**Small –anthered bittercress**
**(*Cardamine micranthera*)**

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

Photo by Moni Bates

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

**5-YEAR REVIEW**

Small-anthered bittercress (*Cardamine micranthera*)

## 1.0 GENERAL INFORMATION

### 1.1 Reviewers

**Lead Region**:
Susan Oetker, Southeast Region, phone 404-679-7050

**Lead Field Office**:
Mara Alexander, Asheville Ecological Services Field Office, phone 828.258.3939 ext. 238

**Cooperating Field Office**:
Kimberly Smith, Gloucester Ecological Services Field Office, phone 804.693.6694 ext. 126

**Cooperating Region**: Mary Parkin, Northeast Region, 617-417-7331

### 1.2 Methodology used to complete the review:

Public notice of this 5-year review was given in the *Federal Register* on July 29, 2008 (73 FR 43947) and a 60 day comment period was opened. We did not receive any additional information about small-anthered bittercress from the public in response to the *Federal Register* notice during the comment period. However, we did receive additional information about the species in response to requests for specific information that were made (by the US Fish and Wildlife Service (USFWS)) directly to biologists familiar with the species. Once all data was obtained, the review was completed by the USFWS's lead recovery biologist for the species in Asheville, North Carolina (Mara Alexander).

A draft of the entire five year review document was circulated to eight peer reviewers. These persons were selected because of their familiarity with the species, their employment within applicable or affected natural resource agencies, or both. Responses were received from five reviewers. These comments were incorporated into this review as appropriate (see Appendix B for a summary of peer review).

### 1.3 Background:

#### 1.3.1 Federal Register Notice citation announcing initiation of this review:
July 29, 2008 (73 FR 43947)

#### 1.3.2 Species Status:
Stable (2014)

#### 1.3.3 Recovery Achieved
1 (1=0-25% species recovery objectives achieved)

### 1.3.4 Listing history

Original Listing
**FR notice:** 54 FR 38947
**Date listed:** September 21, 1989
**Entity listed**: species
**Classification**: endangered

### 1.3.5 Associated rulemakings: n/a

### 1.3.6 Review History:

Recovery Plan: 1991
Each year, the 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 like "Stable" for this plant. We continue to show that species status recommendation as part of our 5-year reviews. The most recent evaluation for this plant was completed in 2016.
Five-year review: November 6, 1991

In the 1991 five-year 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 in the review.

### 1.3.7 Species' Recovery Priority Number at start of 5-year review (48 FR 43098):
5 (a species with a high degree of threat and a low recovery potential)

### 1.3.8 Recovery Plan

**Name of plan or outline**:
Small-anthered bittercress Recovery Plan
**Date issued**: July 10, 1991
**Dates of previous revisions, if applicable**: n/a

## 2.0 REVIEW ANALYSIS

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

The DPS policy applies to only vertebrate species of fish and wildlife. Because *C. micranthera* is a plant, the DPS policy is not applicable and not addressed further in this review.

### 2.2 Recovery Criteria

#### 2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

The species has a final, approved recovery plan with recovery criteria. However, the recovery criteria are not objective and measurable, beyond establishing a minimum number of populations to be protected (six). The recovery criteria do not specify the number of individuals or the quantity and quality of habitat needed for the species' recovery, due to a lack of knowledge of the species' biology. The recovery criteria in the 1991 plan were regarded as interim goals to be modified upon acquiring additional information (specific actions intended to address these information needs are identified among the recovery tasks).

**2.2.2 Adequacy of recovery criteria.**

**2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?**

No. The recovery criteria were devised 25 years ago. Since that time the species' known distribution has expanded to include additional tributaries within the Dan River system (Virginia Department of Conservation and Recreation (VDCR) 2007, Boyer 1996), and additional information has been acquired on the characteristics of its occupied habitat (Boyer 1996).

**2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?**

Yes. The existing recovery criteria could not be met without addressing the three listing factors identified as significantly affecting the status of the species in the listing rule (habitat loss, the inadequacy of existing regulatory mechanisms, and other natural or manmade factors). Overutilization and disease/predation were not regarded as significantly affecting the species in the listing rule, and there is no new information to suggest that these two factors now represent significant threats to the species. Beaver activity has been identified as an additional source of habitat destruction since the recovery plan (Bridle 2009, Piedmont Land Conservancy (PLC), pers. comm.). As with previously identified threats, this new threat requires satisfactory implementation of needed management actions (an existing recovery criterion). Thus, this new threat does not necessitate revision of the recovery criteria.

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

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

Recovery tasks 2.2 through 2.5 identify actions needed to define objective criteria for self-sustaining populations and habitat management guidelines for this species. Several of these tasks have been initiated but have yet to be completed. They are discussed individually below.

Recovery task 2.2 (study abiotic and biotic features of the species' habitat) was implemented in the early 1990s, resulting in the preparation of a report which further describes elements of the species' habitat (Boyer 1996).

Recovery task 2.3 (conduct long-term demographic studies) was initiated in 1992 and continued for three years; however the monitoring effort was limited to one portion of a single population and data were only collected for three subsequent years. As a result, this single monitoring effort was insufficient to substantively inform estimates of minimum population size or criteria for self-sustaining populations of this species. This monitoring effort has been discontinued due to lack of resources.

Recovery task 2.4 (determine the effects of past and ongoing habitat disturbance) would have been addressed, at least in part, by a stream restoration project that spanned one of the species' known populations in North Carolina (North Carolina Natural Heritage Program (NCNHP) Element Occurrence (EO) 23.019, part of USFWS population 23 in Table A.1 of Appendix A). This stream restoration project required formal consultation with the USFWS due to associated impacts to *C. micranthera* (USFWS, 2003). The stated goals of the stream restoration project included enhancement of habitat for *C. micranthera*, which was found within the project footprint. Individuals of *C. micranthera* were rescued from the construction footprint prior to stream restoration work, and 50% of the plants were replanted following the completion of construction activities. However, hurricanes hit central North Carolina in the fall of 2004, and none of the replanted *C. micranthera* individuals could be found following those storm events (NCNHP 2013). The conservation recommendations found within the USFWS's Biological Opinion (USFWS 2003) were to be implemented in full as a special condition to the US Army Corps of Engineers (USACE) permit issued for the stream restoration work. These conservation recommendations included development of a site management plan (to be approved by the USFWS), annual reports on the condition of any *C. micranthera* plants cared for off-site and annual monitoring (and associated reporting) of any *C. micranthera* individuals returned to the project area for a duration of 5 years. As of 2014 the USFWS has not been provided with either a management plan or monitoring reports at this site.

We are now aware of 37 *C. micranthera* populations (Table A.1 of Appendix A). Recent monitoring data (NCNHP 2013, VanAlstine 2014) show that only two of the 37 populations have increased in size over the last 20 years. The majority of the known populations are decreasing in size, and five are now extirpated.

We currently lack the information specific to the species, such as its reproduction requirements and seed viability rates. We believe that the two populations increasing in size (USFWS population number 7 and 35 in Table A.1 of Appendix A) are self-sustaining, but we are still investigating aspects of this plant's biology. Without this life history information, we are unable to develop appropriate habitat management guidelines for existing populations. Therefore, this criterion has not been met.

*Criterion 2: All of the above 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.*

As of this review, portions of two North Carolina populations are afforded some protection and there are no populations protected (in whole or in part) in Virginia. One of the two partially-protected North Carolina populations (NCNHP EO 24.002; part of

USFWS population 16 in Table A.1, Appendix A) is protected by a voluntary registry with the North Carolina Natural Heritage Program, the second (NCNHP EO 23.019; part of USFWS population 23 in Table A.1, Appendix A) is subject to a conservation easement with the North Carolina Ecosystem Enhancement Program (NCEEP).

The first site (NCNHP EO 24.002) supports a sizable occurrence with 507 plants reported from this location (NCNHP 2013). However, at this location *C. micranthera* spans several tracts held by multiple landowners, only one of whom has signed a registry agreement with NCNHP. This registry with the state is a voluntary and non-binding agreement which can be rescinded at any time without penalty. This site has declined in population size over the last ten years.

The second site (NCNHP EO 23.019) is subject to an easement with the NCEEP. During the last survey at this site, no plants were found (NCNHP 2013). Protection without proper management does not benefit the species.

In summary, protections, without active management, currently only exist at portions of two populations of this species. Therefore, the criterion of at least six adequately protected populations has not been met.

## 2.3 Updated Information and Current Species Status

### 2.3.1 Biology and Habitat

**2.3.1.1 New information on the species' biology and life history:**

**2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:**

*Abundance*
Estimates of abundance for the 32 extant populations of the species range from one plant (North Fork of South Mayo River, Virginia) to 8,000 – 10,000 plants (Peters Creek, Virginia) (Table A.1). If the maximum estimates for each population (regardless of observer or year) are considered in aggregate, the global population of *C. micranthera* contains fewer than 23,000 plants. However, population sizes of *C. micranthera* (like most annual plant species) are known to fluctuate widely from one year to the next (Boyer 1996), thereby diminishing the value of such estimates.

*Population trends*
In North Carolina, it has been roughly 20 years between survey efforts for most *C. micranthera* populations. In Virginia, in most cases the same portion of the EO has not been visited between one observation period to the next, and it is therefore not possible to infer meaningful trends from these observation data. For the sites where the North Carolina Natural Heritage Program (NCNHP) and the Virginia Natural Heritage Program (VANHP) have more than two surveys completed, the EO records show no consistent trend in population size, with most sites exhibiting considerable fluctuation from one observation to the next.

Further complicating the interpretation of observation data found in NHP EO records is the fact that they may have been made by different individuals who may have devoted different levels of survey effort, or covered different spatial extents (and different portions of a given "population"). In many cases where observations exist for more than one time period, observations were reported using different units of observation (e.g., some estimates only report numbers of flowering individuals, others report vegetative and flowering individuals separately). Due to a combination of all of the above factors, it is not possible to determine or infer trends for a representative number of populations across the range.

The USFWS is aware of only one repetitive monitoring effort involving this species, in which a portion of a single population in Stokes County, North Carolina was monitored in years 1992, 1993, and 1995 (Boyer 1996)[1]. The objective of Boyer's monitoring program was to determine how stable populations and individual plants were within the stream bed, by mapping individual plants (in relation to a permanent transect) at repeated intervals over time. This effort was intended as a long term monitoring program, and funded with ESA Section 6 dollars provided by the USFWS to the North Carolina Plant Conservation Program. Although not explicitly characterized as such, this study would have been capable of providing demographic level data (Recovery Task 2.3). However, this effort was not continued after 1995. Subsequent efforts to relocate these transects (assisted by Boyer) were unsuccessful (Bridle 2009, pers. comm.). Boyer's three years of monitoring data revealed considerable fluctuation in population size from one year to the next (percent change ranged from -20% to + 124%), as would be expected in a short-lived species like *C. micranthera*. The study also provided evidence of seedling recruitment and adult and seedling mortality, but the data span too few years to provide informed estimates of a minimum viable population size or criteria for "self-sustaining" populations.

*Demographic features and trends*
Demographic features are not being monitored at any population; therefore there is no updated information on demography or demographic trends.

**2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.)**:
The USFWS is not aware of any characterizations of population genetic structure involving *C. micranthera*. However, Wieboldt (2002) did examine phylogenetic relationships between this species and other congeners. These findings are discussed in the next section.

**2.3.1.4 Taxonomic classification or changes in nomenclature**:
Some observers have long reported morphologically intermediate forms between *C. micranthera* and a closely related species, *C. rotundifolia* (American bittercress). Wieboldt (1982) theorized that *C. micranthera* may be derived from *C. rotundifolia*, possibly through increased inbreeding (within the *C. micranthera* lineage) and subsequent divergence among these two taxa. Wieboldt (2002) later conducted a molecular phylogenetic study using sequence data from the internal transcribed spacer (ITS) region of nuclear ribosomal DNA. This study examined the relationship between *C. micranthera* and *C. rotundifolia* species pair, as well as the relationship of these taxa to

[1] The population monitored by Boyer is USFWS population number 17 (NCNHP EO 015) along Little Peters Creek in Stokes County, North Carolina (Table A.1, Appendix A).

other congeners from the region. The study found strong support for the *C. micranthera-rotundifolia* clade, with these taxa forming a close pairing within the phylogenetic tree constructed for all taxa examined. The level of sequence divergence between *C. micranthera* and *C. rotundifolia* was less than 1% but within the range known for other *Cardamine* species and related genera. Wieboldt (2002) concludes that the results, supplemented by known morphological differences, support these as distinct taxa – however he is ambivalent as to whether they should be separated at the specific, or subspecific level. The USFWS will continue to treat *C. micranthera* as a separate species until a change is accepted in the literature.

**2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.)**:

When *C. micranthera* was listed in 1989, the current and historical range was described as confined to the Dan River basin in Stokes and Forsyth Counties, North Carolina. In the 1989 listing rule, the Forsyth County occurrence was described as extirpated, and the current range was described as consisting of four populations in Stokes County, North Carolina. The 1989 listing rule did not provide additional information on the location of these four populations; however information on file with the AFO suggests that they correspond to four tributaries of the Dan River (Peter's Creek, Little Peter's Creek, Elk Creek, and a fourth unnamed tributary to the Dan River).

By the time of the recovery plan (1991), the species had been discovered at five other locations further upstream along Peter's Creek in Patrick County, Virginia. Although these occurrences were within the same watershed as those further downstream in North Carolina, the five occurrences of the species along Peter's Creek in Virginia were counted as five discrete populations in the 1991 recovery plan, also discrete from those located further downstream on Peter's Creek in North Carolina. Thus, the 1991 recovery plan recognizes a total of nine extant populations of the species: the four acknowledged in the 1989 listing rule (all in Stokes County, North Carolina), plus five populations within the Peter's Creek watershed in Patrick County, Virginia. The 1991 recovery plan does not describe any additional extirpated sites across the range beyond the single site in Forsyth County, North Carolina identified in the listing rule.

As of 2014, the species' total global distribution remains confined to the Dan River system in Stokes County, North Carolina, and Patrick County, Virginia. The historical occurrence of the species in Forsyth County, North Carolina (also in the Dan River system) has not been relocated despite subsequent surveys. Since the 1991 recovery plan, the species has been found on additional (named and unnamed) tributaries to the Dan, perhaps most notably the North and South Forks of the Mayo River in Virginia (the Mayo River is itself a tributary to the Dan), and Snow Creek and its tributaries in North Carolina.

The corresponding state Natural Heritage Programs (NHP) have mapped a total of 36 element occurrence (EO) records for this species, with 21 EOs mapped in North Carolina (NCNHP 2014) and 15 in Virginia (VANHP 2014). Because any given EO can consist of more than one spatially discrete location where the species has been observed, these 36 EOs represent some 132 sites (27 in North Carolina and 105 in Virginia). During the preparation of this review, the USFWS examined each of the EOs mapped by the

respective state NHP and determined that they collectively represent 37 extant and one extirpated populations of the species (17 in NC and 21 in VA) (Appendix A, Table A.1). The global distribution of *C. micranthera* is depicted in Appendix A, Figure A.1.

**2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):**
As noted above (2.3.1.5, Spatial Distribution), the amount of habitat known to be occupied by this species has increased to include additional tributaries within the Dan River system (see also Table A.1, Appendix A). Based upon anecdotal observations filed with the respective NHPs, the majority of known sites continue to degrade or be threatened with degradation from a variety of threats (see section 2.3.2, Five-Factor Analysis, for a discussion of threats).

Boyer (1996) provides additional information regarding suitable (and unsuitable) habitat for the species. Specifically, she noted that occupied habitat was generally characterized by the following:

- Partial shade or in full sun for part of the day
- Always where roots are nearly continuously wet or in contact with moisture, but aerial portion [of the plant] above water
- In stream beds, on stream banks, and on terraces in stream valleys thus: in sand deposits among rocks; on and among mossy loose rocks; on low sand-gravel bars (not large pileups); in bedrock crevices close to stream water level or where there is seepage; in floodplain/terrace depressions with long hydroperiod and some sunlight; in seepage bogs at slope bases; and in level spots in feeder streamlets/seepages
- When in streams: consistently below *Xanthorhiza simplicissima* (yellowroot), *Houstonia caerulea* (azure bluet), and *Viola* sp. (violet) on the streambank profile; where plants get frequently overwashed by storm floods but are just above normal water level; and higher on the streambank profile where there is reliable seepage
- When in bogs/depressions, in open spots rather than among dense herbage of other species; wetter than most other species; and same moisture as *Saxifraga micranthidifolia* (brook lettuce), and *Cicuta maculata* (spotted water hemlock)

Boyer (1996) notes that she did not observe the species in areas characterized by the following:

- Deep shade, even when other conditions appeared optimum
- Dense growth of other species (e.g. *Impatiens* sp. (impatiens), *Carex* sp. (sedge), *Osmunda* sp. (fern) in seeps, *Alnus* sp. (alder) on stream bank); it is unclear whether this is due to competition, moisture level, soil texture, or other factors
- Highly dynamic substrate, particularly on low-gradient stretches with substantial sand and gravel deposits on inside curves, and scoured vertical outside banks
- Flatwater with no purchase opportunities except vertical soil banks subject to erosion; usually no plants are found in flatwater stretches at all, even where there are favorable-looking gravel bars
- Recent disturbance of the surroundings (e.g., recent timbering with subsequent dense shrub, stump-sprout and vine overgrowth; active pasture)
- Steep-banked downcutting, even when there seem to be suitable microsites within the stream bed and there are upstream seed sources (this could be due to

the increased intensity of water flow in downcut areas where the stream has a reduced ability to overflow its banks during storm events)
- Seasonal waters (e.g., vernal pools, intermittent tributaries fed mainly by surface runoff)
- Firm clay soil.

In comments on an earlier version of this review, Bridle (2009, pers. comm.) relayed additional observations by Boyer (1996) that the best meta-populations of this species appear to be maintained by seed from parent plants located upstream in a headwater seeps or springs. Bridle confirmed Boyer's (1996) observations during his own field visits to several sites. Bridle also recommended a land protection strategy focused on terrestrial and riparian properties supporting headwater occurrences, which would be most likely to preserve the entire seed source for the watershed.

### 2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms) -

#### 2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Habitat alteration was identified as the primary threat to the species in the listing rule and recovery plan and remains the primary threat to the species as of this review. The listing rule and recovery plan specifically list impoundment, channelization, conversion associated with agriculture or silviculture, flooding, and encroachment of exotic species as threats affecting the species. Each of these remains a threat as of this review. Cattle trampling and downstream beaver impoundments have also been noted as threatening *C. micranthera* habitat (VanAlstine 2014, Virginia Department of Conservation and Recreation, pers. comm.). These threats are substantiated by NHP EO reports for the species. The majority of site records specifically note that one or more of these threats are either ongoing or imminent, further noting the need for active intervention to address them (NCNHP 2013, VANHP 2014). All sites are located along the Dan River and its tributaries, so they all face similar threats.

As of this review, portions of two North Carolina populations are afforded some form of protection from development; however in one case the level of protection afforded is inadequate (not legally binding and does not apply to all tracts containing the species) and in the other case the population's long-term viability is significantly in doubt. See Section 2.2.3 above for additional information on these partially protected populations.

#### 2.3.2.2 Over utilization for commercial, recreational, scientific, or educational purposes:

Consistent with the listing rule and the recovery plan, we are not aware of any new information indicating this constitutes a significant threat to the species.

#### 2.3.2.3 Disease or predation:

Consistent with the listing rule and the recovery plan, we are not aware of any new information indicating this constitutes a significant threat to the species.

#### 2.3.2.4 Inadequacy of existing regulatory mechanisms:

This species is listed as endangered under the North Carolina Plant Conservation and Protection Act (Chapter 106 §106-202.12 through 106-202.22 of the Code of North Carolina) and the Virginia Endangered Plant and Insect Species Act (Chapter 10 §3.2-1000 through 1011 of the Code of Virginia, as amended). However, both of these state

statues primarily regulate collection and trade in listed species, and do not prohibit land owners from neglecting or otherwise impacting such species on their own properties or in conjunction with otherwise legal activities.

**2.3.2.5 Other natural or manmade factors affecting its continued existence:** Since the time of listing and the publication of the recovery plan, beaver dams have been observed to constitute a significant threat to the species at some locations, with one knowledgeable observer regarding this as perhaps the most immediate threat to the species (Bridle 2009, pers. comm.). Bridle notes that beaver activity (especially in drought years) within main stream channels has flooded entire colonies of the species.

## 2.4 Synthesis -

The number of known extant populations of *Cardamine micranthera* has increased from nine to 37 since the recovery plan was written. However, the species continues to be a narrow-ranging endemic of the Dan River system, in Stokes County, North Carolina, and Patrick County, Virginia. The threats identified at listing and in the species' recovery plan continue to affect remaining populations, only two of which are afforded any form of protection. The two protected populations are protected only in part, and the forms of protection currently in place appear to be inadequate to ensure self-sustaining populations buffered from identified threats to the species. The remaining populations occur on privately owned lands where they are threatened by ongoing or imminent problems ranging from inappropriate silvicultural practices to invasive species and drought. Robust monitoring data are lacking, and most available data are not capable of revealing trends in existing populations. However, there is no reason to suspect that identified threats are decreasing, as there have been no significant efforts to actively abate these threats throughout the species' range. Therefore, based on these considerations, we find this species continues to be in danger of extinction.

# 3.0 RESULTS

## 3.1 Recommended Classification:

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist:**
    ____ Extinction
    ____ Recovery
    ____ Original data for classification in error
__X__ **No change is needed**

**3.2 New Recovery Priority Number**: No change.

**3.3 Listing and Reclassification Priority Number:** n/a

# 4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

If completed, the existing set of Recovery Tasks identified for this species would be sufficient to recover this species. Rather than drafting additional action items, those Recovery Tasks deemed most

urgent and most likely to deliver the greatest end result have been identified and listed in order of relative priority here.

1. Continue to pursue follow-up information from stream restoration project on Snow Creek (involving a portion of one population of this species) from appropriate state, federal and private parties. (Recovery Task 4).
2. Communicate existing habitat protection priorities (VDCR 2007, Boyer 1996) to state agencies, local land trusts, and other conservation partners, to assess current and future options for protection. Encourage land protection strategies focused on headwater occurrences likely to serve as a seed source for recolonization of sites further downstream (Bridle 2009, pers. comm.) (Recovery Task 1.4).
3. Identify sites which have experienced recent disturbance, and evaluate the effects of ongoing and prior habitat disturbance upon the species (Recovery Task 2.4).
4. Utilize information obtained from assessments of prior or ongoing habitat disturbance to devise and implement appropriate habitat management guidelines (Recovery Tasks 2.5 and 2.6).
5. Conduct site visits to determine if Boyer's (1996) long-term monitoring transects can be relocated and resurrected. If so, reinitiate monitoring efforts to learn more about the longevity and relative stability of populations of this short-lived species. If Boyer's (1996) monitoring transects cannot be resurrected, work to establish comparable monitoring (using Boyer's protocol or modifications thereof) at priority sites using standardized monitoring methods (Recovery Tasks 2.1, 2.2, and 2.3).
6. Use monitoring data and other information to draft objective, measurable criteria for "self-sustaining" populations (Recovery Tasks 2.3, 2.4, and 2.5).
7. Determine the status of genetic material held in botanical gardens and other institutions, and work to ensure that the species is adequately represented in long-term storage (Recovery Task 3).
8. Pursue development of habitat predictability models for this species, and iteratively refine and use these to search for new populations and guide land protection efforts (Recovery Tasks 1.2 and 1.3).
9. Identify landowners, obtain permission to visit populations, and provide information to landowners about voluntary protection measures that may be implemented to protect the species (including best management practices, NHP Registry programs, conservation easements, and fee simple purchase by cooperating land protection agencies) (Recovery Tasks 1.1, 1,2, 1.3, and 1.4).

## 5.0 REFERENCES -


Boyer, M. 1996. Study of small-anthered bittercress (*Cardamine micranthera*): life history, management and protection. Unpublished report to North Carolina Plant Conservation Program, Plant Industry Division, North Carolina Department of Agriculture and the U.S. Fish and Wildlife Service. May 1, 1996. 16 pp. plus figures, sketches, and maps.

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Virginia Natural Heritage Program, 2014. Element Occurrence records for *Cardamine micranthera* (small-anthered bittercress). Provided July, 2014.

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**U.S. FISH AND WILDLIFE SERVICE**
**5-YEAR REVIEW of** *Cardamine micranthera,* small-anthered bittercress

**Current Classification**: Endangered

**Recommendation resulting from the 5-Year Review**:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

**Appropriate Listing/Reclassification Priority Number, if applicable**: n/a

**Review Conducted By**: Mara Alexander, Asheville Field Office

**FIELD OFFICE APPROVAL:**

**Lead Field Supervisor, Fish and Wildlife Service**

Approve _____ Date 11/21/16

**REGIONAL OFFICE APPROVAL:**

For **Lead Regional Director, Fish and Wildlife Service**

Approve _____ Date 11/25/16

For **Cooperating Regional Director, Fish and Wildlife Service**

✓ Concur ____ Do Not Concur

Signature Martin Miller Date 9-9-16

## Appendix A
## Supporting information

**Table A.1 (see attached file)** – populations of *Cardamine micranthera*

**Figure A.1 (see attached file)** – Cardamine micranthera (small-anthered bittercress): global distribution

**Table A.1**. Populations of *Cardamine micranthera* (small-anthered bittercress).

| USFWS population number | Location[a] | VAHP EO number (EO Rank)[b] | NCHP EO number (EO Rank)[b] | Number of discrete sites | Population trend (if known) | Maximum population size[c] | Date last observed |
|---|---|---|---|---|---|---|---|
| 1 | Dan River – unnamed tributary | 022 (D) | | 1 | | 9 rosettes | 2006 |
| 2 | Little Dan River - unnamed tributary | <023 (BC) | | 4 | | < 300 plants | 2006 |
| 3 | Little Dan River - unnamed tributary | <023 (BC) | | 10 | | ---[d] | ---[d] |
| 4 | Hookers Creek – mainstem and tributary | 024 (B) | | 5 | | 375 plants | 2006 |
| 5 | Browns River – unnamed tributary | <023 (BC) | | 1 | | 100 plants | 2006 |
| 6 | Sandy Creek | <006 (AB) | | 8 | | 560-600 plants | 2004 |
| 7 | Dan River – unnamed tributary | | 007 (A) | 1 | Increase | 705 plants | 2013 |
| 8 | Dan River – unnamed tributary | | 010 (A) | 1 | Stable | 1,276 plants | 1996 |
| 9 | Dan River – unnamed tributary | | 011 (BC) | 1 | Stable | 275 plants | 1996 |
| 10 | Elk Creek (mainstem and tributary) | <006 (AB) | 003 (D) | 8 | Stable | 10 plants | 2013 |
| 11 | Dan River – unnamed tributary | | 004 (C) | 2 | Stable | 104 plants | 2013 |
| 12 | Dan River – unnamed tributary | | 021 (F) | 1 | Severe decline | 0 plants | 2013 |
| 13 | Dan River – unnamed tributary | | 016 (D) | 1 | Rapid decline | 12 plants | 2013 |
| 14 | Peters Creek - mainstem and Long Branch | 001 (AB) | | 30 | | 8000-10,000 plants | 2014 |
| 15 | Peters Creek – unnamed tributary | | 009 (D) | 1 | Decline | <100 plants | 2013 |
| 16 | Peters Creek mainstem, Little Peters Creek and tributaries, unnamed tributary to Peters Creek | | 24.002 (AB), 24.005 (D), 24.012 (B), 24.022 (F) | 6 | Decline | ca. 800 plants | 2013 |
| 17 | Little Creek – mainstem and tributary | | 015 (A) | 1 | Stable | Ca. 500 plants | 2013 |
| 18 | Bonds Branch and tributary | | 008 (F) | 2 | Severe decline | 0 plants | 2013 |
| 19 | Unnamed tributary – Dan River | | 017 (D) | 1 | Stable | 20-50 plants | 2013 |
| 20 | Unnamed tributary – Dan River | | 020 (F) | 1 | Severe decline | 0 plants | 2013 |
| 21 | Snow Creek – unnamed tributary | | 006 (C) | 1 | Stable | 147 plants | 2013 |
| 22 | Snow Creek – unnamed tributary | | 014 (D) | 1 | Stable | 46 plants | 2013 |
| 23 | Snow Creek – unnamed tributary | | 23.018 (D), 23.019 (F) | 2 | Severe decline | 70 plants (23.018), 0 plants (23.019) | 1997, 2013 |
| 24 | Belews Creek | | 001 (X) | 1 | Extirpated | 0 plants | 2013 |
| 25 | North Fork of South Mayo River | 016 (D) | | 1 | | 1 plant | 1997 |
| 26 | Rich Creek | <005 (C?) | | 4 | | 154 plants | 2014 |
| 27 | S Mayo River – unnamed tributary | <005 (C?) | | 1 | | 290 plants | 2014 |
| 28 | S Mayo River – unnamed tributary | 014 (E) | | 1 | | ---[e] | 2003 |
| 29 | S Mayo River – unnamed tributary | <018 (A) | | 1 | | 500-600 plants | 2014 |
| 30 | S Mayo River – unnamed tributary | <018 (A) | | 1 | | 1500-2000 plants | 2014 |
| 31 | Russell Creek mainstem and Noel Branch | 003 (B) | | 13 | | 665-765 clumps | 2004 |
| 32 | Cadwell Creek | 009 (D) | | 4 | | 32 flowering/fruiting clumps | 1999 |
| 33 | Spoon Creek - mainstem and tributaries | <010 (A) | | 7 | | 1550 plants | 2004 |
| 34 | Spoon Creek – unnamed tributary | <010 (A) | | 2 | | 600 plants | 2004 |
| 35 | Little Spoon Creek and tributary | 004 (D) | | 2 | Increase | 100 plants | 2014 |
| 36 | Polebridge Creek tributary | 021 (D) | | 5 | | 35 plants | 2005 |
| 37 | Little Mill Creek | <017 (A) | | 1 | | 700-800 plants | 2014 |
| 38 | Mill Creek – unnamed tributary | <017 (F) | | 3 | Severe decline | 0 plants | 2014 |

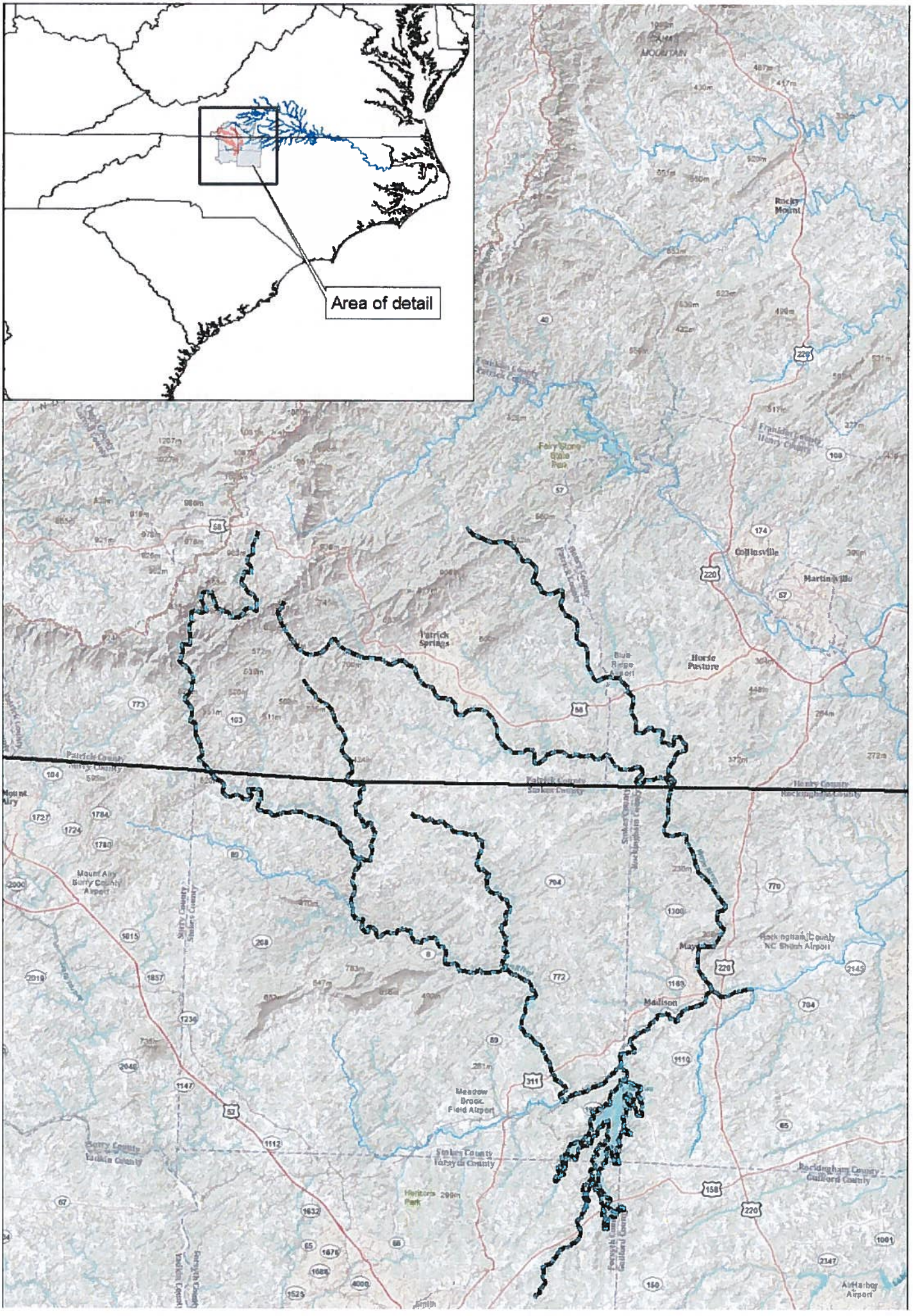
[a] Locations listed in order of confluence with Dan River mainstem (proceeding downstream).

[b] Element Occurrence (EO) ranks are based on a combination population size, habitat condition, and landscape context observed at the last observation date. In situations in which the maximum estimate of population size is larger than the last available estimate, the corresponding EO rank may appear low, due to declines in the population observed at the last observation date.

[c] Based upon Natural Heritage Program data. This represents the largest estimate of population size ever reported, and may not (often does not) correspond to the most recent estimate.

[d] Site data for this location have been merged with data from one or more other locations by the respective Natural Heritage Program; refer to those sites with the same NHP EO number for available data.

[e] Available data (per NHP) state only that this site contains a "small population" – no quantitative estimate of population size is available.


Area of detail
Rocky Mount
Collinsville
Martinsville
Patrick Springs
Blue Ridge Airport
Horse Pasture
Mount Airy Surry County Airport
Madison
Rockingham County NC Shiloh Airport
Meadow Brook Field Airport
Surry County
Yadkin County
Stokes County
Forsyth County
Rockingham County
Guilford County
Henry County
Patrick County
Franklin County
Air Harbor Airport

**Appendix B. Summary of peer review for the 5-year review of Small-anthered bittercress (*Cardamine micranthera*)**

**A. Peer Review Method:**

A draft 5-year review was sent to eight reviewers, as an attachment to an email, requesting their review and any changes or additions that should be included in the document. All reviewers have extensive knowledge of *Cardamine micranthera* and similar species. The following individuals responded to our peer review request:

**Peer Reviewers:**

- Ken Bridle (Stewardship Director, Piedmont Land Conservancy)
- Misty Buchanan (Botanist, NC NHP)
- Laura Gadd (Botanist, NC Plant Conservation Program)
- Kim Smith (Region 5, VA FWS Field Office)
- Dale Suiter (Region 4, Raleigh, NC FWS Field Office)

**B. Peer Review Charge:**

Peer reviewers were asked to conduct a scientific review of technical information presented. Reviewers were not asked to review the legal status determination.

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

Reviewers responded by email. All reviewers agreed that the information in the document provided to them was accurate.

**D. Response to Peer Review:**

Recommendations from the reviewers were incorporated into the document as appropriate. These consisted primarily of additional information concerning the status of certain populations, threats to the species, and recommendations for future actions.