Ruth's Golden Aster
(*Pityopsis ruthii*)

5-Year Status Review: Summary and Evaluation

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U.S. Fish and Wildlife Service
Southeast Region
Tennessee Ecological Services
Cookeville, Tennessee

July 2023

5-YEAR STATUS REVIEW
Ruth's Golden Aster (*Pityopsis ruthii*)

GENERAL INFORMATION

Current Classification: Endangered

Lead Field Office: Tennessee Ecological Services

Review Author(s): Geoff Call, Tennessee Ecological Services, (931) 261-8277

Reviewers:
Lead Regional Office: Southeast Region, Carrie Straight, (404) 679-7226

Date of original listing: August 19, 1985 (50 FR 29341; July 18, 1985)

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 species 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 424.11). The U.S. Fish and Wildlife Service (Service) evaluated the biology, habitat, and threats of Ruth's golden aster to inform this status review.

We announced initiation of this review in the Federal Register on May 13, 2022 (87 FR 29364) with a 60-day comment period. The primary sources of information used in this analysis were the 1985 final listing rule (50 FR 29341), the 1992 recovery plan, peer-reviewed literature, unpublished survey data and reports, and personal communication with recognized experts. This review was completed by the U.S. Fish and Wildlife Service, Tennessee Ecological Services Field Office (TFO), Cookeville, Tennessee. All literature and documents used for this review are on file at the TFO. All recommendations resulting from this review are the result of thoroughly reviewing the best available information on the Ruth's golden aster.

We have not received significant new information, interpreted previously reviewed information in a new, significant light since the last review of the species and the level of public interest is low and non-controversial; therefore, no peer review was conducted.

FR Notice citation announcing the species is under active review: May 13, 2022 (87 FR 29364)

Species' Recovery Priority Number at start of 5-year review (48 FR 43098): 5C (degree of threat is high, potential for recovery is low, and the taxonomy is at the species level)

Review History: Previous 5-year reviews, recommending no change in status, were published on April 23, 2012 (Service 2012), and September 19, 2018 (Service 2018).

REVIEW ANALYSIS

Listed Entity

Taxonomy and nomenclature:

We are not aware of any changes to the taxonomy of this entity, and it is still considered valid by the Service. Since the last 5-year review was completed, an investigation comparing chloroplast genomes for *Pityopsis* placed *Pityopsis ruthii* as a sister species to *P. flexuosa* (Hatmaker *et al*. 2020), but no taxonomic or nomenclatural revisions have been proposed for the species.

Distinct Population Segment (DPS) (61 FR 4722):

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

Recovery Plan or Outline

Final Recovery Plan for the Ruth's golden aster (*Pityopsis ruthii*), June 11, 1992 (Service 1992)

Recovery plans are not regulatory documents but are intended to provide guidance to the Service, States, and other partners on methods of minimizing threats to listed species and on criteria that may be used to determine when recovery is achieved. If the recovery criteria defined in the plan are still valid, meeting recovery criteria can indicate that the species no longer requires protections under the Act. However, when recommending whether a listed species should be delisted, the Service must apply the factors in section 4(a) of the Act (84 FR 45020). The recovery criteria that follow address factors affecting the species and remain valid currently.

Downlisting Criteria

The disparity in the sizes of the two known populations of Pityopsis ruthii and the dramatically different conditions under which each population exists necessitates a separate set of recovery goals for each river. Pityopsis ruthii, then, shall be considered for reclassification to threatened when either of the following situations occurs:

1. *The Ocoee River population, under the criteria described in or to be established by implementation of Task 7 (of the species' recovery plan), is deemed recovered and the rate of natural succession on the phyllite boulders on the Hiwassee River is determined to not be detrimental to the survival of P. ruthii;*

or

2. *The Hiwassee River population, under the criteria described in or to be established by implementation of Task 6 (of the species' recovery plan), is deemed recovered and Tasks 7.2, 7.3, 7.4, and 7.6 accomplished for the Ocoee River population.*

Delisting Criteria

Pityopsis ruthii shall be considered recovered when the full set of recovery goals (Tasks 6 and 7) for each population is fulfilled.

Available data indicate that activities have been conducted to implement some, but not all, elements of Tasks 6 and 7 of the recovery plan, on which achievement of the recovery criteria hinge. We refer the reader to the 2012 and 2018 5-year reviews for *Pityopsis ruthii* for a full discussion of activities that have been conducted to implement portions of the recovery actions described under Tasks 6 and 7 in the recovery plan. Since the 2018 5-year review, the primary recovery action that has been implemented for *P. ruthii* is conducting annual monitoring using a population census approach, which addresses the intent of Task 2 in the recovery plan: Maintain permanent plots.

Biology and Habitat Summary

The range and distribution of *Pityopsis ruthii* are essentially the same as they were known to be at the time of listing. That is, the species remains restricted to limited reaches of the Hiwassee and Ocoee rivers, in Polk County, Tennessee (Figure 1).

Since 2011, TVA, the Service, US Forest Service, and other partners have conducted annual census counts of *Pityopsis ruthii* populations, excluding 2020 (Table 1, Figure 2). There were 1,388 *P. ruthii* counted in the Ocoee River population during 2022. Data collection on the Hiwassee River has occurred at a total of 57 sites, but only 29 sites have been counted annually. The data from all 57 sites are useful for tracking the total counted in each year, with the caveat that the counts do not represent identical areas in each year. The total number of *P. ruthii* counted in 2022, across 44 of the 57 mapped sites, was 8,968. The total number of plants counted in 2022 across the populations in the Ocoee and Hiwassee rivers was 10,356.

Data from these counts (Table 1, Figure 2) demonstrate that the number of plants in the Ocoee River population, where 8 mapped sites have been counted each year, has increased by approximately 21 percent over the 12-year period of record. The 29 consistently counted sites on the Hiwassee River accounted for more than 85 percent of all plants tallied in this population each year from 2011 through 2022, thus are a repeatable count representative of trends for the population on this river. Based on data from these 29 sites, the population in the Hiwassee River experienced a period of increase from 2011 through 2014 but then declined through 2017. Since 2017, the number of *P. ruthii* has fluctuated, reaching a low of 7,164 in 2019, but increased to a total of 8,004 plants in 2022 at the 29, annually counted sites. Overall, the number of plants in these 29 sites has decreased approximately 10 percent from 2011 through 2022. Since 2014, when abundance peaked, the number of plants in these sites has decreased approximately 28 percent.

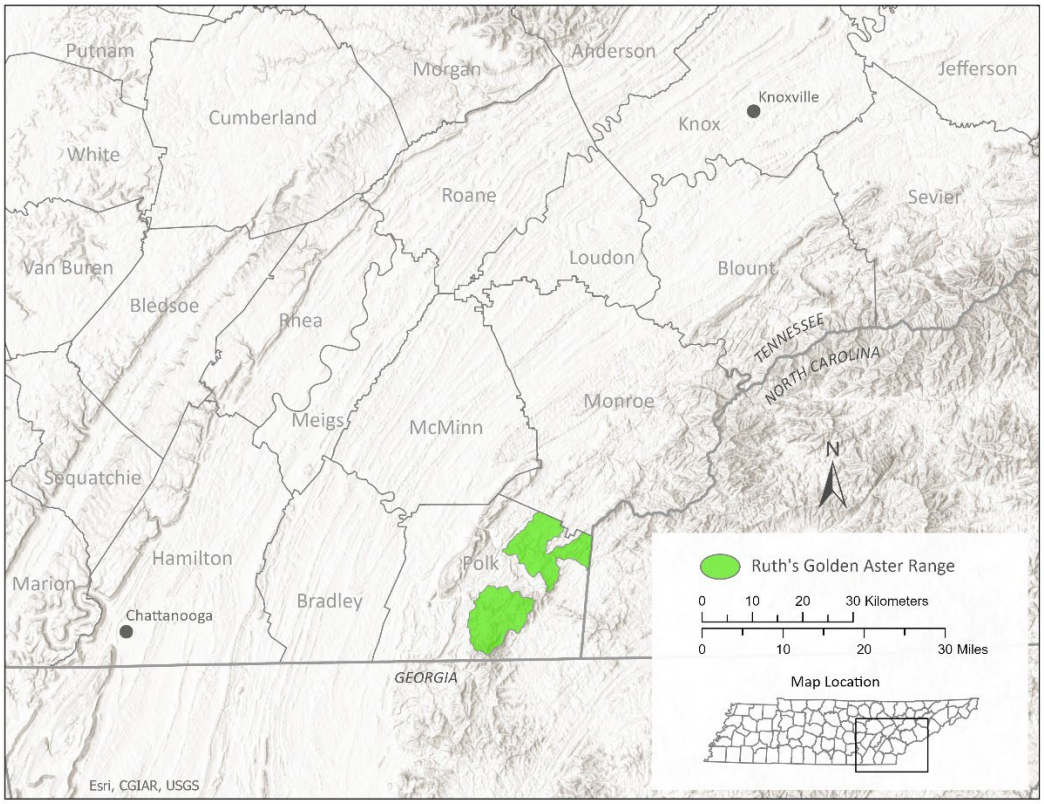

Figure 1. Map of HUC-12 watersheds, in the Hiwassee and Ocoee river basins, encompassing stream reaches within the known range of *Pityopsis ruthii*.

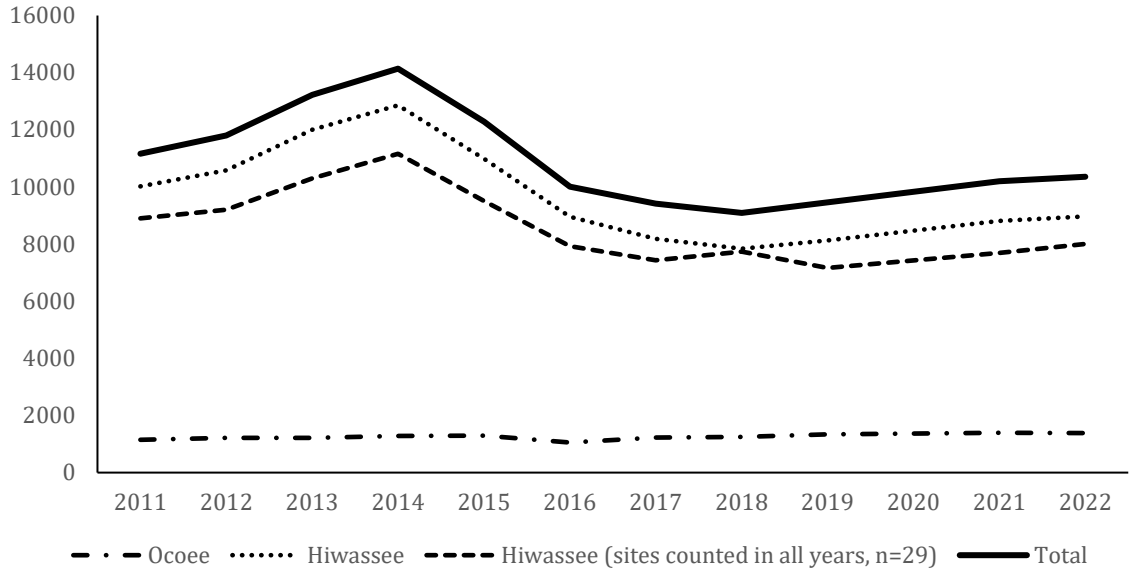

Figure 2. Population count data for *Pityopsis ruthii* for the period 2011 through 2022 (excluding 2020).

Table 1. Population census counts for *Pityopsis ruthii* in the Ocoee and Hiwassee river drainages, 2011 through 2022.

River	2011	2012	2013	2014	2015	2016	2017	2018	2019	2021	2022
Ocoee	1145	1218	1213	1283	1299	1053	1232	1253	1340	1394	1388
Hiwassee	10016	10582	12005	12857	10986	8958	8181	7837	8122	8805	8968
Hiwassee (sites counted in all years, n=29	8902	9199	10295	11160	9509	7929	7432	7733	7164	7687	8004
Total	**11161**	**11800**	**13218**	**14140**	**12285**	**10011**	**9413**	**9090**	**9462**	**10199**	**10356**

In a peer-reviewed publication, expanding on preliminary data from a M.S. thesis (Moore 2014) that we summarized in the 2018 5-year review, Moore *et al*. (2021) provided results from floral insect visitor surveys conducted during 2013 and 2015 at three sites of high *Pityopsis ruthii* abundance in the Hiwassee River population and an *ex situ* location at the University of Tennessee Arboretum. Like the preliminary results (Moore 2014) that we discussed in the 2018 5-year review, eastern bumble bee (*Bombus impatiens*) and introduced honey bee (*Apis mellifera*) were identified as likely contributors to gene flow in the Hiwassee population, owing to their relatively high visitation rates combined with confirmation that sampled individuals of these species carried *P. ruthii* pollen (Moore *et al.* 2021). Flies from the family Syrphidae were the most common visitors to *P. ruthii* in the Hiwassee River sites, comprising 68 percent, with the hover fly (*Toxomerus geminatus*) being the most observed taxon from this family (Moore *et al.* 2021), consistent with previously reported results. However, fly visitors to *P. ruthii* were found to carry little pollen. The relationship between flower abundance and floral visits by bees in the superfamily Apoidea (i.e., wasps and bees) that was reported for 2013 (Moore 2014) was not observed in 2015 for any taxa, including Apoidea, and the authors concluded there was little support for the hypothesis that greater flower abundance increases floral visitation rates to *P. ruthii* (Moore *et al.* 2021).

A study of controlled crosses conducted between genetically similar plants from two geographically separated sites in the Hiwassee River produced proportionally few (i.e., 7.3 percent) filled seeds, and mean germination success from these filled seeds was 33 percent (Moore *et al.* 2021). The authors interpreted this result as further support for hypotheses that inbreeding depression or incompatible genotypes could be influencing spatial and temporal variation in production of filled seeds by *P. ruthii* reported by others (Cruzan 2001, Wadl *et al.* 2014) and concluded that genetic incompatibilities among plants that are distributed across the Hiwassee River are contributing to reduced germination success of filled seeds that are produced through some crosses. A factor that could be contributing to reduced availability of compatible mates, along with previously reported high inbreeding coefficients, is asynchronous flowering within sampling sites (Hatmaker *et al.* 2018, Moore *et al.* 2021) causing only a portion of plants at a given location to be available for outcrossing at a given time.

Pityopsis ruthii exhibited low plasticity to respond to changes in temperature despite being highly plastic in its response to changes in light and water availability, when compared to narrowleaf silkgrass (*P. graminifolia*), a more common and widespread congener (Boyd *et al.*

2022). The authors interpreted higher plasticity in *P. ruthii* responses to light and water availability as an indication of specialization to the temporally dynamic conditions observed for these two environmental parameters in habitats the species occupies – i.e., crevices in boulders and outcrops along rivers with variable discharge and light availability. In contrast, they suggested a lack of plasticity in its response to temperature could indicate that *P. ruthii* might be less capable of persisting in a warming climate than *P. graminifolia.* Further, the plasticity that *P. ruthii* exhibited in response to variability in light and water availability treatments, which mimicked near-future changes anticipated by the authors, was associated with reductions in parameters related to photosynthesis, leaf production, and flowering, which could be maladaptive (Boyd *et al.* 2022).

Threats (Five-Factor Analysis) Summary

The status of a species is determined from an assessment of factors specified in section 4 (a)(1) of the Act, including: Factor A: the present or threatened destruction, modification, or curtailment of its habitat or range; Factor B: overutilization for commercial, recreational, scientific, or educational purposes; Factor C: disease or predation; Factor D: the inadequacy of existing regulatory mechanisms; Factor E: other natural or manmade factors affecting its continued existence. A summary of this assessment is detailed below.

Available data indicate that the Five-Factor Analysis presented in the 2018 5-year review remains accurate. We refer the reader to the 2018 5-year review for a more detailed discussion, but summarize the relevance of each of the five factors here:

- Present or threatened destruction, modification or curtailment of the habitat or range (Factor A) for *Pityopsis ruthii* remains a threat to the Hiwassee River population, because current hydroelectric dam operations and river management provide river flows that generally are inadequate for regulating encroachment of competing vegetation in many sites the species occupies. Further, due to the advanced stage of woody vegetation encroachment in many sites, it would not be possible to reduce this threat and enhance *P. ruthii* habitat through the restoration of more ecologically compatible river flows, alone. Additional means of control (e.g., mechanical or chemical) would be needed to remove established vegetation from some sites, in addition to providing river flows that would help to prevent future encroachment.
- Overutilization for commercial, recreational, scientific, or educational purposes (Factor B) remains a threat to the Ocoee River population due to commercial and private whitewater recreational use and associated trampling of plants. The US Forest Service, Tennessee State Parks, and commercial outfitters have taken measures to install barriers and signage and educate raft guides and the public to prevent impacts associated with recreational activities. These measures have reduced the severity of, but not eliminated, this threat to *P. ruthii*.
- There have been recorded observations of invertebrate herbivores feeding on greenhouse plants and, in the wild, on plants in the Hiwassee River. Despite observations of these potential threats involving disease or predation (Factor C), data are inadequate to determine whether this herbivory occurs in a manner that adversely affects *P. ruthii* individuals or magnitude that adversely affects *P. ruthii* population demographics.

- *Pityopsis ruthii* is listed as endangered by the State of Tennessee (Tennessee Department of Environment and Conservation 2021) and is protected under the Tennessee Rare Plant Protection Act of 1985 (T.C.A 51-901), which forbids persons from knowingly uprooting, digging, taking, removing, damaging, destroying, possessing, or otherwise disturbing for any purpose, any endangered species from private or public lands without the written permission of the landowner. The TVA has developed a Biodiversity Policy that recognizes the importance of biodiversity to the quality of life experienced by residents of the electricity provider's service area (TVA 2023). This policy strengthens TVA's commitment to fulfill responsibilities that Federal agencies share under the Act for recovering threatened and endangered species. Specifically, this policy commits TVA to, among other things, "minimize the adverse impact of TVA operations on biodiversity and ecosystems, including by protecting endangered species." Absent these limited protections, and those afforded to plants by the Act, regulatory mechanisms (Factor D) to protect individuals or populations of *P. ruthii* are generally lacking.
- Other natural or manmade factors (Factor E) continue to pose a potential threat to *P. ruthii*. The potential for road and highway construction adjacent to the Ocoee River remains, and an analysis of alternative modifications proposed for US Highway 64 has not yet been completed. Depending on the alternative selected for this project, the potential exists for road construction to adversely affect populations located adjacent to US Highway 64. Hybridization between individuals of *P. ruthii* and *P. graminifolia* may also be impacting *P. ruthii*, but we are not aware of data to indicate the scale at which this phenomenon might be occurring. We consider prior assessments indicating that *P. ruthii* is highly vulnerable to climate change to be valid based on available data, including those reported here that indicate the species exhibits low plasticity to respond to increasing temperature.

Synthesis

Pityopsis ruthii is an herbaceous, tufted perennial that reproduces via seed or through rhizomatous growth, reaching heights of up three decimeters (one foot). The species is restricted to two populations located along short reaches of the Hiwassee and Ocoee rivers, in Polk County, Tennessee. Available data indicate that the Ocoee River population has increased by approximately 20 percent since 2011, to a total of 1,388 individuals in 2022. While it is the larger of the two populations, the species abundance in the Hiwassee River population has decreased by approximately 10 percent since 2011, to a total of 8,968 individuals in 2022. The species continues to be considered highly vulnerable to effects of climate change across its range, as explained in the 2018 5-year status review and further supported by information presented herein. The threat of habitat loss due to encroaching vegetation continues to affect many of the sites where plants in the Hiwassee population are located, and the threat of potential habitat disturbance due to road construction adjacent to the Ocoee River remains, because an alternative for proposed modifications to US Highway 64 has not been selected. Variable rates of filled seed production, germination, and seedling viability in the species, as noted in the 2018 5-year status review, constrain the ability of populations to recover from declines, such as those that have been observed in the Hiwassee River population. Because of ongoing threats and the current condition of the species, this species continues to meet the definition of an endangered species.

RECOMMENDED FUTURE ACTIVITIES

Recovery Activities

In the absence of river flows sufficient to regulate vegetation encroachment in many sites where *Pityopsis ruthii* occurs along the Hiwassee River, it could be necessary to develop effective approaches for mechanical or chemical control to prevent the species' displacement from some sites where this threat of encroaching vegetation is most aggressive. It would likely be infeasible to conduct such intensive management at the scale of the entire occupied reach, owing to the remoteness of the area and other environmental considerations (e.g., presence of endangered mussel species and designated critical habitat in this reach of the Hiwassee River). A management plan identifying the areas under the greatest threat and that guides incremental habitat restoration over a period of several years, however, may need to be developed in order to advance recovery of the species at a biologically meaningful scale. Additionally, flow prescriptions could be developed to regulate vegetation encroachment and enhance *P. ruthii* habitat, as discussed below.

Monitoring and Research Activities

The 2012 and 2018 5-year status reviews for *Pityopsis ruthii* discussed at length how a better understanding of artificially regulated river flows in the Hiwassee River and their influence on *P. ruthii* population growth could inform the development and implementation of more ecologically compatible flow prescriptions. The presumed importance of river flows that inundate occupied *P. ruthii* habitats at a frequency sufficient to regulate encroachment of competing herbaceous and woody vegetation are discussed in the species recovery plan, which calls for an analysis of contemporary and historical flow regimes to understand how flow alterations have contributed to changes in riparian vegetation conditions and availability of suitable sites for *P. ruthii*. Hydrological reference conditions for the Hiwassee River, however, are unavailable prior to the closing of Apalachia Dam.

An alternative approach for understanding how flows interact with vegetation and suitable sites for *P. ruthii* would be to adapt a methodology used for assessing effects of river flows on another species in the family Asteraceae, beautiful Barbara's buttons (*Marshallia pulchra*) (Tracey and Simmerman 2021). These methods could be adapted to investigate relationships between discharge, depth and duration of inundation, and response of *P. ruthii* and the associated vegetation community to compare these dynamics for the Hiwassee River to the Ocoee River, where conditions have supported population increase for more than a decade of monitoring. With a better understanding of the relationship between river flows, habitat inundation, and *P. ruthii* population responses in both river systems, it might be possible to prescribe a flow regime that would support population growth in the Hiwassee River population. A collaborative effort leveraging the authorities and resources of multiple partners, such as the U.S. Fish and Wildlife Service, Tennessee Valley Authority (TVA), American Whitewater Association, US Forest Service, and Tennessee State Parks, could potentially take on such an investigation to advance the status of the species.

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RESULTS / SIGNATURES

U.S. Fish and Wildlife Service
Status Review of Ruth's Golden Aster (*Pityopsis ruthii*)

Status Recommendation:

A 5-year status review presents a recommendation of the species status. Any change to the status requires a separate rulemaking process that includes public review and comment, as defined in the Act. On the basis of this review, we recommend the status for this species remains as endangered.

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist:
____ *The species is extinct*
____ *The species does not meet the definition of an endangered or threatened species*
____ *The listed entity does not meet the statutory definition of a species*
_X__ No change needed

FIELD OFFICE APPROVAL:

Field Supervisor, Tennessee Ecological Services Field Office, Fish and Wildlife Service
Approve DANIEL ELBERT Digitally signed by DANIEL ELBERT Date: 2023.07.10 09:10:14 -05'00'