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

June 2023

5-YEAR REVIEW
Small-anthered bittercress (*Cardamine micranthera*)

GENERAL INFORMATION

Reviewers

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Methodology used to complete the review

In accordance with Section 4(c)(2) of the Endangered Species Act of 1973, as amended (Act), the purpose of a status review is to assess each threatened or endangered species to determine whether its status has changed and if it should be classified differently or removed from the Lists of Threatened and Endangered Wildlife and Plants (50 CFR 424.12). The U.S. Fish and Wildlife Service (Service) evaluated the biology, habitat, and threats of the small-anthered bittercress (*Cardamine micranthera*) to inform this status review. Public notice of this 5-year review was given in the *Federal Register* on July 14, 2021 (86 FR 37178) 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, the Service received additional information about the species from biologists familiar with the species in response to requests for specific information.

Background:

Federal Register Notice citation announcing initiation of this review:
July 14, 2021 (86 FR 37178)

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

Review History
Five-year review: November 6, 1991
In the 1991 5-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.

Five-year review: November 21, 2016
A 5-year review for Small-anthered bittercress was conducted in 2016. The review concluded that the species remain classified as endangered due to habitat fragmentation and lack of increasing status trend (Service 2016).

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)

Recovery Plan
Name of plan or outline:
Small-anthered bittercress Recovery Plan
Date issued: July 10, 1991

REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) policy
The Act defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing of a DPS to only vertebrate species. Because the species under review is a not a vertebrate, the DPS policy does not apply.

Recovery Criteria
Throughout this review, the terms 'population' and 'element occurrence' (EO) are used interchangeably to reference historical, extirpated, and extant known locations for small-anthered bittercress. For the purpose of this review, we will consider most EOs as distinct populations unless proximity indicates they may be related. A breakdown of current and presumed extirpated populations and their corresponding EOs can be found in Appendix A. A summary of the current population can be found in Appendix A. The condition of each population is assessed based on data from the North Carolina National Heritage Program (NCNHP) and from the Virginia Department of Conservation and Recreation (VADCR) was evaluated for population presence and protection status. EO ranks establish a measurement which estimates the sustainability of a species. A-ranked (excellent viability) and AB-ranked (excellent-good viability) populations demonstrate favorable characteristics which are very likely to persist into the future. The EO can consist of more than one spatially discrete location where the species has been observed.

The following are the recovery criteria as defined in the 1991 recovery plan (Service 1991). Information about the status of each criterion are provided below.

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.

Of the 37 known populations (Appendix A), 29 known populations are still extant, 12 populations within North Carolina and 17 populations within Virginia, all on privately owned lands (Van Alstine 2016; Van Alstine 2018; Stanley 2021; NCNHP 2021). The remaining eight populations are likely extirpated with no plants found in the 2020 surveys (i.e., recorded as extirpated or failed to find by the state natural resource agencies). The number of populations identified has changed from the 2016 5-year review, populations have been either added or removed from Appendix A based on recent data. Additions include subpopulations which were newly identified, subpopulations were lumped into a single population and identified by multiple EO Rankings and names in the Location field of Appendix A.

Of the 29 extant populations, 7 have a rank of A (excellent viability) and 4 have at least one EO with a rank of AB (excellent-good viability) (NCNHP 2021; Virginia Natural Heritage Program, 2014). Of the seven populations with excellent viability (rank of A), two are in North Carolina and five are in Virginia. Of these seven populations three were surveyed in 2014, two surveyed in 2013, and two surveyed in 2004. Each of the seven excellent viability sites lacks a management plan and does not have a survey which post-dates the 2016 5-year review. Due to the outdated information, these populations cannot be assumed to meet this recovery criteria until re-evaluated. All 29 extant populations of *C. micranthera* are located on private property making private landowner permission a requirement for further evaluation of habitat protection priorities.

We currently lack information specific to the species and 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.

Currently, there are only two populations afforded some protection, one (NCNHP EO 24.002; part of Service population 16 in Appendix A) is protected by a voluntary registry with the NCNHP, the second (NCNHP EO 23.019; part of Service population 23 in Appendix A) is subject to a conservation easement with the North Carolina Division of Mitigation Services. Neither site, (NCNHP EO 24.002 and NCNHP EO 23.019) has received an update to the status of its population or protection since the 2016 5-year review. Therefore, the criterion of at least six adequately protected populations has not been met.

Biology and Habitat

Abundance and demographics

Cardamine micranthera was federally listed in 1989, the listing rule described four populations all confined to the Dan River basin in North Carolina. In 1991 a recovery plan was developed for the species and by then five additional populations had been discovered in Patrick County, Virginia totaling nine extant populations (four in North Carolina and five in Virginia) (Service 1991).

At the time of the 2016 5-year review, the number of known extant populations had increased from 9 to 32 (Service, 2016). New populations remained in the narrow range of the Dan River system of Stokes County, North Carolina and Patrick County, Virginia. Estimates of abundance for the 32 extant populations of the species ranged from one plant (North Fork of South Mayo River, VA) to 8,000 – 10,000 plants (Peters Creek, VA) (Appendix A).

Since the 2016 5-year review, three populations (Service populations 1, 25, and 32, Appendix A have been moved from a D-ranking (poor viability) to F (failed to find). Therefore, the current species range remains confined to 29 populations in the Dan River system in Stokes County, NC and Patrick County, VA. The 29 extant populations (13 in NC and 16 in VA) represented by current (within the last 5 years) population surveys ranged from 10 to 3,000 plants. New occurrences were identified in Patrick County, VA (Van Alstine 2018). One hundred and fifty-two new plants were found within Peters Creek and Little Peters Creek and one new plant in Russell Creek (Van Alstine, N.E. 2018). One new discrete site has been added to the Dan River, NC (NCNHP 2021). The EOs have been expanded to represent these increases. These 29 populations represent some 124 sites (28 in NC and 96 in VA). A historical review of extant populations and more current information is provided below (Tables 1 and 2).

The number of populations in North Carolina has remained stable at 13 since 2016. Of these 13 populations, five were surveyed in 2013 and eight were surveyed in 2018 (NCNHP 2021). The number of extant populations in Virginia has declined from 20 to 16 (Van Alstine 2016, 2018). Of these 16 populations, 2 were surveyed in 2004, 6 in 2014, 4 in 2015, 2 in 2017 and 2 in 2020. Current estimates of abundance for the 29 populations range from ten plants (Dan River, NC) to 3,000 – 5,000 plants (Peters Creek, VA) (Appendix A). Nine of the 29 populations are in a decline, 4 are stable, 8 are increasing, and 8 are unknown.

Table 1. Number of small-anthered bittercress extant populations.

Year	Number of Populations in North Carolina	Number of Populations in Virginia	Total Number
1991	4	5	**9**
2016	13	20	**32**
2021	13	16	**29**

Table 2. Number of small-anthered bittercress populations surveyed since 2016 in each status category.

Status	Number of Populations in North Carolina	Number of Populations in Virginia	Percentage	Total Number
Extirpated		3	**15%**	**3**
Failed to Find	1		**5%**	**1**
Decline	4	6	**50%**	**10**
Stable	1		**5%**	**1**
Increase	3	2	**25%**	**5**

Survey data which post-dates the 2016 5-year review has been provided by the VADCR which completed population counts of *C. micranthera* in the area surrounding Patrick County, VA. This effort was accomplished with funds provided under Section 6 of the Act, and data includes both extant and extirpated populations. This monitoring revealed population sizes from 11 known sites. Six of the 11 populations declined, ranging from 19.29% to 100% population loss, two sites had a population increase of 68% and 90%, and three populations are extirpated. In North Carolina, nine surveys post-date the previous 2016 5-year review and include both extant and failed to find populations. Four populations declined, ranging from 28.26% to 90.38% population loss; one remains stable; and three have increased by an average of 217 plants and one population is considered a 'failed to find.' A summary of the current survey data is provided in Appendix A.

Recent survey efforts find that the number of documented *C. micranthera* populations has decreased since the last 5-year review in 2016. Inconsistent and infrequent monitoring increases uncertainties associated with the species' status and trends and the status of individual populations cannot be adequately assessed at this time.

Genetics information
The Service is not aware of any genetic research (including genetic variation within or among populations) conducted for this species since the 2016 5-year review.

Taxonomic classification
The Service is not aware of any changes in taxonomic classification or nomenclature since the 2016 5-year review. Small-anthered bittercress (*Cardamine micranthera*) is still considered a valid species by and is recognized by Weakley and the Southeastern Flora Team (2022).

Spatial distribution
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, NC. 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, NC. The 1989 listing rule did not provide additional information on the location of these four populations; however, information on file with the Asheville Field Office 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).

At the time of the 2016 5-year review *C. micranthera* remained confined to 32 populations in the Dan River system in Stokes County, North Carolina, and Patrick County, Virginia (Service 2016). The current species range remains confined to 29 extant populations in the Dan River system in Stokes County, NC (13 populations), and Patrick County, VA (16 populations). Occurrences of this species and its habitat have increased to include additional tributaries of Peters Creek, Little Peters Creek and Russell Creek. Locations where new individuals were identified contained tributary access, seepy banks, mossy rocks and muddy to rocky bars within a narrow channel. Because this species is associated waterways, an appropriate way to determine its distribution is by looking at watersheds. A hydrologic unit code (HUC) is a national measurement describing the area of land located upstream from a specific point on the stream that contributes surface water runoff directly to this outlet point (Seaber et al. 1987). The delineation of these streams where *C. micranthera* has been located captures the small tributary systems indicative of streambanks, sandbars, seepages, wet rock crevices, and wet woods along small streams, which the recovery plan identifies as suitable habitat. The species is confined to the Dan River system (HUC 8, the highest or most spatially wide extent of the species), 7 subbasins (HUC 10 watersheds, analogous to medium-sized rivers), and 8 sub-watersheds (HUC 12, analogous to tributaries) (North Carolina Department of Environmental Resources, 2022).

Habitat or ecosystem conditions

Details of suitable habitat information can be found in the 2016 5-year review (Service 2016). Three populations along the Dan River and North Fork and Caldwell creeks are now considered extirpated. The three extirpated populations are in Patrick County, VA where timber harvesting is a common practice (Van Alstine 2018). *Cardamine micranthera* benefits from control of erosion and sedimentation as well as maintaining canopy over the stream banks to provide the partial shade and moisture contact (Service, 1991)

Five-Factor Analysis

Present or threatened destruction, modification or curtailment of its habitat or range (Factor A)

The recovery plan for *C. micranthera* identifies habitat alteration as the primary threat to the species and this remains the primary threat as of this review. Habitat alteration is listed as stream impoundment, stream channelization, habitat conversion associated with agriculture or silviculture, flooding, and encroachment of exotic species (Service 1991). When *C. micranthera* was federally listed in 1989 there were four known extant populations, all confined to the Dan River basin in Stokes and Forsyth counties of North Carolina (Service, 1991).

Habitat modification and destruction is still considered a continuing threat to the species and is unlikely to be alleviated in the future. Since the 2016 5-year review, 13 informal consultations under Section 7 of the Act have occurred in Stokes County, NC where 22 *C. micranthera* populations have been observed. The 2017 surveys identified needing

increased habitat protection due to timber harvesting, a common practice within the county (VanAlstine, 2018). Disturbances to the floodplain, tributaries, and river basins due to timber harvesting further support erosion and sedimentation loss while also removing the canopy over stream banks where *C. micranthera* is often located. Additionally, these disturbances present a risk of common invasive species which were found in the Gilbert Mills, Peters Creek North, and Peters Creek Central Sites of Virginia. *Microstegium vimineum* (Japanese stiltgrass) was commonly found on the silt/sand bars, *Lonicera japonica* (Japanese honeysuckle) and *Rosa multiflora* (multiflora rose) were occasionally present on streambanks and *Murdannia keisak* (marsh dewflower) was also noted (VanAlstine, 2018). Three site records, Gilbert Mills, Peters Creek North, and Peters Creek Central Sites of Virginia, 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 2021, VanAlstine, 2018).

Over utilization for commercial, recreational, scientific, or educational purposes (Factor B)
We are not aware of any new information indicating this constitutes a significant threat to the species.

Disease or predation (Factor C)
We are not aware of any new information indicating this constitutes a significant threat to the species.

Inadequacy of existing regulatory mechanisms (Factor D)
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) list *C. micranthera* as endangered. State and federal statues primarily regulate collection and trade in listed species, and do not prohibit landowners from neglecting or otherwise impacting such species on their own properties or in conjunction with otherwise legal activities.

Other natural or manmade factors affecting its continued existence (Factor E)
Although we are unaware of direct evidence that climate change will impact the species, we have seen increases in temperatures and a long-term increase in extreme precipitation events since the beginning of the century which are expected to continue into the future (Frankson et al. 2022; Runkle et al. 2022). Although the impacts to the species are unknown, they have the potential for direct impacts to species through landslides and flooding events and indirect impacts through changes in habitat and potential impacts to pollinator species.

In addition to the information above, small, isolated populations are generally less resilient to natural stochastic events and have higher extinction risk (Pimm et al. 1988). In the event of local extirpation, because of isolation, it may be more difficult to recolonize those areas. Isolation of populations may also have long-term impacts to genetic health of

the species, increase the chance of inbreeding depression, and reduce its adaptive ability in the future.

Synthesis

C. micranthera is a small herb in the mustard family native to North Carolina and Virginia. The number of known extant populations of has decreased from 32 to 29 since the last 5-year review. Since the recovery plan was written (1991), a number of new populations were discovered, however, four populations have been determined to be extirpated and four populations have not been found. Although monitoring for the 32 populations since the last 5-year review has been infrequent and inconsistent, the species continues to be endemic of the Dan River system, in Stokes County, NC, and Patrick County, VA. Habitat alteration threats continue to affect current populations. The remaining populations all occur on privately owned lands where developmental pressure, timber harvest, invasive species, erosion, and sedimentation are ongoing problems. Many small, isolated populations also increase risk of extirpation for the species because it may be more difficult to recolonize those areas and isolation may limit genetic exchange which could result in inbreeding depression and reduced genetic health. Data and information outlined in this review highlight the need for continued management and monitoring throughout the range and show *C. micranthera* continues to meet the definition of an endangered species under the Act.

RECOMMENDATIONS FOR FUTURE ACTIVITIES

The following activities are recommendations to improve recovery of the species.

1. Continue to pursue follow-up information from stream restoration projects 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).

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RESULTS/SIGNATURES

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
____ Delist
_X_ No change needed

Review Conducted By: Karla Quast, Asheville Field Office

FIELD OFFICE APPROVAL:

Field Supervisor, Asheville Ecological Services Field Office, U.S. Fish and Wildlife Service

JANET MIZZI Digitally signed by JANET MIZZI
Date: 2023.08.09 13:31:13 -04'00'

Approve _____

** Since 2014, Field Supervisors in the Region have been delegated authority to approve 5-year reviews that do not recommend a status change.*

COOPERATING REGIONAL OFFICE APPROVAL:

We emailed this 5-year review to the Northeast Regional Office for their concurrence prior to finalizing the document. We will retain any comments that we received, as well as verification of concurrence from other regions, in the administrative record for this 5-year review.

APPENDIX A

Populations of *Cardamine micranthera* (small-anthered bittercress). Data presented from the Virginia Natural Heritage Program (VANHP) and North Carolina Natural Heritage Program (NCNHP) Elemental Occurrences (EO) and their ranks.

Service population number	Location[a]	VAHP EO number (EO Rank)[b]	NCHP EO number (EO Rank)[b]	Number of discrete sites "Subpopulations"	Population trend (if known)	Maximum population size[c]	Date last observed
3	Little Dan River - unnamed tributary	023 (BC)		14	Increase	362 plants	2015
4	Hookers Creek – mainstem and tributary	024 (B)		5	Decline	143 plants	2015
5	Browns River – unnamed tributary	<023 (BC)		1	Increase	190 plants	2015
6	Sandy Creek	<006 (AB)		8	Decline	452 plants	2017
7	Dan River – unnamed tributary		007 (B)	1	Decline	478 plants	2018
8	Dan River – unnamed tributary		010 (A)	1	Stable	1,276 plants	2013
9	Dan River – unnamed tributary		011 (BC)	1	Stable	275 plants	2013
10	Elk Creek (mainstem and tributary)	<006 (AB)	003 (D)	8	Stable	10 plants	2013
11	Dan River – unnamed tributary		004 (D)	2	Decline	10 plants	2018
13	Dan River – unnamed tributary		016 (D)	1	Rapid decline	12 plants	2013
14	Peters Creek - mainstem and Long Branch	001 (AB)		30	Decline	3,000-5,000 plants	2017
15	Peters Creek – unnamed tributary		009 (D)	1	Decline	36 plants	2018

Service population number	Location[a]	VAHP EO number (EO Rank)[b]	NCHP EO number (EO Rank)[b]	Number of discrete sites "Subpopulations"	Population trend (if known)	Maximum population size[c]	Date last observed
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	2018
17	Little Creek – mainstem and tributary		015 (A)	1	Stable	Ca. 500 plants	2013
19	Unnamed tributary – Dan River		017 (C)	2	Increase	346 plants	2018
21	Snow Creek – unnamed tributary		006 (B)	1	Increase	344 plants	2018
22	Snow Creek – unnamed tributary		014 (D)	1	Decline	33 plants	2018
23	Snow Creek – unnamed tributary		23.018 (C), 23.019 (F)	2	Increase	199 plants (23.018), 0 plants (23.019)	2018, 2013
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 (UNK)		1		---[e]	2020
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	Increase	408 plants	2020
33	Spoon Creek - mainstem and tributaries	<010 (A)		7		1550 plants	2004

Service population number	Location[a]	VAHP EO number (EO Rank)[b]	NCHP EO number (EO Rank)[b]	Number of discrete sites "Subpopulations"	Population trend (if known)	Maximum population size[c]	Date last observed
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	Increase	59 plants	2015
37	Little Mill Creek	<017 (A)		1		700-800 plants	2014
38	Mill Creek – unnamed tributary	<017 (F)		3	Severe decline	0 plants	2014
32	Cadwell Creek	009 (X)		4	Severe decline	0 plants	2020
25	North Fork of South Mayo River	016 (X)		1	Severe decline	0 plants	2020
1	Dan River – unnamed tributary	022 (X)		1	Severe decline	0 plants	2016
24	Belews Creek		001 (X)	1	Extirpated	0 plants	2013
18	Bonds Branch and tributary		008 (F)	2	Severe decline	0 plants	2013
12	Dan River – unnamed tributary		021 (F)	1	Severe decline	0 plants	2013
20	Unnamed tributary – Dan River		020 (F)	1	Severe decline	0 plants	2018

[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.*