (e.g., protection from habitat loss, habitat management) on Federal, State, and non-governmental conservation organization lands. However, this does not meet the recovery criteria of 15 populations receiving permanent protection.

While progress has been made toward recovery of this species, inadequate and inconsistent monitoring of Mohr's Barbara's buttons occurrences hampers long-term assessment of population trends, management activities, and recovery efforts for this

species. Coupled with the presence of persistent threats, the species continues to meet the definition a threatened species.

III. RESULTS

A. Recommended Classification:

X No change is needed

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed.
- Conduct studies to determine the number and distribution of populations required to maintain the species' genetic diversity.
- Investigate metapopulation structure and dynamics of the species.
- Conduct studies into the species' life history, biology, and ecology.
- Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods.
- Update the species' recovery plan to reflect current knowledge (e.g., distribution, habitats) and needs (e.g., data/knowledge deficiencies, management).

V. REFERENCES

- Alabama Army National Guard (AANG). 2011. Updated Integrated Natural Resources Management Plan and Record of Environmental Consideration. Fort McClellan Army National Guard Training Center, Pelham Range and the Main Enclave, Calhoun County, Alabama. Alabama Army National Guard, Environmental Branch, Anniston, AL. 151 pp. + appendices.
- Alabama Army National Guard (AANG). 2015. *Marshallia mohrii* monitoring data for Fort McClellan Army National Guard Training Center. Alabama Army National Guard, Environmental Branch, Fort McClellan Army National Guard Training Center, Anniston, AL. 15 January 2015.
- Albrecht, M. 2015a. Conservation Ecologist, Center for Conservation and Sustainable Development, Missouri Botanical Garden, St. Louis, MO. E-mail to M. Wiggers and Q. Long RE: *Marshallia mohrii* seed banking and germination study at Missouri Botanical Garden. 22 January 2015.
- Albrecht, M. 2015b. Conservation Ecologist, Center for Conservation and Sustainable Development, Missouri Botanical Garden, St. Louis, MO. E-mail to M. Wiggers and Q. Long RE: *Marshallia mohrii* seed germination study and live plant collection at Missouri Botanical Garden. 22 January 2015.
- Allison, J.R. 1993. Status of three Federal listed plants in Bibb County, Alabama. Unpublished report for U.S. Fish and Wildlife Service. 10 pp. + appendices.
- Allison, J.R. 1994. A botanical "lost world" in central Alabama. In Proceedings of the North American Conference on Savannas and Barrens. In: J.S. Fralish, R.C. Anderson, J.E.

- Ebinger, and R. Szafoni, eds. Proceedings of the North American conference on Savannas and Barrens. U.S. Environmental Protection Agency, Great Lakes National Program Office, Chicago, IL. pp. 323-327. Available at: <http://www.epa.gov/greatlakes/ecopage/oak-savanna-conference-1994/proceedings/Allison.html>.
- Allison, J.R. 1995. The status of *Marshallia mohrii* Beadle & F.E. Boynton in Georgia. Unpublished report for the U.S. Fish and Wildlife Service. 15 pp.
- Allison, J.R., and T.E. Stevens. 2001. Vascular flora of Ketona dolomite outcrops in Bibb County, Alabama. *Castanea* 66:154-205.
- AMEC Earth and Environmental, Inc. 2002. Endangered Species Management Plan for the Fort McClellan Army National Guard Training Center, Calhoun County, Alabama. Prepared for the Alabama Army National Guard. 34 pp. + appendices.
- Anderson, P.K., A.A. Cunningham, N.G. Patel, F.J. Morales, P.R. Epstein, and P. Daszak. 2004. Emerging infectious diseases of plants: pathogen pollution, climate change and agrotechnology drivers. *Trends in Ecology and Evolution* 19:535-544.
- Ceska, J. 2015. Conservation Coordinator, State Botanical Garden of Georgia, University of Georgia, Athens, GA. E-mail to M. Wiggers and R. Determann RE: *Marshallia mohrii* live plant collection at State Botanical Garden of Georgia. 24 June 2015.
- Chafin, L.G. 2007. Field guide to the rare plants of Georgia. State Botanical Garden of Georgia, Athens, GA. 526 pp.
- Chafin, L., and K. Owers. 2010. *Marshallia mohrii*. Available at: http://www.georgiawildlife.com/sites/default/files/uploads/wildlife/nongame/pdf/accounts/plants/marshallia_mohrii.pdf
- Davenport, L.J. 2007. Climate change and its potential effects on Alabama's plant life. Department of Biological and Environmental Sciences, Samford University, Birmingham, AL. 75 pp.
- Determann, R. 2015. Conservatory and Conservation Director, Atlanta Botanical Garden, Atlanta, GA. E-mail to M. Wiggers RE: *Marshallia mohrii* live plant collection at Atlanta Botanical Garden. 22 June 2015.
- Diggs, J.T. 2013. The evolution and phylogeography of a glade-restricted species of prairie clover (*Dalea cahaba* J. Allison) from Bibb County, Alabama: a molecular approach. Ph.D. Dissertation. University of Alabama at Birmingham, Birmingham, AL. 118 pp.
- Duncan, R.S. 2013. Southern wonder: Alabama's surprising biodiversity. University of Alabama Press, Tuscaloosa, AL. 436 pp.
- Duncan, R.S., C.B. Anderson, H.N. Sellers, and E.E. Robbins. 2008. The effect of fire reintroduction on endemic and rare plants of a southeastern glade ecosystem. *Restoration Ecology* 16:39-49.
- Edwards, L., J. Ambrose, and L.K. Kirkman. 2013. The natural communities of Georgia. University of Georgia Press, Athens, GA. 675 pp.
- Ellstrand, N.C., and D.R. Elam. 1993. Population genetic consequences of small population size: implications for plant conservation. *Annual Review of Ecology and Systematics* 24:217-242.

- Garland, B. 2008. Bibb County glades: botanical discovery of the century. *Outdoor Alabama* 80(2):6-11.
- Garrett, K.A., S.P. Dendy, E.E. Frank, M.N. Rouse, and S.E. Travers. 2006. Climate change effects on plant disease: genomes to ecosystems. *Annual Review of Phytopathology* 44:489-509.
- Gathmann, A., and T. Tschardt. 2002. Foraging ranges of solitary bees. *Journal of Animal Ecology* 71:757-764.
- Goertzen, L., and C. Hansen. 2014. Origin and evolution of *Marshallia mohrii*. Unpublished report for U.S. Fish and Wildlife Service, Jackson, MS. 5 pp.
- Govus, T.E. 1999. Survey for *Clematis socialis* and significant calcareous flatwoods. Unpublished report for the Georgia Natural Heritage Program. 12 pp.
- Greenleaf, S.S., N.M. Williams, R. Winfree, and C. Kremen. 2007. Bee foraging ranges and their relationship to body size. *Oecologia* 153:589-596.
- Hansen, C. 2015. Plants Collections Manager, Museum of Natural History, Auburn University, Auburn, AL. E-mail to M. Wiggers RE: *Marshallia mohrii* herbarium records. 21 January 2015.
- Hansen, C.J., and L.R. Goertzen. 2014. Validation of nrDNA ITS as a DNA barcode for *Marshallia* (Asteraceae). *Paysonia* 3:5-10.
- Hawkins, B., S. Sharrock, and K. Havens. 2008. Plants and climate change: which future? Botanic Gardens Conservation International, Richmond, UK. 96 pp.
- Highland, A. 2015. Director of Collections, Mt. Cuba Center, Hockessin, DE. E-mail to M. Wiggers RE: *Marshallia mohrii* collection, conservation, and outreach efforts. 20 August 2015.
- Hodges, M. 2015. Director of Stewardship, The Nature Conservancy, Atlanta, GA. E-mail to M. Moffett RE: Updated *Marshallia mohrii* population data. Attachment. 27 October 2015.
- Integrated Taxonomic Information System (ITIS). 2015. Integrated Taxonomic Information System [on-line database]. Available at <http://www.itis.gov>. Accessed 22 June 2015.
- Lacefield, J. 2013. Lost worlds in Alabama rocks: a guide to the state's ancient life and landscapes. The Alabama Museum of Natural History, University of Alabama, Tuscaloosa, AL. 276 pp.
- Jenkins, A. 2015. Senior Botanist, Florida Natural Areas Inventory, Tallahassee, FL. E-mail to M. Wiggers RE: *Marshallia mohrii* in Florida. 25 June 2015.
- Joyce, L.A., D.T. Price, D.W. McKenney, R.M. Siltanen, P. Papadopol, K. Lawrence, and D.P. Coulson. 2011. High resolution interpolation of climate scenarios for the coterminous USA and Alaska derived from general circulation model simulations. Gen. Tech. Rep. RMRS-GTR-263, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO. 87 pp.
- Kral, R. 1983. A report on some rare, threatened, or endangered forest-related vascular plant of the South. U.S. Department of Agriculture, Forest Service, Technical Publication R8-TP2, pp. 1203-1206.

- Lawless, P.J., J.M. Baskin, and C.C. Baskin. 2006. Xeric limestone prairies of the Eastern United States: review and synthesis. *The Botanical Review* 72:235-272.
- Lichvar, R.W., N.C. Melvin, M.L. Butterwick, and W.N. Kirchner. 2012. National Wetland Plant List indicator rating definitions. ERDC/CRREL TN-12-1. U.S. Army Corps of Engineers, Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH. 7 pp.
- Long, Q. 2015a. Conservation Ecologist, Center for Conservation and Sustainable Development, Missouri Botanical Garden, St. Louis, MO. E-mail to M. Wiggers and M. Albrecht RE: *Marshallia mohrii* seed banking and germination study at Missouri Botanical Garden. 22 January 2015.
- Long, Q. 2015b. Conservation Ecologist, Center for Conservation and Sustainable Development, Missouri Botanical Garden, St. Louis, MO. E-mail to M. Wiggers and M. Albrecht RE: *Marshallia mohrii* live plant collection at Missouri Botanical Garden. 23 January 2015.
- Melton, A.E. 2015. Molecular evolutionary and functional genomic studies of *Marshallia* (Asteraceae) utilizing next generation sequencing technology. M.S. Thesis. Auburn University, Auburn, AL. 73 pp.
- Memmott, J., P.G. Craze, N.M. Waser, and M.V. Price. 2007. Global warming and the disruption of plant-pollinator interactions. *Ecology Letters* 10:710-717.
- Mohlenbrock, R.H. 2009. This land: the magic rock garden. *Natural History* 118(3):36-37.
- Moffett, J.M. 2008. *Xyris tennesseensis*: status survey, habitat restoration/management concerns, and relation to a new Xyrid, *Xyris spathifolia*. Ph.D. Dissertation. Auburn University, Auburn, AL. 178 pp.
- NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. Available at <http://explorer.natureserve.org>. Accessed 22 June 2015.
- Nerem Storino, L. 2015a. Natural Resources Program Manager, Environmental Branch, Fort McClellan Army National Guard Training Center, Alabama Army National Guard, Anniston, AL. E-mail to M. Wiggers RE: Ft. McClellan *Marshallia mohrii*. 2 January 2015.
- Nerem Storino, L. 2015b. Natural Resources Program Manager, Environmental Branch, Fort McClellan Army National Guard Training Center, Alabama Army National Guard, Anniston, AL. E-mail to M. Wiggers RE: Ft. McClellan *Marshallia mohrii* monitoring. 2 January 2015.
- Noss, R.F. 2012. *Forgotten grasslands of the South: natural history and conservation*. Island Press, Washington, DC. 317 pp.
- Patrick, T.S., J.R. Allison, and G.A. Krakow. 1995. *Protected plants of Georgia: an information 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. 246 pp.
- Schotz, A. 2014. Range-wide status update on *Marshallia mohrii* Beadle (Asteraceae, Mohr's Barbara's-buttons). Unpublished report for U.S. Fish and Wildlife Service, Jackson, MS. 102 pp. + appendices.

- Schotz, A. 2015. E-mail to M. Wiggers RE: *Marshallia mohrii* in Walker County, Alabama. 25 February 2015.
- Spaulding, D. 2013. Checklist of Alabama's vascular flora. 5 February 2013 edition. 196 pp.
- Spaulding, D. 2015. Curator of Collections, Anniston Museum of Natural History, Anniston, AL. E-mail to A. Schotz RE: *Marshallia mohrii* in Etowah County, Alabama. 9 January 2015.
- Stein, S.M., M.A. Carr, R.E. McRoberts, L.G. Mahal, and S.J. Comas. 2010. Threats to at-risk species in America's private forests: a Forests on the Edge report. Gen. Tech. Rep. NRS-73. U.S. Department of Agriculture, Forest Service, Northern Research Station, Newtown Square, PA. 20 pp.
- Tennessee Valley Authority (TVA). 2015. *Marshallia mohrii* element occurrence records. Tennessee Valley Authority Regional Natural Heritage Project, Knoxville, TN. Accessed 10 February 2015.
- The Nature Conservancy (TNC). 2012. The Nature Conservancy acquires 758 acres on Little Cahaba River [website]. Available at: <http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/alabama/newsroom/the-nature-conservancy-acquires-758-acres-on-little-cahaba-river.xml>. Accessed 6 January 2015.
- The Nature Conservancy (TNC). 2015. Alabama. Kathy Stiles Freeland Bibb County Glades Preserve [website]. Available at: <http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/alabama/placesweprotect/kathy-stiles-freeland-bibb-county-glades-preserve.xml>. Accessed 6 August 2015.
- Thompson, P. 2015. Arboretum Specialist, Donald E. Davis Arboretum, Auburn University, Auburn, AL. E-mail to M. Wiggers RE: Davis Arboretum safeguarding of *Marshallia mohrii*. 23 June 2015.
- U.S. Army Corps of Engineers. 2014. National Wetland Plant List, v. 2.3 [web application]. U.S. Army Corps of Engineers, Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH. Available at: http://wetland_plants.usace.army.mil/. Accessed 29 June 2015.
- U.S. Department of Agriculture (USDA). 2015. The PLANTS Database [web application]. U.S. Department of Agriculture, Natural Resource Conservation Service, National Plant Data Team, Greensboro, NC. Available at: <http://plants.usda.gov>. Accessed 6 January 2015.
- U.S. Fish and Wildlife Service (Service). 1991. Recovery plan for Mohr's Barbara's buttons. U.S. Fish and Wildlife Service, Jackson, MS. 15 pp.
- U.S. Fish and Wildlife Service (Service). 2007. Cahaba River National Wildlife Refuge Habitat Management Plan. U.S. Fish and Wildlife Service, Atlanta, GA. 133 pp.
- von Schmeling, H. 2015. Sr. Director of Operations, Chattahoochee Nature Center, Roswell, GA. E-mail to M. Wiggers RE: *Marshallia mohrii* live plant collection at Chattahoochee Nature Center. 24 June 2015.
- Walther, G.-R. 2010. Community and ecosystem responses to recent climate change. *Philosophical Transactions of the Royal Society B* 365:2019-2024.

- Ware, R.T. 1999. Survey for *Clematis socialis* and other rare plants of the significant calcareous or Coosa flatwoods in the Ridge and Valley Province of Northwest Georgia. Unpublished report for the Georgia Natural Heritage Program. 11 pp.
- Watson, L.E. 2006. *Marshallia*. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 19+ vols. New York, NY. Vol. 21, pp. 456-458.
- Watson, L.E., and J.R. Estes. 1990. Biosystematic and phenetic analysis of *Marshallia* (Asteraceae). Systematic Botany 15:403-414.
- Watson, L.E., W.J. Elisens, and J.R. Estes. 1991. Electrophoretic and cytogenetic evidence for allopolyploid origin of *Marshallia mohrii* (Asteraceae). American Journal of Botany 78:408-416.
- Weakley, A.S. 2015. Flora of the southern and mid-Atlantic states. Working draft of 21 May 2015. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina at Chapel Hill, Chapel Hill, NC. 1320 pp.

Table 1. Distribution and status of Mohr’s Barbara’s buttons populations.

State Pop. Count	County Pop. Count
Alabama: 15 ¹ (8)	Bibb: 5 Blount: (1) Calhoun: 3 Cherokee: 3 ¹ (3) Cullman: (1) Etowah: (1) Jefferson: 3 Walker: 1 (2)
Georgia 5 ¹ (1)	Floyd 5 ¹ (1)
Total: 19¹ (9²)	

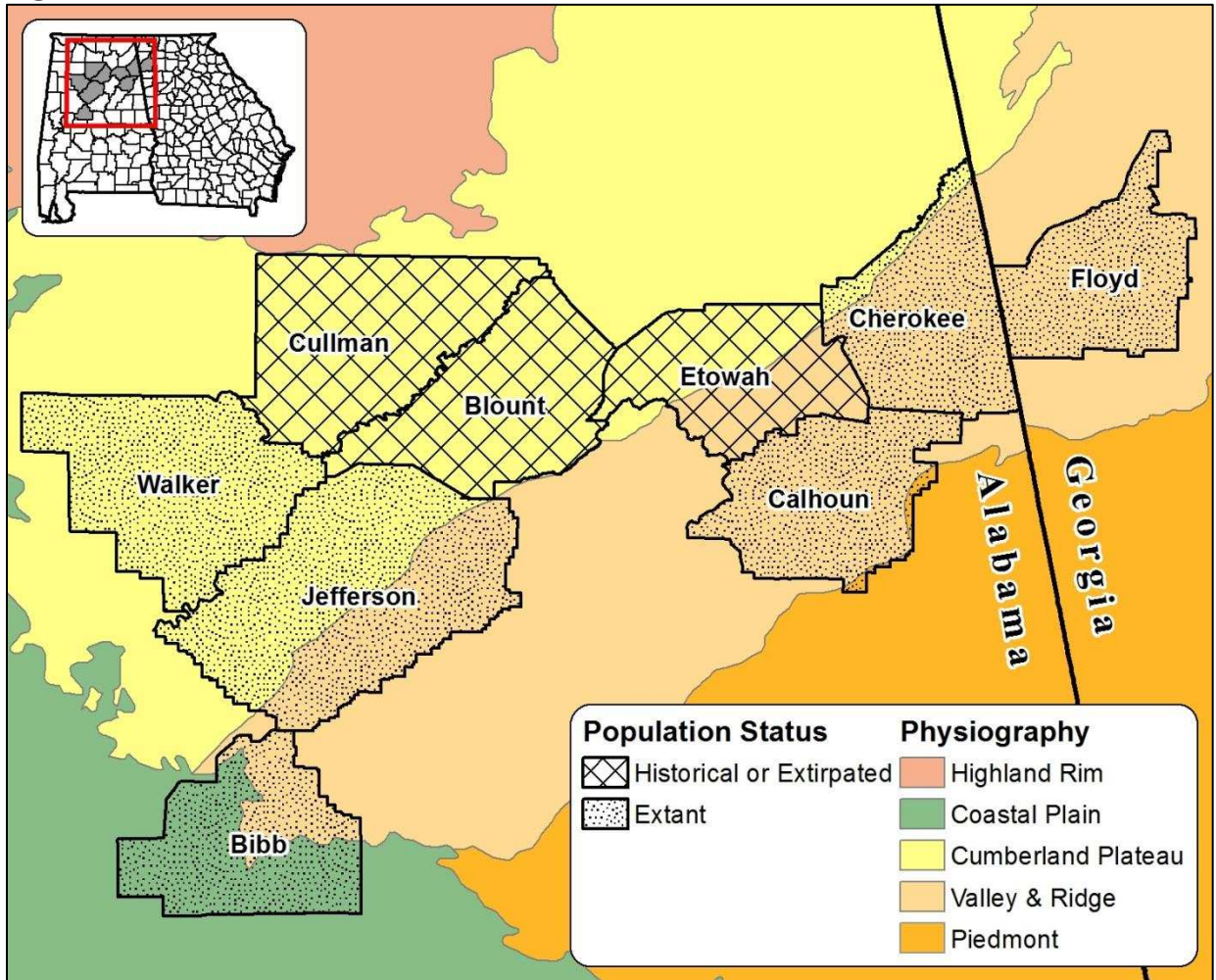
Notes: Parentheses indicate populations that are either extirpated or historical, whereas numbers that are not in parentheses denote extant populations. ¹One population traverses the Alabama–Georgia state line and is shared by Cherokee and Floyd Counties. This population is recorded as one population for tallies within each county and state, but is only counted as one population toward the overall total. Therefore, the total (19) does not equal the sum of either the State or County population counts; rather, it represents one population less than either of these sums. ²Portions of five populations have also not been relocated in recent years.

Table 2. Distribution of extant Mohr’s Barbara’s buttons occurring on State, Federal, or non-governmental lands receiving at least some protection.

State	County	Site	Owner/Manager	Pop. Count ¹
Alabama	Bibb	Cahaba River NWR	USFWS	<u>1</u> ²
	Bibb	Kathy Stiles Freeland Bibb County Glades Preserve	TNC	<u>2</u> ²
	Calhoun	Ft. McClellan	AANG	3
Georgia	Floyd	Berry College WMA	Berry College/GDNR	2
	Floyd	Conservation Easement	Private timber company/TNC	<u>1</u>
Total				5, <u>3</u>²

Notes: AANG = Alabama Army National Guard; GDNR = Georgia Department of Natural Resources; NWR = National Wildlife Refuge; TNC = The Nature Conservancy; USFWS = U.S. Fish and Wildlife Service; WMA = Wildlife Management Area. ¹Population count indicates number of unique populations (not underlined) or partial populations (underlined) receiving some level of protection. ²Cahaba River NWR and Kathy Stiles Freeland Bibb County Glades Preserve share one population.

Figure 1. Mohr's Barbara's buttons distribution.



**U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Mohr's Barbara's buttons (*Marshallia mohrii*)**

Current Classification: Threatened.

Recommendation resulting from the 5-Year Review:

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

Appropriate Listing/Reclassification Priority Number, if applicable: Not applicable.

Review Conducted By: M. Scott Wiggers, Mississippi Field Office.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve: Cary Mungert Date: 7/5/16

REGIONAL OFFICE APPROVAL:

Lead Regional Director, U.S. Fish and Wildlife Service, Region 4

Approve: Liv Ellis Date: 7/24/16

Appendix A. Summary of peer review for the 5-year review of Mohr's Barbara's buttons (*Marshallia mohrii*)

A. Peer Review Method: The Service conducted peer review. Three peer reviewers were selected by the Service for their knowledge of and expertise with Mohr's Barbara's buttons. Individual responses were received from all three of the peer reviewers.

Peer Reviewers: Curtis Hansen, Auburn University, Auburn, AL; Dr. Quinn Long, Center for Conservation and Sustainable Development, Missouri Botanical Garden, St. Louis, MO; Dr. Mincy Moffett, Georgia Department of Natural Resources, Nongame Conservation Section, Wildlife Resources Division, Social Circle, GA.

B. Peer Review Charge: See attached guidance.

C. Summary of Peer Review Comments:

Curtis Hansen – Mr. Hansen was supportive of the information and conclusions presented.

Dr. Quinn Long – Dr. Long provided a thorough review of the draft document and was generally supportive of the information presented and conclusion that the species' status remains unchanged. Dr. Long also noted various typographical, grammatical, and stylistic errors and provided suggestions to clarify several statements within the review. In addition to these editorial comments and revisions, Dr. Long suggested incorporating the following changes:

1. Suggested citing NatureServe's recommended population separation distances for the provisional population definition used herein.
2. Suggested using NatureServe's definition of "occurrence" or clarifying that the usage herein does not meet NatureServe's usage guidelines for "occurrence."
3. Noted that "multiple occurrences in a larger landscape" constitute a meta-population.
4. Noted that, in addition to each stem being capable of producing multiple flower heads, each individual can produce multiple stems from its basal rosette. Suggested language to clarify this point and, further, noted that due to this potential for multiple stems to arise from each basal rosette, stem counts will not necessarily equate to individual plants.
5. Noted that various plant species were erroneously included in the list of rare and uncommon associates of Mohr's Barbara's buttons.
6. Suggested revising the current treatment of threat Factor B (overutilization for commercial, recreational, scientific, or educational purposes) to reflect the potential value of collection for *ex situ* conservation. Furthermore, Dr. Long noted the potential desirability of this attractive plant for use in the horticultural trade.
7. Suggested including more detail in how invasive species (discussed in threat Factor E) may threaten Mohr's Barbara's buttons and suggested stronger wording to describe the need for invasive species management.
8. Requested additional detail on the recommendation to "Update the species' recovery plan."

9. Suggested referencing individual natural heritage program element occurrences when discussing populations.

Dr. Mincy Moffett –

1. Dr. Moffett requested additional population data regarding The Nature Conservancy's (TNC) Floyd County, Georgia conservation easement from TNC's Malcolm Hodges. Mr. Hodges provided the requested data.
2. Noted that protected populations do in fact occur in the Ridge and Valley physiographic region of Georgia.
3. Expressed confusion over the number of populations occurring north of Rome, Georgia and about the use of the term "historic" to describe one of these populations.

D. Response to Peer Review: Each of the peer reviewers' responses were incorporated as follows.

Curtis Hansen – No response required.

Dr. Quinn Long – Dr. Long's editorial suggestions were addressed (typographical, grammatical, and stylistic errors were corrected) and clarifications were incorporated within the document. Responses to Dr. Long's remaining comments are as follows:

1. While the 1 mile population separation distance used herein is similar to NatureServe's recommended population separation distances, NatureServe's recommendations were not used. Rather, pollinator foraging distances were used to determine the provisional population definition used. Additional explanation on the rationale used has been added for clarification.
2. The term "occurrence", as used herein, is not the same as that used by NatureServe; however, the term "occurrence" has been replaced, as appropriate, throughout this document for clarity.
3. While Dr. Long's assessment of meta-populations is accurate, defining and assessing meta-populations is beyond the intended scope of this document. Addressing meta-populations for this species has been added as a recommended future action.
4. Paragraph was revised for clarity and to reflect Dr. Long's suggested edits regarding stem counts and flower heads.
5. The list of rare and uncommon plant associates has been corrected.
6. Noting the potential benefits of collections for *ex situ* conservation is not appropriate within the context of threat Factor B, as suggested by Dr. Long. Additionally, there is already a discussion of *ex situ* conservation within this document and the topic is included as Task 8 (preserve genetic stock) in the species' recovery plan. Discussion of threat Factor B has, however, been expanded to note the potential threat that collection for the horticultural trade may pose.
7. Additional specificity regarding invasive species' potential threats to Mohr's Barbara's buttons has been included. The sentence was revised to reflect Dr. Long's suggestion.
8. The recommendation has been expanded to provide additional detail.

9. Referencing individual element occurrence records throughout the document is beyond the scope of this review, which is intended to summarize and synthesize populations and recovery activities. Additionally, natural heritage program element occurrence data do not reflect every record reviewed in preparation of this document.

Dr. Mincy Moffett –

1. Mr. Malcolm Hodges information provided at Dr. Moffett's request has been incorporated within the document, as appropriate, and is cited as "M. Hodges pers. comm. 2015" The full citation of Mr. Hodges' data has been incorporated into this review's References.
2. This statement was a typographical error and has been corrected to reflect that all known protected populations occur in the Ridge and Valley physiographic region.
3. The section describing the number of populations north of Rome, Georgia has been revised for clarity.

Guidance for Peer Reviewers of Five-Year Status Reviews
U.S. Fish and Wildlife Service, Mississippi Field Office

As a peer reviewer, you are asked to adhere to the following guidance to ensure your review complies with U.S. Fish and Wildlife Service (Service) policy.

Peer reviewers should:

1. Review all materials provided by the Service.
2. Identify, review, and provide other relevant data apparently not used by the Service.
3. Not provide recommendations on the Endangered Species Act classification (e.g., endangered, threatened) of the species.
4. Provide written comments on:
 - Validity of any models, data, or analyses used or relied on in the review.
 - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.
 - Oversights, omissions, and inconsistencies.
 - Reasonableness of judgments made from the scientific evidence.
 - Scientific uncertainties by ensuring that they are clearly identified and characterized, and that potential implications of uncertainties for the technical conclusions drawn are clear.
 - Strengths and limitations of the overall product.
5. Keep in mind the requirement that the Service must use the best available scientific data in determining the species' status. This does not mean the Service must have statistically significant data on population trends or data from all known populations.

All peer reviews and comments will be public documents and portions may be incorporated verbatim into the Service's final decision document with appropriate credit given to the author of the review.

Questions regarding this guidance or the peer review process should be referred to M. Scott Wiggers, Botanist, Mississippi Ecological Services Field Office, at (601) 364-6910, e-mail: marion_wiggers@fws.gov.