

Recovery Outline
For
Leavenworthia exigua var. *laciniata* (Kentucky glade cress)
May 2014



* Photo courtesy of James Gruhala, USFWS.

I. INTRODUCTION

This document outlines a preliminary course of action for the recovery of *Leavenworthia exigua* var. *laciniata* until a comprehensive recovery plan for the species is approved. *Leavenworthia exigua* var. *laciniata* is a small (2-4 inches in height), annual plant that grows on areas of flat, thin soil. It occurs only in extreme southeastern Jefferson County and the northeastern portion of Bullitt County, Kentucky. A member of the mustard family, it typically blooms in late February to early March and has a small white to lilac colored flower. *Leavenworthia exigua* var. *laciniata* was listed as a threatened species under the Endangered Species Act (ESA) on May 6, 2014 (79 FR 25683). The primary threat to this plant is habitat destruction, modification, and fragmentation.

Listing and Contact Information:

Listing Classification:	Threatened range wide
Effective Listing Date:	June 5, 2014
Critical Habitat Designation:	June 5, 2014
Lead Agency, Region:	U.S. Fish and Wildlife Service, Southeast Region
Lead Field Office:	Frankfort, Kentucky Ecological Services Field Office
Contact Biologist:	Jennifer Garland, Jennifer_Garland@fws.gov , 502-695-0468 ext. 115

II. RECOVERY STATUS ASSESSMENT

A. BIOLOGICAL ASSESSMENT

Taxonomy, Life History, Habitat, Distribution, and Trends [Note: For a more detailed description of this species' biology and an assessment of listing factors as they relate to this plant, please refer to the proposed listing rule (78 FR 31498; May 24, 2013) and the final listing rule (79 FR 25683 published on May 6, 2014).]

L. exigua var. *laciniata* is an annual member of the mustard family (*Brassicaceae*) known only from two counties in Kentucky. Plants are about 5 to 10 cm (1.97 to 3.94 in) in height with early leaves that are simple with a slender petiole (central stalk of the leaf) and mature leaves that are sharply lobed (appear as disconnected pieces along the main leaf vein), somewhat squarish at the ends and arranged as a rosette (circular cluster of leaves) (Evans and Hannan 1990). The flowers are small (3 to 6 mm (0.12 to 0.24 in)), white to lilac in color with four petals, green rather than lavender sepals (the outer of two floral leaves that make up the flower), and leafless stems. Leaves typically disappear by the time the plant is in fruit (Evans and Hannan 1990). The fruit is flat and pod-shaped.

L. exigua var. *laciniata* appears to be adapted to environments with shallow soils interspersed with flat-bedded, Silurian dolomite and dolomitic limestones, which is an uncommon geological formation in Kentucky (Rollins 1963; Evans and Hannan 1990). The soil on these horizontally bedded limestone areas is often only a few inches in depth or may be completely lacking in some areas (Rollins 1963). Because of the thin soils and underlying limestones, these habitats, called cedar or limestone glades, are extremely wet from late winter to early spring and quickly become dry in May and June. The natural habitat for *L. exigua* var. *laciniata* is these cedar glades (Baskin and Baskin 1981), but the taxon is also known from overgrazed pastures, eroded shallow soil areas with exposed bedrock, and areas where the soil has been scraped off the underlying bedrock (Evans and Hannan 1990). *L. exigua* var. *laciniata* does not appear to compete well with other vegetation and is shade intolerant (Evans and Hannan 1990).

The life cycle is nearly identical for all members of the genus *Leavenworthia* (Baskin and Baskin 1981; Solbrig 1971). All are winter annuals, endemic to cedar glades or glade-like habitats (Baskin and Baskin 1985). For *L. exigua* var. *laciniata*, seed germination occurs in September and October (Baskin and Baskin 1981). Baskin and Baskin (1971; 1972) found that freshly harvested *Leavenworthia* spp. seeds were dormant at any temperature and that once dormancy was broken, germination was prevented by high temperatures, regardless of moisture levels. This seems to protect *Leavenworthia* spp. from germination following short summer showers that temporarily moisten the glade habitats (Baskin and Baskin 1985), and allows it to avoid the hot, dry summer (Baskin and Baskin 1972). All seeds may not germinate each fall, allowing seed reserves to accumulate (Baskin and Baskin 1981). A study by Baskin and Baskin (1981) found collected *L. exigua* var. *laciniata* seeds germinated in a greenhouse over four autumns, although at drastically reduced numbers after the first year (4,907 in 1976, 190 in 1977, 156 in 1978, and 71 in 1979).

L. exigua var. *laciniata* persist through the winter as rosettes, and flowering begins in late February to early March (Baskin and Baskin 1981; Evans and Hannan 1990). Seeds are set and plants die in April and May as the glade habitats dry out (Baskin and Baskin 1985; Solbrig 1971). At maturity, most of these seeds are dormant and will not germinate following dispersal, even if the soils are moist (Baskin and Baskin 1985). During the summer, these seeds undergo physical changes known as after-ripening and move from dormancy to conditional dormancy and finally, become non-dormant for fall germination (Baskin and Baskin 1985).

The cyclical moisture availability on the thin soils of glades and other habitats acts to limit the number of plant species that can tolerate these extremes. Consequently, very few other plants occur on undisturbed glades (Evans and Hannan 1990). Common associates of *L. exigua* var. *laciniata* include *Northoscordum bivalve* (false garlic), *Scutellaria parvula* (little skullcap), *Sporobolus vaginiflorus* (poverty dropseed), *Viola septemloba* var. *egglestonii* (cedar glade violet), and *Houstonia canadensis* (Canadian bluets) (Baskin and Baskin 1981; Evans and Hannan 1990). In areas where the glades have been disturbed, native and introduced weedy species (annual and perennial) have invaded glades from nearby roads, fields, and waste areas (Baskin and Baskin 1985).

Areas surrounding glade openings tend to have deeper soils that support plants with prairie/barren affinities like *Schizochyrium scoparium* (little bluestem), *Lithospermum canescens* (hoary pocoon), *Viola pedata* (birdfoot violet), *Echinacea pallida* (pale purple coneflower), and *Liatis aspera* (tall gayfeather) (White 2004).

L. exigua var. *laciniata* is a Kentucky endemic and is known from only northeastern Bullitt County and extreme southeastern Jefferson County (Evans and Hannah 1990; Jones 2005; White 2004). Populations of *L. exigua* var. *laciniata* are disjunct (separated) from populations of the other two varieties of *L. exigua* that occur in Alabama, Georgia, and Tennessee (Rollins 1963, NatureServe Explorer 2012).

Based on our data, the species is currently limited to 61 extant occurrences. A total of 23 historical occurrences are considered extirpated or were not located by the Kentucky State Nature Preserves Commission (KSNPC) during the most recent surveys (KSNPC 2012). Of the 61 extant occurrences, 43 are of poor quality (D-rank; 70 percent). Approximately half of these poor-quality occurrences are located on residential lawns, with few, if any, native plants. These lawn occurrences are not believed to be sustainable, due to competition from lawn grasses and lawn maintenance and improvement activities. A summary of current occurrence ranks for all known sites is listed in Table 1 below.

Over the last 20 years, KSNPC has systematically used aerial photography to identify potential *L. exigua* var. *laciniata* glade habitat in areas of Laurel and other suitable types of limestone bedrock with the intent of identifying new populations within the known range and exploring potential areas to expand the known habitat. Very little potential habitat fitting these parameters has not been surveyed. Also, this part of the State is heavily explored because it is so populated and accessible; therefore, discovering any

additional limestone glades, the only habitat known for this species, in another part of the region is very unlikely (D. White, pers. comm., 2012).

Table 1. 2012 status ranks for *L. exigua* var. *laciniata* (KSNPC 2012)

Rank	Viability	# Occurrences
A	Excellent	1
B	Good	4
C	Fair	13
D	Poor	43
F	Not Located	7
X	Extirpated	16
	TOTAL	84

Critical Habitat:

Note: For a more detailed description of the critical habitat designated for this species, please refer to the proposed critical habitat rule (78 FR 31479 published on May 24, 2013) and the final critical habitat rule (79 FR 25689 published on May 6, 2014)

Based on our current knowledge of the physical or biological features and habitat characteristics required to sustain the species' life-history processes, we determine that the primary constituent elements specific to *L. exigua* var. *laciniata* are:

- (1) Cedar glades and gladelike areas within the range of *L. exigua* var. *laciniata* which include:
 - (a) Areas of rock outcrop, gravel, flagstone of Silurian dolomite or dolomitic limestone, and/or shallow (1–5 cm), calcareous soils;
 - (b) Intact cyclic hydrologic regime involving saturation and/or inundation of the area in winter and early spring, then drying quickly in the summer;
 - (c) Full or nearly full sunlight; and
 - (d) An undisturbed seed bank.

- (2) Vegetated land around glades and gladelike areas that extends up and down slope and ends at natural (e.g., stream, topographic contours) or manmade breaks (e.g. roads).

The U.S. Fish and Wildlife Service (Service) is designating approximately 2,053 acres of critical habitat for *L. exigua* var. *laciniata*. Six critical habitat units containing a total of 18 subunits were designated in Bullitt and Jefferson Counties, Kentucky. All units and subunits were considered occupied at the time of listing.

Table 2. Designated critical habitat units for *L. exigua* var. *laciniata*.

Critical Habitat Unit	Sub Unit	Land Ownership by Type	Size of Unit in Acres (Hectares)
1		Louisville/Jefferson County Metro Government	18 (7)

2	2A	Private	102 (41)
2	2B	Private	870 (352)
2	2C	Private	42 (17)
3	3A	Private	25 (10)
3	3B	Private	7 (3)
3	3C	Private	10 (4)
4	4A	Private	91 (37)
4	4B	KSNPC; Private; Private with KSNPC easement	69 (28)
4	4C	Private	83 (34)
4	4D	Private	46 (19)
4	4E	Private	102 (41)
4	4F	Private	120 (49)
4	4G	Private	20 (8)
4	4H	Private	16 (6)
5	5A	Private	8 (3)
5	5B	Private	50 (20)
6		Private	374 (151)
Total			2,053 (830)

Note: Area sizes may not sum due to rounding.

B. THREAT ASSESSMENT

Factor A. Habitat destruction and modification have been the primary cause of population declines and extirpations of the *L. exigua* var. *laciniata* (KSPNC 2012) occurrences. Filling and/or grading of glade habitat for residential and commercial construction has resulted in or contributed to the loss of at least seven known populations (KSPNC 2012). Conversion of glade areas to landscaped settings such as golf courses and residential lawns by filling, grading, and seeding of lawn grasses has impacted an additional five occurrences. Nearly a third of the extant occurrences are of low quality and occur in managed (e.g., residential, commercial, and agricultural) landscapes. Many of the extant occurrences are threatened by encroaching lawn grasses and nonnative plants that compete with *L. exigua* var. *laciniata* for space and nutrients (D. White, pers. comm., 2012). Winter annuals, such as *Leavenworthia* spp., are documented to be poor competitors (Rollins 1963, Kral 1983, Baskin and Baskin 1988). Shading from shrubs and trees makes habitats unsuitable for *L. exigua* var. *laciniata*, which is shade-intolerant (Baskin and Baskin 1988). Recreational activities such as horseback riding and off-road vehicle (ORV) use can change water flow patterns and damage fragile glade habitats. Construction and maintenance of linear infrastructure such as roads and utility lines can also destroy or degrade *L. exigua* var. *laciniata* habitat. A few voluntary conservation measures are in place on private, state and local government owned properties that reduce

threats to specific *L. exigua* var. *laciniata* occurrences, but to date, none have resulted in any measurements of success or assurances that these activities will continue into the future. Climate change has the potential to impact this species, but to what extent we cannot predict.

Factor B. Due to the small size and limited distribution of the few remaining populations, *L. exigua* var. *laciniata* is potentially vulnerable to overutilization. However, the few current and historic collections are not believed to have a significant impact on *L. exigua* var. *laciniata*. The Service will coordinate with any agency or university studying *L. exigua* var. *laciniata* to ensure that future collections will not significantly contribute to the decline of the species. We have no information to suggest that *L. exigua* var. *laciniata* is collected for commercial, recreational, or educational purposes, and we have no reason to believe that this factor will become a threat to the species in the future.

Factor C. We have identified no available information regarding disease in *L. exigua* var. *laciniata*. Furthermore, we have identified no information regarding animal (wild or domestic) predation on *L. exigua* var. *laciniata*. Field observations by the KSNPC during extensive surveys of this species indicate that neither disease nor predation is a factor contributing to the decline of the species at this time (Evans and Hannan 1990; White, pers. comm., 2012).

Factor D. We are not aware of any other State or Federal statutes or regulations that would provide protections to *L. exigua* var. *laciniata*.

Factor E. *L. exigua* var. *laciniata* is subject to several ongoing natural and manmade factors, which could affect its continued existence. The species has a narrow range, occurring in only small portions of two counties. Within this range, *L. exigua* var. *laciniata* is restricted to cedar glades and similar shallow-soiled areas that occur sporadically across the range. More than half of the remaining occurrences had low (fewer than 100 individuals) population counts at the time of the most recent survey. Additionally, the presumed low genetic diversity within individual occurrences of *L. exigua* var. *laciniata* could place those occurrences at a high risk of extirpation as their capacity for adaptation to change is reduced.

C. CONSERVATION ACTIONS

While there are no formal pre-listing conservation plans or agreements in place for this species, the KSNPC and The Nature Conservancy (TNC) have been implementing conservation actions for this species listing for over 20 years.

The KSNPC has been monitoring this plant and its populations since before 1990, when the first range wide survey was conducted. This important conservation work has provided much of the information required by the Service for its listing and critical habitat determinations.

Using section 6 monies provided by the Service, KSNPC has also been working on a preliminary plan for the use of seed in the recovery of *L. exigua* var. *laciniata*. To date, efforts have focused on collecting seed (no more than 10%) from donor sites. Donor sites are those occurrences with relatively large amounts of seed and little potential for recovery (e.g. roadsides and lawns).

In 1986, KSNPC entered into a written agreement with the owner of Rocky Run Glade, who agreed not to alter the registered area and to allow KSNPC agents to enter the area for scientific observation, research or education, in exchange for the Registered Natural Area designation. KSNPC regularly monitors this occurrence and has provided active management on the site with invasive species control and removal of encroaching trees.

In 1991, the Kentucky Chapter of TNC purchased Pine Creek Barrens, a 110 acre cedar glade and barren containing the highest quality occurrence of *L. exigua* var. *laciniata*. Over the years, TNC has implemented numerous conservation actions that have benefited the species such as, prescribed burning, invasive species management and cedar tree removal.

In addition to its monitoring efforts, KSPNC has been actively purchasing and protecting the Apple Valley Glade, which contains another high quality occurrence of *L. exigua* var. *laciniata*.

Jefferson Metro Parks, which manages McNeely Lake Park for the Jefferson County Metro Government, has received flexible funding from the Service to develop a management plan for *L. exigua* var. *laciniata* occurrence within the park and to implement habitat improvement measures such as invasive species and woody plant removal in the areas surrounding *L. exigua* var. *laciniata*. This work has not yet been initiated.

III. PRELIMINARY RECOVERY STRATEGY

A. RECOVERY PRIORITY NUMBER WITH RATIONALE

Leavenworthia exigua var. *laciniata* is assigned a recovery priority of 9, which indicates that the species faces a moderate degree of threat and demonstrates a high recovery potential. *L. exigua* var. *laciniata* is a subspecies (or variety). The threat level for this species is considered moderate; because the threats are ongoing and occur across the species' range but are unlikely to impact all populations equally. The recovery potential for *L. exigua* var. *laciniata* is high because the biological and ecologically limiting factors for this species are relatively well understood. Active management will be needed to maintain populations. The threats to the species' existence are primarily habitat related and could be alleviated through habitat restoration, protection, and management.

B. RECOVERY STRATEGY

The recovery strategy for *L. exigua* var. *laciniata* will involve a significant amount of outreach and work with private landowners. The Service sent letters to all known property owners within the critical habitat designations, concurrent with the publishing of the proposed critical habitat designation in the Federal Register. The Service has established relationships with the owners of Unit 1 (McNeely Lake Park, Jefferson/Louisville Metro Parks), Subunit 4A (Pine Creek Barrens, TNC) and Subunit 4B (Apple Valley Glade, KSNPC). Three owners with property within Subunits 3B and 4E contacted the Service after receiving the letter. The Service plans to work with these landowners to improve habitat conditions for *L. exigua* var. *laciniata* on their properties. Additionally, KSNPC's long-standing relationship with the partial owners of Unit 6 (Rocky Run) will allow for ongoing management on portions of that critical habitat unit. Work with these landowners and others will be critical for the recovery of *L. exigua* var. *laciniata*.

There are 61 known extant occurrences of *L. exigua* var. *laciniata*, and the 18 most viable occurrences were designated as critical habitat. While these critical habitat sites will be the highest priority for protection and management, the Service and its partners will take advantage of opportunities to benefit the species, where those opportunities present themselves.

Management of disturbance, invasive species, and forest encroachment are likely to be the most widely required management activities for this species. Additionally, an increased understanding of how the occurrences do or do not interact with each other will be necessary for determining what impact habitat fragmentation has had on the genetic diversity of this species and the importance of proximity of protected occurrences for the recovery of the species.

This genetic information will be important as the role of seed collection and population augmentation and re-introductions become more fully developed. The Service expects that information regarding the genetic diversity at and between sites will be used to drive the identification of appropriate recipient sites for donor seed. While the species is still broadly distributed within its narrow range and there are a relatively high number of occurrences remaining, most of these sites are in private ownership and under threat from future development. As such, opportunities to provide protected and managed habitats for this species should be capitalized upon, with considerations of population augmentation or reintroduction where appropriate.

The Service's initial recovery planning will involve working with our partners and the public to protect, conserve, and restore appropriate glade habitats.

C. INITIAL ACTION PLAN

Anticipated Recovery Actions in relation to our recovery strategy described above:

1. Continued public outreach to provide education and explore opportunities to work on private property.

2. Develop and implement management strategies for the species.
3. Conduct regular monitoring at all accessible sites.
4. Conserve and manage existing populations and habitat.
5. Establish methods to effectively reintroduce and monitor *L. exigua* var. *laciniata*.
6. Enhance the suitability of known sites and potential reintroduction sites.
7. Conserve germplasm (genetic material; e.g. seed) and promote genetic diversity.
8. Conduct studies of genetic variation within and between known sites.
9. Determine the minimum number of populations required to ensure survival of *L. exigua* var. *laciniata*.
10. Define population regulation factors.

IV. PREPLANNING PROCESS

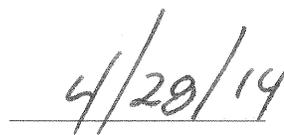
We will prepare a recovery plan for *L. exigua* var. *laciniata* that includes objective and measurable criteria which, when met, will ensure the conservation of the species. Recovery criteria will address all meaningful threats to the species, as well as estimate the time and the cost to achieve recovery. The recovery plan will be prepared by the Kentucky Field Office. The draft recovery plan should be finalized and sent to the Regional Office for review in March 2015. The final recovery plan should be finalized and sent to the Regional Office for review by March 2016. These timelines may be affected by available resources and regional priorities.

During the recovery planning process, input, comments and review will be sought from multiple stakeholders within the Commonwealth of Kentucky. These will include State and Federal agencies, industrial and agricultural groups, research universities, and conservation organizations.

Approved:



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



Date

References

Baskin, J. and C. C. Baskin. 1971. Germination ecology and Adaptation to Habitat in *Leavenworthia* spp. (Cruciferae). *American Midland Naturalist* 85(1):22-35.

- Baskin, J. and C. C. Baskin. 1972. The ecological lifecycle of the cedar glade endemic *Leavenworthia exigua* var. *exigua*. *Canadian Journal of Botany* (50): 1711-1723.
- Baskin, J. and C. C. Baskin. 1981. Geographical distribution and notes on the ecology of the rare endemic *Leavenworthia exigua* var. *laciniata*. *Castanea* 46:243-247.
- Baskin, J. and C. C. Baskin. 1985. Life cycle ecology of annual plant species of cedar glades of southeastern United States. Pages 371-398 in: White, J. *The Population Structure of Vegetation*. Dr. W Junk Publishers, Boston, Massachusetts
- Evans, M. and R. R. Hannan. 1990. Status survey report on *Leavenworthia exigua* var. *laciniata*. Unpublished report prepared by Kentucky State Nature Preserves Commission, Frankfort, Kentucky for U.S. Fish and Wildlife Service, Asheville, North Carolina. Cooperative Agreement No. 14-16-0004-89-956, Work Order No. 89-1. 95 pp.
- Jones, R. L. 2005. *Plant life of Kentucky: an illustrated guide to the vascular flora*. The University Press of Kentucky, Lexington, Kentucky. 834 pp.
- Kentucky State Nature Preserves Commission. 2012. Element Occurrence Record for *Leavenworthia exigua* var. *laciniata*. Frankfort, Kentucky. Printed May 7, 2012.
- Kral, R. 1983. A report on some rare, threatened, or endangered forest-related vascular plants of the south, Volume I Isoetaceae through Euphorbiaceae. U. S. Dept. Agric., Forest Service, Southern Region, Technical Publication RP-TP 2, Atlanta, Georgia.
- Rollins, R. C. 1963. The evolution and systematics of *Leavenworthia* (Cruciferae). *Contributions from the Gray Herbarium of Harvard University* No. CXCII, Cambridge, Massachusetts.
- Solbrig, O. T. 1972. Breeding System and Genetic Variation in *Leavenworthia*. *Evolution* 26(1): 155-160.
- White, D. 2004. Status Survey of *Leavenworthia exigua* var. *laciniata*, Gladecress – 2004 Update on Population Status. Unpublished report prepared by Kentucky State Nature Preserves Commission, Frankfort, Kentucky for U.S. Fish and Wildlife Service, Atlanta, Georgia.