Ruth's Golden Aster
(*Pityopsis ruthii*)

5-Year Review:
Summary and Evaluation

Photo by M. Pistrang, USFS

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

5-YEAR REVIEW
Ruth's golden aster
(*Pityopsis ruthii* (Small) Small)

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on available information pertaining to historic and current distributions, life history, and habitat of this species. Our sources include the final rule listing this species under the Endangered Species Act; the recovery plan; unpublished field observations by Service, U.S. Forest Service, Tennessee Valley Authority, State and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists or experts. We published an announcement in the *Federal Register* requesting information on this species on July 28, 2006 (71 FR 42871), and a 60-day public comment period was opened. Comments received and suggestions from peer reviewers were evaluated and incorporated as appropriate (see Appendix A). We received comments from Tennessee Valley Authority (TVA), the Tennessee Department of Environment and Conservation- Division of Natural Areas, and University of Mississippi. No part of this review was contracted to an outside party. This review was completed by the Service's lead Recovery biologist for the species in the Cookeville Field Office, Tennessee.

B. Reviewers

Lead Region: Southeast Region – Kelly Bibb, 404-679-7132

Lead Field Office: Cookeville Ecological Services Field Office – Geoff Call, 931-525-4983

C. Background

1. **Federal Register Notice citation announcing initiation of this review:** July 28, 2006 (71 FR 42871)

2. **Species status:** Declining, 2011 Recovery Data Call. A complete census of the Hiwassee population coordinated by TVA in 2010 revealed declines at 5 of 6 sites for which comparisons could be confidently made to data from a census taken in 1999 by TDEC. The declines ranged from -21% to -62%.

3. **Recovery achieved:** 2 (2=26-50% recovery objectives achieved)

4. **Listing history**
Original Listing
FR notice: 50 FR 29341
Date listed: August 19, 1985
Entity listed: species
Classification: endangered

5. **Associated rulemakings**: N/A

6. **Review History**:
Recovery Data Call: 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002, 2001, and 2000
Recovery Plan: 1992

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

8. **Recovery Plan**
Name of plan: Recovery Plan for Ruth's Golden Aster [*Pityopsis ruthii* (Small) Small]
Date issued: June 11, 1992

II. REVIEW ANALYSIS

A. 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 of a species of vertebrate wildlife. This definition limits listing a DPS to only vertebrate species of fish or wildlife which interbreeds when mature. Because the species under review is a plant, and the DPS policy is not applicable, the application of the DPS policy is not addressed further in this review.

B. Recovery Criteria

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

2. **Adequacy of recovery criteria.**

a. **Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?** No

b. **Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?** Yes

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

The disparity in the sizes of the two known populations of *P. 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.

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

The Recovery Plan for Ruth's golden aster, as stated above, includes only tasks 6 and 7 and associated subtasks in defining recovery criteria for the species. However, we include tasks 1 through 5 in our discussion below and provide information on relevant accomplishments since publication of the Recovery Plan in 1992. We only note the listing factors addressed by those subtasks associated with tasks 6 and 7, as tasks 1-5 are neither threats-related nor recovery criteria.

Note: Most of the recovery work for *P. ruthii* has been accomplished by an informal recovery coordination working group (RCWG), consisting of representatives from the U.S. Forest Service – Cherokee National Forest (USFS-CNF), Tennessee Valley Authority (TVA), Tennessee Department of

Environment and Conservation (TDEC), and the Service, with occasional participation from university researchers (Clebsch and Sloan 1993, Cruzan 1998 and 2001, Cruzan and Beaty 1998, Cruzan and Estill 2001, Thomson and Schwarz 2006). This group will be referred to as the RCWG throughout this document.

Task 1. Maintain formal agreements among the appropriate concerned agencies on the preservation of *Pityopsis ruthii*.

This recovery task has not been accomplished with establishment of formal agreements, but the cooperative partnership of the RCWG provides a venue for coordinating recovery work for *P. ruthii*. Routine coordination by the RCWG concerning monitoring, research, and management for *P. ruthii* that has taken place since the early 1990s has been vital to sustaining recovery efforts for this species. Formal agreements among these agencies have not been necessary in order to advance coordinated recovery efforts for *P. ruthii*.

Task 2. Maintain permanent plots.

This recovery task has been accomplished.

TVA established two permanent 10 x 10 m (meter) plots in the Hiwassee drainage in 1986, at the Bridge and McFarland sites, and a third at the Upperbend site in 1987. TVA and other members of the RCWG collected data annually from each of these plots through 1993 and resumed monitoring in 1995. In 1996, the RCWG decided to rotate monitoring of these plots on an annual basis, so that each would be monitored every three years, because of trampling of plants outside of the sampled quadrats by investigators during the data collection. This monitoring consists of two tiers of data collection.

For demographic monitoring, TVA established 10 randomly selected 1 x 1 m quadrats in each plot and records the number of rosettes (i.e., non-flowering stems < 2 cm height), flowering stems, and non-flowering stems for each *P. ruthii* plant in the quadrat. They also record the percent cover of *P. ruthii*, percent cover of other vegetation, and number of woody stems. In addition to data collected from these quadrats, TVA gathers a census of *P. ruthii* plants within the 100 m^2 plot and in the vicinity of the plot, as far upstream and downstream as plants extend without a large break or without crossing the river (Baxter et al. 2005). Data on total plant numbers in the 10 x 10 m monitoring plots at these sites during the period 1986 – 2010 appear in Figure 1.

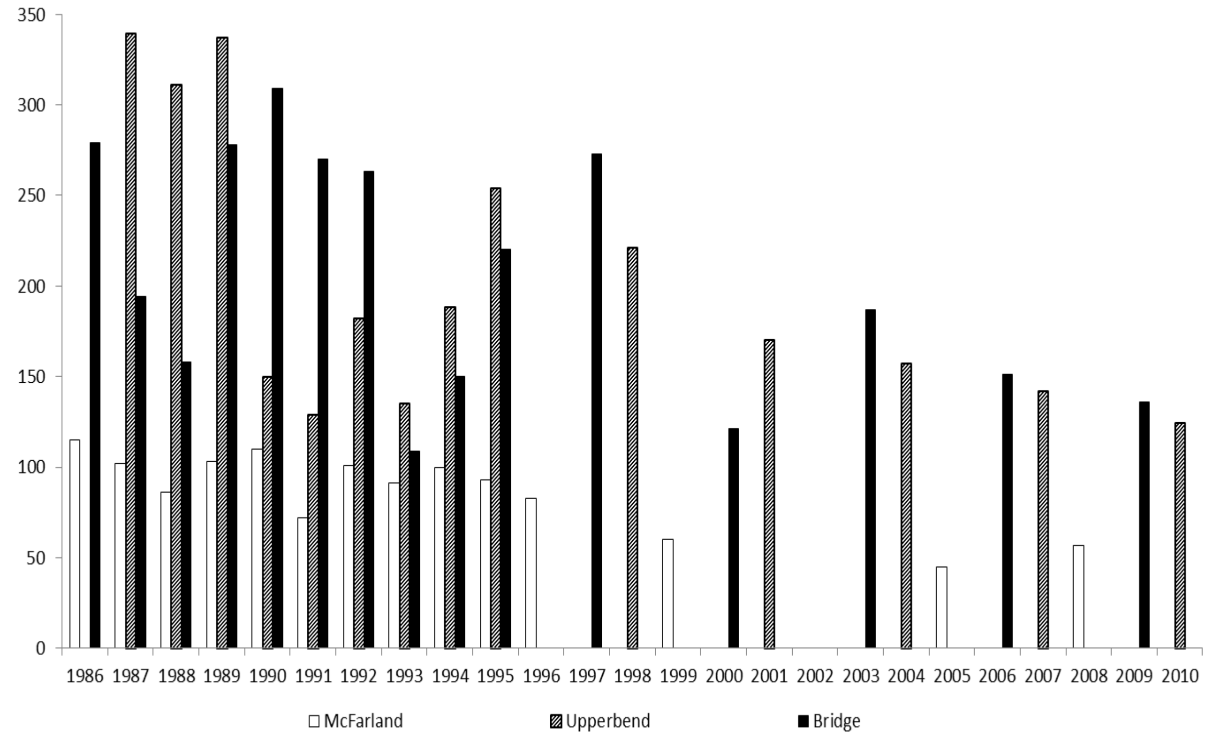

Figure 1. ***Pityopsis ruthii*** **abundance in three 10 x 10 m plots in the Hiwassee River drainage, 1986 - 2010 (TVA unpublished data).**

In 1993, the USFS-CNF established two permanently marked 10 x 10 m plots in the Hiwassee drainage at the Loss Creek site, for the purpose of monitoring response of *P. ruthii* to removal of competing vegetation (Pistrang 1993). The USFS-CNF and TDEC established an additional pair of plots at the Narrows site in 2000, for the purpose of replicating the vegetation control treatments. These plots are sectioned into twenty-five 2 x 2 m quadrats, from each of which the following data were collected: number of *P. ruthii* plants, percent cover of *P. ruthii* plants, percent cover woody vegetation, percent cover herbaceous vegetation, percent cover nonvascular plants and lichens, percent cover woody debris, and percent cover bare rock and soil. The location of each *P. ruthii* plant within a quadrat is mapped on the datasheet and assigned a number, and each is further described by the following: number of flowering stems > 2 cm height, number of non-flowering stems > 2 cm, total number of stems > 2 cm, and the number of rosettes – i.e., stems < 2 cm height (Lincicome 2003). Details concerning the vegetation removal experiment and monitoring results are discussed under Task 6.6 below.

TVA began monitoring the Ocoee River population annually in 1987 and has done so annually, except during 2005 and 2009. This monitoring consists of a total census of *P. ruthii* plants within the Ocoee drainage, with data collected at the six sites where the species occurs, which are named for adjacent whitewater features: Bouquet Rock, Cat's Pajamas, Lone Rock, Powerhouse, Doublesuck, and Tablesaw. Because of the large numbers of plants found at the Doublesuck and Powerhouse sites, TVA established ten 1 x 1 m permanently marked quadrats at each to permit monitoring of individual plants across years. TVA measures, counts, and maps individual plants within these 20 quadrats (i.e., 10 each at Doublesuck and Powerhouse), and records numbers of flowering stems, non-flowering stems, and rosettes in each quadrat. TVA also records the number of plants outside these quadrats, regardless of stage-class, to provide numbers for the census of the entire Ocoee population (Baxter et al. 2005). Data for total stem numbers counted at each of the six sites on the Ocoee River during 1987 – 2011 appear in Figure 2.

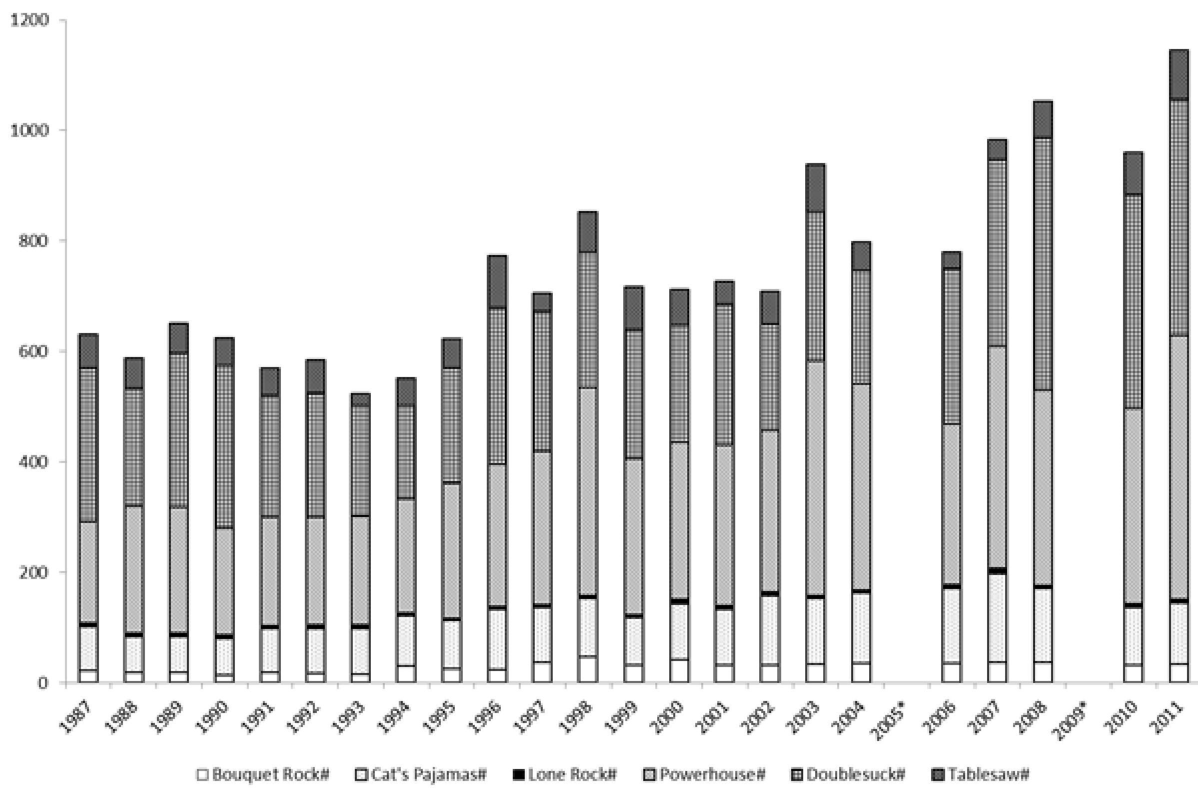

Figure 2. *Pityopsis ruthii* abundance at the six sites where the species is known to occur in the Ocoee River drainage, 1987 – 2011 (TVA unpublished data).

Task 3. Determine what is necessary for effective and successful achene dispersal, seed germination, and seedling establishment.

3.1 Study achene dispersal.

This task has been partially accomplished.

Based on field observations, Clebsch and Sloan (1993) concluded that wind is not likely to be an important dispersal mechanism for *P. ruthii* achenes, which they observed do not glide on the wind, but rather drop vertically to the substrate when released into the air. While they did not calculate mass:surface ratios in their analysis, they observed that the angle formed between the pappus (highly modified outer perianth series of plants in the Aster family, located at the top of the seed – e.g., hairs on dandelion seeds) and the linear axis of the achene is much narrower than that of the closely related, sympatric *P. graminifolia*, the seeds of which are wind dispersed. The authors deduced that the achenes are better adapted for dispersal by water, or by rolling about on the substrate until becoming wedged into loose substrate or crevices.

3.2 Determine life history, seed germination, and seedling establishment requirements

This task has been partially met through research projects conducted by Clebsch and Sloan (1993), Cruzan and Beaty (1998), and Cruzan (2001).

Clebsch and Sloan (1993) studied seed production and germination, pollination, and seedling establishment of *P. ruthii* in the wild. They found the fraction of achenes that were filled with an embryo to be highly variable and noted that ray flowers in *P. ruthii* are sterile. The earliest flowers, some of which opened in June, did not produce filled achenes; and most pollination, fertilization, and embryo maturation occurred during September and October. The investigators collected a few specimens of potential pollinators and provided them to entomologists, but we have no information on the identification of those specimens. Clebsch and Sloan (1993) observed that germination and production of new seedlings occurred in the wild as early as mid-November.

Cruzan (2001) also studied pollination, seed set, and seed viability in *P. ruthii*. He found that neither the Hiwassee nor Ocoee population of *P. ruthii* appears to be pollen limited, based on counts of pollen grains in florets; though, he did not attempt to discern the relative contributions of cross- versus self-pollination in the pollen loads he documented. Despite apparently adequate pollen loads on individual florets (i.e., each stigma produces only one seed and multiple pollen grains were found on the stigma of most florets), Cruzan found seed set to be much lower than the potential based on the typical numbers of flowers found on each head. The Hiwassee populations averaged 11 to 12 seeds per head, while the

Ocoee populations ranged from 3 to 8 seeds per head. Mean numbers of filled seeds per head were greater in the Hiwassee than in the Ocoee. Seed set varied among collection dates differently between the two drainages, with highest numbers of seed per head occurring in early October and late November in the Hiwassee population. In the Ocoee, the highest numbers of seed per head were found in late October, corresponding to the middle of the flowering season.

Percent of filled seeds that proved to be viable averaged 38.7 percent for the two populations combined, but was higher in the Ocoee (53 percent) versus the Hiwassee (33 percent). This difference was attributed to the higher frequency of seed heads that contained no viable seeds in the Hiwassee population and to the higher proportion of seed heads in the Ocoee population with 100 percent viable seeds. The lower viability rates in seeds produced in the Hiwassee offset the higher seed production rates observed in that drainage such that the average number of viable seeds produced per head was only slightly higher in that population (3.7) than in the Ocoee population (3.1). Cruzan noted that low seed production and viability rates could be attributable to either fertilization failure or to post-fertilization ovule abortion and suggested histological studies of fertilization and embryo development would resolve this question.

Dr. Stephen Brewer (2007) commented on an earlier draft of this 5-year Review regarding observations about low rates of seed production and seedling recruitment in *P. ruthii*, indicating that, while seed set in *P. ruthii* might be lower than in other species of *Pityopsis*, the low seedling recruitment observed in the species is consistent with observations of other members of this genus. Dr. Brewer commented that despite the fact that many *Pityopsis* species are associated with xeric habitats, their seedlings seem not to tolerate dessication very well, and that this could influence the tendency of all *Pityopsis* species to rely to varying degrees on clonal growth and vegetative reproduction from rhizomes.

P. ruthii achenes appear to be morphologically adapted for anchoring into crevices or loose soil in which they become lodged. Clebsch and Sloan (1993) noted that *P. ruthii* achenes are beset with multiple ridges lined with short hairs, the orientation of which they believed adjusted in response to diurnal changes in atmospheric humidity so as to progressively wedge the achene into suitable substrate for germination and seedling establishment.

3.3 Determine the role of interspecific and intraspecific competition

This task has not been completed.

Task 4. Determine what constitutes suitable habitat

This task has been partially completed; though, habitat requirements as relates to a suitable hydrologic regime for the Hiwassee River are still unclear.

Cruzan (1998) analyzed monitoring data collected between 1986 and 1995 to assess overall trends for the Hiwassee and Ocoee populations and identify environmental variables that might be affecting survival, reproduction, and long-term viability in those populations. Cruzan intended to analyze several demographic variables for which data were collected from three plots on the Hiwassee and two sites on the Ocoee, but found that observer error led to inconsistent identification of individual plants among years. Instead, he analyzed data on total number of plants per quadrat, total number of stems per quadrat, total number of vegetative stems, and total number of flowering stems, placing greater reliability on data for total number of stems because of the lower potential for observer error to influence these data (Cruzan 1998). Cruzan (1998) also compiled and analyzed data on several environmental variables, including percent cover of other herbaceous species, number of woody stems, measurements of crevice length and width within quadrats, percent open sky visible from the quadrats, precipitation, and hydrologic variables (i.e., data characterizing discharges from Apalachia Dam on the Hiwassee and Ocoee Dam #2).

Cruzan (1998) found the primary factors that appeared to affect the survival and growth of *P. ruthii* were availability of suitable habitat (as determined through measurements of crevice lengths and widths), competition from other herbaceous species, and the amount of precipitation received in the prior year. Crevice length and width were positively correlated with all measures of *P. ruthii* abundance examined – total number of plants, number of flowering stems, number of non-flowering stems, and total number of stems – and each of these was negatively correlated with herbaceous cover. Not surprisingly, herbaceous cover was also positively correlated with crevice length and width, as these two variables provide an indication of habitat space available to plant life on the phyllite outcrops. The effect of these competing forces became evident when Cruzan found a quadratic relationship between crevice width and total number of *P. ruthii* stems. Cruzan (1998) concluded that *P. ruthii* is able to inhabit narrower crevices than most other herbaceous species, but is excluded from the widest cracks by competitors.

Cruzan (1998) found a strong relationship between the amount of precipitation in a given year and the total number of stems per quadrat in the following year. This he attributed to the fact that rosettes produced in the fall become the following year's stems and the likelihood that spring and summer rainfall promoted rosette initiation later in the year. Thomson and Schwarz (2006) found that yearly total river flow related best to *P. ruthii* population performance in the following year when expressed as a quadratic relationship, such that intermediate flows were associated with greatest performance. Their analysis found a weaker relationship between rainfall and population performance; but, the rainfall analysis was limited to the Ocoee population only, due to an insufficient number of overlapping years of precipitation and population census data for the Hiwassee.

As discussed above, Thomson and Schwarz (2006) found that mean population growth rates tended to be greater in years classified as high-flow years than in low-flow years. The negative relationship that Cruzan found between maximum spill and both total number of stems and non-flowering stems in the following year, combined with the Thomson and Schwarz (2006, p. 1138) finding that greatest performance in *P. ruthii* typically followed years of intermediate-to-high flows, highlight the importance of completing recovery task 6.1 and developing appropriate prescriptions for flow management below Apalachia Dam on the Hiwassee River.

Task 5. Search for *Pityopsis ruthii* on other rivers

This task has been completed.

Clebsch and Sloan (1993) thoroughly investigated survey efforts conducted by numerous persons, between the 1970s and early 1990s, who searched for *P. ruthii* in the Ocoee, Hiwassee, Tellico, Conasauga, and Jacks river drainages. No data were recovered that expanded upon the range for *P. ruthii* that was reported in the recovery plan.

Task 6. Determine and implement for the Hiwassee River population the management necessary for long-term reproduction, maintenance, and vigor.

6.1. Determine and compare past and present stream flow regimes.

This criterion addresses listing factor A (present or threatened destruction, modification or curtailment of habitat or range of *P. ruthii*) and has not been met.

TVA owns and operates the dams that have altered the flow regimes in the reaches of the Hiwassee and Ocoee rivers in which *P. ruthii* occurs. Based on email correspondence from TVA (Collins 2005), it appears that limited analyses of historic water flows were conducted ca. 2004 to establish a basis for evaluating potential impacts of a deviation from flow regimes that TVA had committed to maintain as part of an Environmental Assessment (EA) for the Modernization of Turbine Units at Apalachia Hydroplant (TVA 2002). However, the information in our files only states that, due to a better understanding of historic water flows in the river reach inhabited by *P. ruthii*, TVA did not anticipate that a proposed flow regime of 10 days exceeding 350 cfs (cubic feet per second) followed by at least five days of flows less than 350 cfs would be detrimental to *P. ruthii*. A report describing the methods and results of TVA's analysis is needed in order to better understand whether the intent of this recovery task has been met.

6.2. Determine the nature and role of natural succession on the phyllite boulders

This criterion addresses listing factor A and has not been met.

No formal studies have been conducted to document rates of succession or the ecological factors governing this process on the phyllite outcrops inhabited by *P. ruthii*; though, Cruzan (2000) reported that, based upon coarse historical photo analysis, there has been an approximately 50 percent increase in vegetative cover within the Hiwassee River floodplain since the late 1940s. The encroachment of competing herbaceous and woody vegetation into this habitat is a continuing threat to the species.

Dr. Stephen Brewer commented on an earlier version of this 5-year Review and suggested that management of the slopes adjacent to the Hiwassee River could play an indirect role in vegetation succession on the boulders and outcrops that *P. ruthii* inhabits. Specifically, he suggested that restoring fire to these slopes could have a beneficial effect of reducing a source of propagules of mesophytic trees and vines that encroach upon *P. ruthii* habitat.

6.3. Determine whether or not the population is self-sustaining.

This criterion addresses listing factor E (other natural or manmade factors affecting the continued existence of *P. ruthii*) and has been met. Note that we discuss information here that is relevant also to task 7.4 below, which calls for determining whether or not the Ocoee River population is self-sustaining.

Cruzan and Beaty (1998) examined germination and seedling establishment in the wild, based on demographic monitoring of 12-2 x 2 m plots distributed across three sites, in relation to seed production data generated by collection of mature seed heads in the vicinity of these plots. These data were collected to support the development of a size-based transition probability matrix for modeling population trends in *P. ruthii*. However, observer error among years with respect to consistent identification of individual plants precluded doing so (Cruzan 2007).

Thomson and Schwarz (2006) used monitoring data collected over 15 years by members of the RCWG to develop a count-based population viability analysis (PVA) for *P. ruthii*. The PVA estimated absolute probability of extinction within 50 years for each of the Hiwassee (n=3) and Ocoee (n=6) populations measured, which the authors used for the purpose of comparing relative extinction risk between populations and evaluating whether there were systematic differences between the two watersheds. While they found the Hiwassee populations to be at greater risk of extinction than the Ocoee populations, the populations sampled in the Hiwassee comprise only approximately 10 percent of the total population in that drainage.

Estimated extinction risks for the Ocoee populations were lower than for the

Hiwassee populations, which all had larger starting population sizes (Thomson and Schwarz 2006). Further, the three relatively secure Ocoee populations account for almost 90 percent of this river's total populations, suggesting low short-term extinction risk for this river's overall population. The authors suggested two different factors were influencing the high extinction risks estimated for all of the Hiwassee and the three smallest Ocoee populations. The estimated mean population growth rate for the Ocoee populations (0.009 ± 0.01) was significantly greater than that for the Hiwassee populations (-0.044 ± 0.012), for which projected extinction risks ranged from 20 to 48 percent (note: confidence intervals for the projections for the Hiwassee populations encompass zero and one, underscoring the need for caution in interpreting absolute versus relative extinction risks). While lower population growth rates influenced the high extinction risks projected for the Hiwassee populations, which had starting population sizes ranging from 140 to 528 plants, starting population size was found to be more important in the Ocoee populations, where this value ranged from 5 to 42 plants in the three populations with high extinction risk. When starting population size was adjusted to 100 individuals and extinction risk was recalculated for each Ocoee population, only the Tablesaw population still faced a high extinction risk. Tablesaw also had the lowest estimated mean population growth rate of the Ocoee populations (Thomson and Schwarz 2006).

6.4. Establish *P. ruthii* on unoccupied suitable habitat.

This criterion addresses listing factor E and has not been met. Note that we discuss information here that is relevant also to task 7.5 below, which calls for establishing *P. ruthii* on unoccupied suitable habitat in the Ocoee River drainage.

Cruzan and Beaty (1998) were unsuccessful in their experimental efforts to establish a cultivated population of plants from either seeds or transplanted rosettes grown in a greenhouse setting. This replicated study involved planting seeds, greenhouse-raised seedlings, and wild rosettes into crevices in apparently suitable habitat, with and without artificial planting media to promote root establishment. In plots where seeds were planted, they observed extremely low germination rates and almost no seedling survival after a complete growing season. In trials conducted using both rosettes excised from other plants in the wild and seedlings grown in the greenhouse, no plants survived. From the study, the authors concluded that germination and seedling recruitment presented substantial barriers to *P. ruthii* recruitment in the wild and that any future attempts to expand populations through introduction of seed, seedlings, or rosettes should compensate for low recruitment by introducing large numbers. Further, they recommended additional genetic studies to determine whether inbreeding depression might be a factor contributing to low recruitment rates they observed.

To address the challenges for reintroduction efforts posed by low germination and seedling recruitment rates, Wadl et al. (2011a) developed techniques for culturing

P. ruthii plants from both tissue and stem cuttings. The preliminary phase of this work has been successful at multiplying stems of a limited number of genotypes from each of the Hiwassee and Ocoee populations. A pilot reintroduction study is planned to begin in 2012 for the Hiwassee population, which would experimentally test the effects of using a bonded fiber matrix on survival, growth, and flowering of introduced plants. This project also will test the effect of four clonal genotypes on these variables.

6.5. Establish a cultivated population of plants descended from the Hiwassee River population and provide for long-term seed storage.

This criterion addresses listing factors A and E and has been partially met. Note that we discuss information here that is relevant also to task 7.6 below, which calls for establishing a cultivated population of and storing seed from Ocoee River plants.

The Center for Plant Conservation and TVA entered into an agreement in 1990 to subcontract with the University of North Carolina (UNC) Botanical Garden to: receive seed of *P. ruthii* to germinate, produce mature plants, maintain a permanent supply of seed, and maintain descendents of cultivated plants in garden plots. Collins (2007) reported that seeds were provided on two separate occasions to the UNC Botanical Garden. Kunz (2007) reported that UNC Botanical Garden was holding seeds in long-term storage, from four locations in the wild and two accessions from plants grown at the garden, and that a few cultivated plants still survived at the garden. Seed collections were attempted at the Hiwassee River population during the 2010 census, but few plants had transitioned from a flowering to fruiting state at that time, so very few seeds were collected.

While Wadl et al. (2011a) have developed techniques for culturing *P. ruthii* from tissue and stem cuttings, plans have not been fully developed for establishing a cultivated *ex situ* population of plants that would be maintained as a safeguard against the loss of one or more subpopulations within either river where *P. ruthii* occurs.

6.6. Determine feasibility and/or necessity of water releases and hand-clearing of phvllite boulders.

This criterion addresses listing factor A and has not been met.

Thomson and Schwarz (2006) evaluated whether there was a link between yearly population growth rates in *P. ruthii* and river flows, and how such a difference might affect relative extinction risk among populations. Their analyses found that greater population performance tended to be associated with years of intermediate flows and that a quadratic model explained the relationship better than a linear one. Comparing mean population growth rates among years they classified as low-flow or high-flow, the authors found that all but one population had lower mean population growth rates during low-flow years than during high-flow years. These results suggest that providing periodic intermediate-to-high flows could be an important component of management to improve growth rates in the Hiwassee population and reduce the extinction risk it faces. However, it should be noted that population growth rates remained negative for the Hiwassee populations even in high-flow years. This could be due to the prevailing trend of vegetation succession in the Hiwassee floodplain due to flow alterations since 1943.

Clebsch and Sloan (1993) noted that extensive moss mats were established on much of the suitable habitat for *P. ruthii* in the Hiwassee drainage, presumably as a consequence of altered flows. They observed that many *P. ruthii* achenes germinated in these mats, but that the high rates of mortality they observed among such seedlings was probably due to dessication of the moss mats during dry periods. Improved flows will be an important component in any long-term solution for controlling vegetation succession and maintaining suitable habitat conditions for *P. ruthii* in the Hiwassee drainage.

While the RCWG has recognized a substantial increase in competing vegetation as a threat to *P. ruthii* habitat, only preliminary efforts have been undertaken to explore management options for controlling competing vegetation and to evaluate how such management might affect *P. ruthii* populations. In 1991, a pilot project was initiated at a single site on the Hiwassee River to mechanically remove competing vegetation. Because this initial treatment was viewed as beneficial, the RCWG chose to initiate a study involving the use of herbicides for more lasting control of competing vegetation. The USFS-CNF established a pair of 10 x 10 m plots in 1993 at the Loss Creek site for the purpose of studying the potential effects of removing competing vegetation on a small scale (Pistrang 1993). The experimental treatment, consisting of application of Rodeo (active ingredient: glyphosate) to cut stumps, was conducted on May 3, 1995 (Ramey 1995). While results of this management experiment were considered inconclusive due to lack of replication, small spatial scale, and difficulty separating treatment response from interannual variability observed in *P. ruthii* populations generally, monitoring data collected between 1993 and 2001 suggest the treatment might have been beneficial (Lincicome 2003). Analyzing those monitoring data, Thomson and Schwartz (2006) found that the treatment plot was the only Hiwassee population that had a positive mean population growth rate, out of five for which they analyzed monitoring data collected by the RCWG.

To address the lack of replication in this experiment, the USFS-CNF and TDEC established two additional permanently marked plots at the Narrows site and collected pre-treatment data in 2000, 2001, 2003 – 2005, and 2007 (Figure 3). The USFS in cooperation with Dow AgroSciences, TVA, TDEC, and USFWS, treated one of the two plots at each site during 2009 using the chemicals triclopyr (for larger woody stems) and glyphosate for all other vegetation (i.e., shrubs, vines, and herbaceous plants). In order to minimize potential for non-target effects to *P. ruthii*, triclopyr was applied directly to stumps of freshly cut stems using hand sprayers or to standing stems using either hack-and-squirt or basal bark applications. Glyphosate was applied to species other than *P. ruthii* using backpack and hand-held sprayers or hand-held brushes, sometimes to freshly cut stems to minimize quantity used for treatment. These two chemicals were combined for application in plot 1 at the Narrows to more effectively treat a large infestation of poison ivy. Post-treatment monitoring data were collected in 2010 (Figure 3).

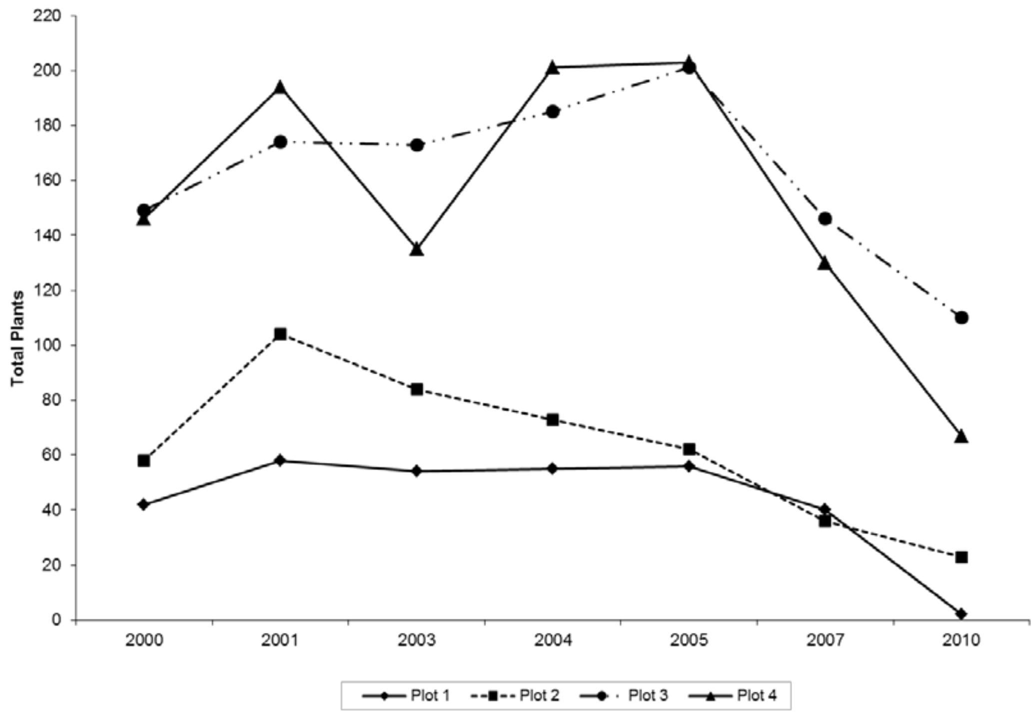

Figure 3. ***Pityopsis ruthii*** **abundance in four 10 x 10 m plots established to monitor effects of vegetation removal treatments implemented at Narrows (plots 1 and 2) and Loss Creek (plots 3 and 4) sites, Hiwassee River, during 2009. Solid lines represent treated plots (i.e., plots 1 and 4) (USFS unpublished data).**

Pityopsis ruthii abundance decreased in all plots following treatments in 2009 (Figure 3). It is likely that effects of extreme drought conditions during 2007 and 2008 contributed to the downward trend seen in data collected during 2007 and 2010. However, much of the decline in plot 1 (from 40 plants in 2007 to 2 plants in 2010) is likely attributable to the combined application of triclopyr and glyphosate, followed by rainfall during the same afternoon. Both triclopyr and glyphosate are bound by soil; however, there is very little soil present at the plots, and it is speculated that overspray residue of triclopyr was washed down the rocks by the rain that followed treatment at plot 1. Consequently, *P. ruthii* plants were probably exposed to this chemical, as many plants in this plot died in the weeks following treatment. No direct treatment mortality was seen in the treatment plot

4, where only glyphosate was used as a spray application (Pistrang pers. comm. 2012).

The RCWG will continue to monitor these vegetation control treatment plots, to determine how long the competing vegetation is held at bay by the treatments and to track *P. ruthii* responses. It is clear from the level of coordination and human resources required for implementing treatments in two 100-m^2 plots, and potential for unintended effects to *P. ruthii*, that vegetation control alone will not be sufficient for preventing the further reduction in suitable habitat in the Hiwassee drainage for this species. Manipulation of flows to better mimic the natural disturbance regime in the Hiwassee River will likely be necessary to manage habitat and sustain the *P. ruthii* population in this drainage.

Task 7. Determine and implement for the Ocoee River population the management necessary for long-term reproduction, maintenance, and vigor.

7.1. Study the relationship of the river to *P. ruthii*.

This criterion addresses listing factor A and has not been met.

The narrative for this task in the recovery plan discusses information needs, including possible effects from (1) hydrologic manipulations on the Ocoee River for power generation and whitewater recreation, and (2) water quality threats stemming from mine tailings, acid precipitation, industrial wastewater effluent, and erosion of acidified soils. To our knowledge, no studies have been conducted to fill these information needs. However, analyses of monitoring data (Figure 2) collected annually from all Ocoee River populations suggest the species is relatively stable in this drainage (Baxter et al. 2005) and faces a lower relative risk of extinction within the next 50 years than the Hiwassee River populations (Thomson and Schwarz 2006). Impacts due to trampling from whitewater recreationists and spectators are considered the greatest threat to this population, other than the potential for road improvement or construction to take place through the Ocoee gorge (see discussion at task 7.3).

Thomson and Schwarz (2006) found that greater population performance in *P. ruthii* tended to be associated with years of intermediate flows. Comparing mean population growth rates among years they classified as low-flow or high-flow, the authors found that all Ocoee populations except for Doublesuck had positive mean annual growth rates in high-flow years. Conversely, all populations but Doublesuck had negative mean annual growth rates in low-flow years. In addition to providing long-term control of vegetation succession rates in *P. ruthii* habitat, years of intermediate to high flows apparently provide some unknown short-term benefit to the populations.

7.2. Determine impacts of river recreational users and implement required management actions.

This criterion addresses listing factor A and has been partially met.

The following information is taken from Herrig and Wyrick (1996) unless otherwise indicated. The USFS-CNF prepared an Environmental Impact Statement (EIS) in 1993 for a proposal to conduct Olympic whitewater events in the Ocoee River gorge during the 1996 Olympics. This EIS concluded that increased public use in the areas inhabited by *P. ruthii* was likely, but that measures could be taken to avoid human impacts. In 1994, the USFS-CNF installed placards onto bedrock and boulders at the three sites on the Ocoee River (i.e., Doublesuck, Tablesaw, and Cat's Pajamas – all named for adjacent whitewater features) where human impacts were expected to be greatest, based on accessibility either by whitewater paddlers from the river or by spectators from trails leading to nearby roads on which they parked vehicles. These placards designated areas as "Biologically Sensitive" and requested that visitors not enter those areas. Following installation of these placards, the USFS-CNF initiated a study to measure visitor compliance during the whitewater recreation season of June 1 – September 30, 1994 and 1995.

This study found that declining trends in the Ocoee River populations of *P. ruthii* included in their study tended to be associated with the two sites where non-compliance was high (Doublesuck and Tablesaw) and found an increasing trend at the one site where compliance was greatest (Cat's Pajamas). Based on these results and their observations of the source of the threat at the two sites with low compliance, Herrig and Wyrick (1996) recommended differing approaches for addressing human impacts at the Doublesuck and Tablesaw sites.

Because the Doublesuck site was being used primarily by non-commercial whitewater paddlers, they suggested installing a bulletin board at the access points where those boaters entered the river to inform the public of the presence of "Biologically Sensitive" areas in the reach they used. They also recommended that all law enforcement officers patrolling the area should monitor and discourage human use of outcrops inhabited by *P. ruthii*. Lincicome and Bishop (pers. comm. 2007) and Pistrang (2012) report that commercial outfitters on the Ocoee River have been informed about the presence of *P. ruthii* and that Tennessee State Parks reminds outfitters at the beginning of each season to avoid impacting the plants. Both law enforcement officers and commercial guides have been asked to monitor private paddler activity in the vicinity of *P. ruthii* and to discourage such activity in those areas (Pistrang pers. comm. 2012). However, no kiosk has been constructed to inform non-commercial paddlers about the presence of *P. ruthii* on the boulders and bedrock in and along the river.

The Tablesaw site was used primarily by spectators parked on Hwy 64, who would use rocks adjacent to the river as observation points. To remedy this situation, the authors recommended removal of the parking area on Hwy 64 by extending a guardrail from the curve in the road at Tablesaw to approximately 1.25 miles up the road. The guardrail extension has been constructed.

Thomson and Schwarz (2006) found that estimated mean population growth rates for Doublesuck and Tablesaw were lower than other Ocoee River populations. However, data in Figure 2 indicate that *P. ruthii* abundance is greater at these locations than it was at the time Herrig and Wyrick (1996) investigated recreation-related impacts to the species in the Ocoee River drainage.

7.3. Ensure that highway construction will not damage or destroy plants or suitable habitat.

This criterion addresses listing factor A and has not been met.

The Tennessee Department of Transportation is currently analyzing transportation alternatives for Corridor K, which passes through the Ocoee River Gorge. The information below concerning this project is from URS (2010).

Corridor K, in Polk County (US 64/US 74/SR 40) from west of the Ocoee River to the SR 68 interchange near Ducktown, is primarily a 2-lane road with 12-foot lanes and variable width shoulders (two to 12 foot) through the Ocoee River Gorge. One mile west of the Ocoee Whitewater Center, the road is a 4-lane divided facility before transitioning back to a 2-lane typical section with passing lanes for the final six miles. There is one designated pedestrian and bicycle path running behind an existing barrier just south of US 64 between National Forest System Road (NFSR) 45 (Gassaway Creek Rd) and the Ocoee Whitewater Center. Within the project study area US 64 transitions from a 4-lane section with flush median to the west and to a 4-lane with depressed median section to the east.

The purpose of the proposed project is to implement a safe, reliable, and efficient east–west transportation route that will improve regional transportation linkages and preserve environmental quality. It is also to support local, regional, and state plans and land use and transportation goals and to support economic development in the Southeastern region of Tennessee. The project needs include roadway deficiencies, safety, system linkage, and economic development. Due to topographic and natural constraints, US 64 from just west of the Ocoee River crossing to SR 68 does not satisfy appropriate design standards. The current roadway is lacking in its horizontal alignment, shoulder widths, sight distance around curves, and guardrail placement. Rockslides along the current route cause notable travel time delays due to a lack of convenient detour routes. The route is unique in that it is used by a mixture of commercial, recreational, and commuter traffic. In summer months, pedestrians and boaters often walk and park along the road. Pedestrians and parked vehicles slow traffic on the only east-west arterial in the region and increase safety concerns.

Two of the options that TDOT is analyzing (i.e., options 2 and 2A) would involve construction within the Ocoee River gorge in the vicinity of the *P. ruthii* population. The potential for adverse effects to *P. ruthii* that could result from these two options has not yet been analyzed; though, the presence of *P. ruthii* in the project area has been acknowledged. Descriptions of these two options follow:

Option 2 – Improvements to Existing US 64

Option 2 is a 500 foot corridor that runs along the north side of the existing US 64 alignment. Improvements for the entire project length would be made with standard typical section and some areas with new location construction or widening with a minimum design speed of 50 miles per hour (mph) to eliminate existing curves below a posted speed of 45 mph. Some bridges would be widened or replaced. One location within the corridor could have a tunnel which would eliminate a series of curves. The estimated cost is $304,563,000 for a 2-lane section; $497,794,000 for a 4-lane section. Because the entire corridor is not improved, funding from the Appalachian Regional Commission (ARC) could not be used. Option 2 would address all design deficiencies that exist on US 64 and thus would satisfy the critical element of providing a safe, reliable and efficient east-west route as stated in the project purpose and need.

Option 2A – Spot Improvements to Existing US 64

Option 2A is similar to Option 2 but would only involve improvements to select areas along US 64 to improve the mobility and safety of the existing route. Twenty locations have been identified for potential improvements with the elimination of sharp curves, shoulder widening on roads and bridges, and new location construction, including the tunnel location also in Option 2. This option would maintain most of the existing alignment and typical section. The estimated cost is $198,884,000. The existing system even with spot improvements to correct some design deficiencies, does not support the critical element of providing a safe, reliable and efficient east-west route as stated in the projects purpose and need.

7.4. Determine whether the population is self-sustaining.

This criterion addresses listing factor E and has been met.

See discussion under Task 6.3 above.

7.5. Establish *P. ruthii* on unoccupied suitable habitat.

This criterion addresses listing factor E and has not been met.

See discussion under Task 6.4 above.

7.6. Establish a cultivated population of plants descended from the Ocoee River population and provide for long-term seed storage.

This criterion addresses listing factors A and E and has not been met.

See discussion for Task 6.5 above.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Abundance, population trends (e.g. increasing, decreasing, stable), demographic features, or demographic trends:

Baxter et al. (2005) concluded that *P. ruthii* populations in the Hiwassee and Ocoee drainages were "fairly stable", and we concur with this assessment for the Ocoee population. In 2011, the Ocoee population census documented 1145 plants, compared to a baseline of 631 when monitoring began in 1987 (TVA unpublished data). The judgment that this population is stable is consistent with the determination that the Ocoee population faces a lower extinction risk than the monitored Hiwassee populations, despite the much larger size of the latter, and that many of the Ocoee populations were found to have a mean positive growth rate (Thomson and Schwarz 2006).

The Hiwassee population appears to have declined since monitoring began in 1986, as evidenced by the number of plants measured in three 10 x 10 m monitoring plots (Figure 1). The most recent plot data for the three subpopulations that TVA monitors in the Hiwassee drainage revealed an approximately 50 percent overall decline from the baseline established from all three in 1987 (Table 1). As noted above, Cruzan (2000) reported that, based upon coarse historical photo analysis, there has been an approximately 50 percent increase in vegetative cover within the Hiwassee River floodplain since the late 1940s. The threat of encroaching vegetation due to altered flows continues today. This population will likely continue to decline if nothing is done to ameliorate vegetation encroachment in *P. ruthii* habitat and to improve flows below Apalachia Dam.

Table 1. ***Pityopsis ruthii* abundance (baseline and most recent data presented) in three 10 x 10 m monitoring plots in the Hiwassee drainage.**

Site	*1986*	*1987*	*Most recent data*
McFarland	115	102	57 (2008)
Upperbend	--	339	124 (2010)
Bridge	279	194	136 (2009)
Total		635	317

Biologists from TDEC undertook a census and mapping effort for *P. ruthii* in the Hiwassee drainage during October 1999 through February 2000, which resulted in a count of 8,235 plants distributed among 12 "subpopulations" (TDEC 2000). Populations were defined in the report as distinct groupings of *P. ruthii* delineated by significant distances (at least 100 meters) and changes in habitats (e.g., different boulder sizes or unsuitable habitat). This report acknowledged that not all subpopulations or individuals were observed during the survey, with greater potential for plants to have been missed on the south side of the river.

During 2010 and 2011, TVA coordinated an effort to census and precisely map the distribution of patches of *P. ruthii* in the Hiwassee drainage using global positioning satellites. This survey mapped 54 discrete patches, totaling 10,404 *P. ruthii* plants (TVA unpublished data). Unfortunately, it is not possible to directly compare data from 1999-2000 to data from the 2010-2011 surveys. The effort during 2010-2011 was more exhaustive, involving multiple crews of 2-3 observers each carefully surveying all suitable habitat within the 4-mile reach where *P. ruthii* is known to occur. While these data demonstrate that a sizeable population of *P. ruthii* exists in the Hiwassee River drainage, no conclusions can be drawn about long-term trends in overall population abundance at this time. These data will provide a useful baseline against which to measure changes in the future. During the survey, habitat reduction due to encroaching native and non-native vegetation was routinely observed to be threatening *P. ruthii*. Indeed, plot-based monitoring reveals negative trends at three sites in the Hiwassee drainage since 1987 (Figure 1 and Table 1).

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

Cruzan and Estill (2001) conducted a survey of chloroplast DNA variation among populations of *P. ruthii* to infer history and phylogeography of Ocoee and Hiwassee river populations. They found different genotypes present among populations in the upper versus the lower Hiwassee and between the Hiwassee and Ocoee drainages. They concluded that the populations in each of these three regions were derived from separate Pleistocene refugia and that the largest difference was evident between the two drainages, which probably diverged during the early to mid Pleistocene.

Cruzan and Estill (1998) listed the following management implications stemming from these genetic differences:

- Collections for *ex situ* preservation of *P. ruthii* should be made from several sites across both populations in order to preserve the maximum amount of genetic diversity within the species.
- Transplants, crosses, or other movement of genetic material between drainages should not be done until studies have been completed to determine whether doing so would have deleterious effects.
- Cross fertilization studies should be conducted using plants grown from several sites on both rivers to test the effects of inbreeding within sites, outbreeding (among sites on one river) and hybridization between sites on different rivers.

Leaf samples were collected, for a population genetics study, from all patches of *P. ruthii* in the Hiwassee drainage during the 2010 census effort and from all sites on the Ocoee River. Wadl et al. (2011b) developed a set of 12 polymorphic microsatellite markers, which will be useful for assessing gene flow and population genetics of *P. ruthii.* TDEC provided section 6 recovery grant funds to Dr. Wadl to analyze population structure in *P. ruthii*, beginning in 2012.

c.Taxonomic classification or changes in nomenclature:
We have no new information on taxonomic classification of *P. ruthii*.

d. Spatial distribution, trends in spatial distribution or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

We have no new information to suggest that changes in the distribution of *P. ruthii* have occurred in the Ocoee River drainage. As discussed above in section C.1.a, the spatial distribution of *P. ruthii* in the Hiwassee was first precisely mapped during 2010-2011. Unfortunately, no prior data are available that would support a reliable analysis of changes in the spatial distribution within this drainage.

It has been hypothesized that the Hiwassee population was smaller than at present prior to the construction of Apalachia Dam (TVA 2002), a possibility that was discussed in the recovery plan. *P. ruthii* inhabits sunny, exposed rocks in and along the river's edge where scouring floods cleared competing vegetation, which would have become more abundant once Apalachia Dam was closed. This would have allowed *P. ruthii* to expand its distribution towards the river channel into habitats that would have been uninhabitable due to frequent or extended submergence under natural flow regimes. However, such expansion has been followed by a reduction in available habitat at the periphery of the narrow floodplain due to encroachment of competing vegetation in the absence of frequent scouring floods. While the scenario described above might be plausible, we only have monitoring data that extend far enough back in time to document declines in three monitoring plots in the Hiwassee drainage.

2. Five-Factor Analysis

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

Information summarized in this review confirms earlier concerns about the loss of habitat in the Hiwassee drainage to encroachment of competing herbaceous and woody vegetation. A Biological Assessment prepared by TVA (2002) discussed the threat posed to the Hiwassee population by vegetation encroachment onto the phyllite boulders due to altered flows in the river below Apalachia Dam since its construction in 1943. They identified this threat as the cause for the observed decline of *P. ruthii* since monitoring began in 1986. Several lines of evidence support this conclusion, including the general declining trend in the Hiwassee population since monitoring began (Figure 1 and Table 1), the finding of Thomson and Schwarz (2006) that all Hiwassee populations suffered mean negative growth rates except for one plot from which vegetation had been removed in the past, and Cruzan's (2000) observation that vegetative cover in the Hiwassee floodplain has increased approximately 50 percent since the late 1940s.

Altered flow regimes and encroachment of competing vegetation into suitable habitat in the Hiwassee drainage remain the greatest active threats for *P. ruthii*. Because the process of vegetation encroachment has occurred over a period of several decades, riparian communities have become established on the phyllite boulders to the extent that periodic high flows alone would not be enough to remove this threat and restore *P. ruthii* habitat.

b. Overutilization for commercial, recreational, scientific, or educational purposes:

The development of a whitewater recreation facility on the Ocoee River and hosting of whitewater events during the 1996 Olympics elevated concerns about recreation-related impacts to *P. ruthii*, both from whitewater paddlers and spectators. The USFS-CNF recommended corrective measures to reduce recreation-related impacts at two sites (Doublesuck and Tablesaw) where they were found to be greatest (Herrig and Wyrick 1996). The threat of trampling by spectators at the Tablesaw site was reduced by the extension of a guardrail on the nearby highway, eliminating parking access in close vicinity to this population. However, no billboard or kiosk has been constructed at the access point for paddlers upstream of Doublesuck, to inform paddlers of the presence of *P. ruthii* and biologically sensitive areas near particular whitewater features.

c. Disease or predation:
Trigiano et al. (2011) reported the first observations of powdery mildew on propagated plants of *P. ruthii*; however, this phenomenon has not been seen in the wild. This suggests that it will be important to take measures to minimize the risk of disease transmission from the laboratory/greenhouse setting when outplanting *P. ruthii* into the wild to accomplish recovery tasks 6.4 and 7.5.

d. Inadequacy of existing regulatory mechanisms:
We have no new information concerning this threat.
Pityopsis ruthii is listed as endangered by the State of Tennessee (TDEC 2008) 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.

Section 7(a)(2) of the Endangered Species Act requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect Federally listed species. Section 7(a)(1) also requires these agencies use their authorities to further the conservation of Federally listed species, which has been the impetus for recovery efforts by TVA and the USFS that are described above.

Sections 9 and 10 of the Act and the corresponding implementing regulations found in 50 CFR 17.61, 17.62, and 17.63 set forth a series of prohibitions and exceptions that apply to all plants listed as endangered under the Act. These prohibitions, in part, make the following activities illegal for any person subject to the jurisdiction of the United States: import or export; transport in interstate or foreign commerce; sell or offer for sale this species in interstate or foreign commerce; remove and reduce to possession this species from areas under Federal jurisdiction; and maliciously damage or destroy this species on any other area in knowing violation of any state law or regulation in the course of any violation of a state criminal trespass law. These regulations apply to any part of the plant, including seeds, roots, and other parts. The Act provides for the issuance of permits for scientific purposes or for the enhancement of propagation and survival of the endangered species.

e. Other natural or manmade factors affecting its continued existence: The Tennessee Department of Transportation is currently analyzing transportation alternatives for Corridor K, which passes through the Ocoee River Gorge (URS 2010). Two of the options that TDOT is analyzing (i.e., options 2 and 2A) would involve construction within the Ocoee River gorge in the vicinity of the *P. ruthii* population. The potential for adverse effects to *P. ruthii* that could result from these two options has not yet been analyzed; though, the presence of *P. ruthii* in the project area has been acknowledged.

D. Synthesis

The final listing rule and the recovery plan for *P. ruthii* both address the primary threats known to be currently affecting *P.ruthii*: (1) habitat alteration due to altered flows and subsequent vegetation encroachment in the Hiwassee River drainage and (2) whitewater recreation-related impacts in the Ocoee River drainage. Many of the recovery criteria remain unmet; though, substantial work has been accomplished through the combined efforts of members of the RCWG. While efforts to establish *P. ruthii* on suitable habitat in the Hiwassee by planting seed, greenhouse grown seedlings, and excised wild rosettes have failed, much has been learned about seed production and viability in *P. ruthii*. Efforts to establish *P. ruthii* on suitable habitat will be designed to prevent transfer of genetic material among populations, unless further genetic study were to reveal that inbreeding depression threatens the species, and should involve sufficient material to represent the genetic diversity distributed among the populations. Further investigation of population genetic structure and gene flow has been initiated by Dr. Phil Wadl, University of Tennessee, which will be used in formulating any reintroduction plans for *P. ruthii*.

Various approaches to analyzing long-term monitoring data reveal the declining status of *P. ruthii* in the Hiwassee drainage. This underscores the long-accepted belief that implementing management to prevent further vegetation encroachment into *P. ruthii* habitat in the Hiwassee drainage and restore habitats already degraded will be essential to the recovery of this species. The Service must work with members of the RCWG, using their authorities granted by sections 6 (TDEC) and 7(a)(1) (USFS-CNF, TVA) of the Endangered Species Act, to determine the best method for controlling vegetation encroachment and restoring habitat. Once this method is determined, the partners should seek a commitment for a long-term project to address this threat across the entire Hiwassee population. Ultimately, for this effort to be effective and sustainable, flow management to prevent repeated vegetation encroachment would be necessary. The Ocoee River population appears to be stable; though, efforts to prevent trampling by whitewater paddlers and spectators must be maintained, and monitoring of this threat should continue. While none are expected, any changes in flow management proposed by TVA for Ocoee Dam #2 should be evaluated for the potential to cause a similar problem to the ones caused by low flows in the Hiwassee or to cause prolonged flooding of existing *P. ruthii* habitat beyond a duration and frequency the species would be expected to tolerate.

We believe that *P. ruthii* still meets the definition of an endangered species because (1) the primary threats to *P. ruthii* of altered flows and vegetation encroachment in the Hiwassee drainage and whitewater recreation-related threats in the Ocoee drainage remain and (2) several of the recovery criteria remain unmet. Concerning the recovery criteria, we believe that accomplishing those that pertain to preventing vegetation encroachment in the Hiwassee drainage are of utmost importance. Also important is the development of effective methods for reintroducing *P. ruthii* into suitable habitat, which could be necessary if suitable habitat conditions can be restored where vegetation encroachment has reduced habitat availability in the Hiwassee drainage.

III. RESULTS

A. Recommended Classification:

__X_ No change is needed

B. New Recovery Priority Number _NA_

The recovery priority number for *P. ruthii* should remain 5C, as the species has apparently declined in the Hiwassee drainage since the completion of the Recovery Plan and because the likelihood of recovery remains low unless the RCWG can develop and implement a program for preventing vegetation encroachment in this drainage.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

The primary actions needed to move *P. ruthii* towards a status at which downlisting or delisting could be considered, include:

1. Determining effective methods for controlling vegetation encroachment and restoring degraded habitat in the Hiwassee drainage.
2. Implementing a vegetation control and habitat restoration program to restore suitable habitat conditions across the occupied range in the Hiwassee drainage. For long-term prevention of repeated vegetation encroachment, altering flows to provide sufficient frequency and duration of scouring of phyllite boulders will likely be necessary.
3. Analyzing and comparing contemporary flow regimes (i.e., since 1943) on the Hiwassee River to pre-impoundment flow regimes.
4. Conducting future surveys of *P. ruthii* populations in the Hiwassee drainage in order to assess (1) the degree to which suitable habitat for the species declines due to vegetation encroachment and (2) whether the species' linear distribution along the Hiwassee River changes over time.
5. Developing effective reintroduction methods for establishing *P. ruthii* in suitable habitat, in order to fulfill recovery tasks 6.4 and 7.5.
6. Ensuring that recommendations for controlling whitewater recreation-related threats to the Ocoee population are implemented.

7. Continuing long-term monitoring effort that has been implemented by TVA, USFS-CNF, and TDEC.
8. Continuing annual meetings of the RCWG to coordinate recovery efforts.

V. REFERENCES

Peer reviewed original research based on data

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<u>Personal communications</u>

Letter from John F. Ramey, U.S. Forest Service, Cherokee National Forest (May 3, 1995).

Statement from Mitchell B. Cruzan, Ph.D., University of Tennessee, recorded in RCWG Meeting Minutes (August 23, 2000).

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Email from Mitchell B. Cruzan, Ph.D., Portland State University (August 9, 2007)

Email from Michael Kunz, Ph.D., North Carolina Botanical Garden (October 3, 2007)

Letter from David Lincicome and Andrea Shea Bishop, Tennessee Department of Environment and Conservation, Subject: 5-year Review of *Pityopsis ruthii* (November 14, 2007)

Email from Mark Pistrang, U.S. Forest Service (February 16, 2012)

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Ruth's golden aster (*Pityopsis ruthii*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**
__X_ **No change is needed**

Review Conducted By __Geoff Call, Tennessee Ecological Services Field Office________

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve Mary E Jennings Date 3/22/12

The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record.

REGIONAL OFFICE APPROVAL:

The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.

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

Approve ____________________ Date 4/9/12

***APPENDIX A: Summary of peer review for the 5-year review of* Ruth's golden aster (*Pityopsis ruthii* (Small) Small)**

A. Peer Review Method: On October 17, 2007, the Service mailed letters to biologists at Tennessee Department of Environment and Conservation, US Forest Service, and the Tennessee Valley Authority, Dr. Steven Brewer – University of Mississippi, and Dr. Mitch Cruzan – Portland State University asking for peer review of the draft Ruth's golden aster 5 year review. These individuals are considered to be species experts or experts in the fields of plant ecology and genetics.

B. Peer Review Charge:
Peer reviewers were asked to pay special attention to discussions of existing populations, genetics, taxonomic classification, and recommendations for future actions.

C. Summary of Peer Review Comments/Report –

We received either no response or a response recommending no changes from Dr. Mitch Cruzan and the Cherokee National Forest.

The Tennessee Department of Environment and Conservation (Lincicome and Bishop 2007) provided a comment letter with numerous, though minor, technical and editorial suggestions.

Dr. Stephen Brewer (2007) provided comments regarding observations about low rates of seed production and seedling recruitment in *P. ruthii*, indicating that, while seed set in *P. ruthii* might be lower than in other species of *Pityopsis*, the low seedling recruitment observed in the species is consistent with observations of other members of this genus. Dr. Brewer suggested a moisture-retaining polymer that could be useful in establishing outplanted seedlings of *P. ruthii*. Dr. Brewer also suggested possible approaches for discerning effects of vegetation removal treatments from other confounding effects (e.g., drought) by incorporating measures of a congener, *P. graminifolia*, which has longer leaves and might be more tolerant of competition. Analyzing differences between responses of *P. graminifolia* and *P. ruthii* to treatments intended to reduce competition could improve ability to discern treatment effects from responses to environmental factors, such as drought, which would likely be reflected in both species declining. Dr. Brewer also suggested that restoring fire to the forested slopes of the Hiwassee River drainage could benefit *P. ruthii* by reducing a source of propagules of mesophytic trees and vines that encroach upon *P. ruthii* habitat.

D. Response to Peer Review –

We have incorporated most comments and editorial suggestions provided by Lincicome and Bishop into this 5-year review. At this time, we did not incorporate a suggestion to recommend updating the recovery plan, because this 5-year review serves the purpose of updating information on the species' biology, status, and threats – none of which reveals the need for additional recovery actions that are not identified in the existing recovery plan.

We have incorporated comments provided by Dr. Brewer concerning low seed set and seedling establishment rates in *P. ruthii* and other species of *Pityopsis*, as well as his comments concerning the potential role of fire in reducing the threat of encroachment into *P. ruthii* habitat by mesophytic species of woody plants and vines. We have not addressed Dr. Brewer's recommendation to use a specific moisture-retaining polymer to improve success in establishing outplanted seedlings, as work is underway to test the effects of bonded fiber matrix on attempts to establish outplantings of propagated seedlings in the wild. We also have not addressed Dr. Brewer's comments concerning the potential for measuring the response of *P. graminifolia* to treatments intended to reduce competition by encroaching woody plants and vines, because there are very few *P. graminifolia* plants growing in the specific locations where such treatments have been conducted. We will consider this recommendation if future treatments are planned in locations where these species co-occur.