

VIRGINIA SNEEZEWEED (*Helenium virginicum*)
RECOVERY PLAN

TECHNICAL/AGENCY C DRAFT

U.S. FISH AND WILDLIFE SERVICE
REGION FIVE
HADLEY, MASSACHUSETTS



VIRGINIA SNEEZEWEED (*Helenium virginicum*)

RECOVERY PLAN

Prepared by:

Nancy E. Van Alstine
Virginia Department of Conservation and Recreation
Division of Natural Heritage
Richmond, Virginia 23219

for

U.S. Fish and Wildlife Service
Region Five
Hadley, Massachusetts

September 2000



EXECUTIVE SUMMARY
DRAFT VIRGINIA SNEEZEWEED RECOVERY PLAN

Current Species Status: *Helenium virginicum* was federally listed as threatened on December 3, 1998, and is state-listed as endangered in Virginia. Since its first collection in 1935, Virginia sneezeweed has been found at 30 sites in the Shenandoah Valley of Virginia. At four of these sites, plants have not been seen despite several site visits in recent years, indicating that these populations may no longer be extant. Virginia sneezeweed occurs in seasonally wet sinkhole pond habitats, in some cases closely associated with agricultural and residential land uses. Recent studies of a *Helenium* sp. From a sinkhole pond in southern Missouri suggest that it may represent a disjunct population of *H. virginicum*, but further studies are needed to resolve this.

Habitat Requirements and Limiting Factors: *Helenium virginicum* is limited to seasonally flooded sinkhole ponds, a restricted and threatened habitat. Conditions in the Virginia habitat to which Virginia sneezeweed is adapted, including a variable hydroperiod, low pH, and soils high in aluminum and arsenic and low in other elements, may reduce competition from other species. In addition to the restricted habitat of Virginia sneezeweed, a self-incompatible breeding system has been documented for one *H. virginicum* population, that, if true of other populations, may increase the threat of local extinctions in small populations.

Recovery Objective: To delist the species.

Recovery Criteria: Delisting of *Helenium virginicum* will be considered when: (1) twenty self-sustaining populations and their habitats have received permanent protection across the species' Virginia range; (2) monitoring over a 15-year period indicates that populations in the 20 sites are viable; (3) life history and ecological requirements are understood sufficiently to allow for effective protection, monitoring, and, as needed, management; (4) seeds representing the range of genetic diversity in *H. virginicum* are placed in long-term storage to provide a source of genetic material in the event of extinction; and (5) if determined to be *H. virginicum*, the Missouri population and its habitat are permanently protected and seeds placed in long-term storage.

Needed Actions:

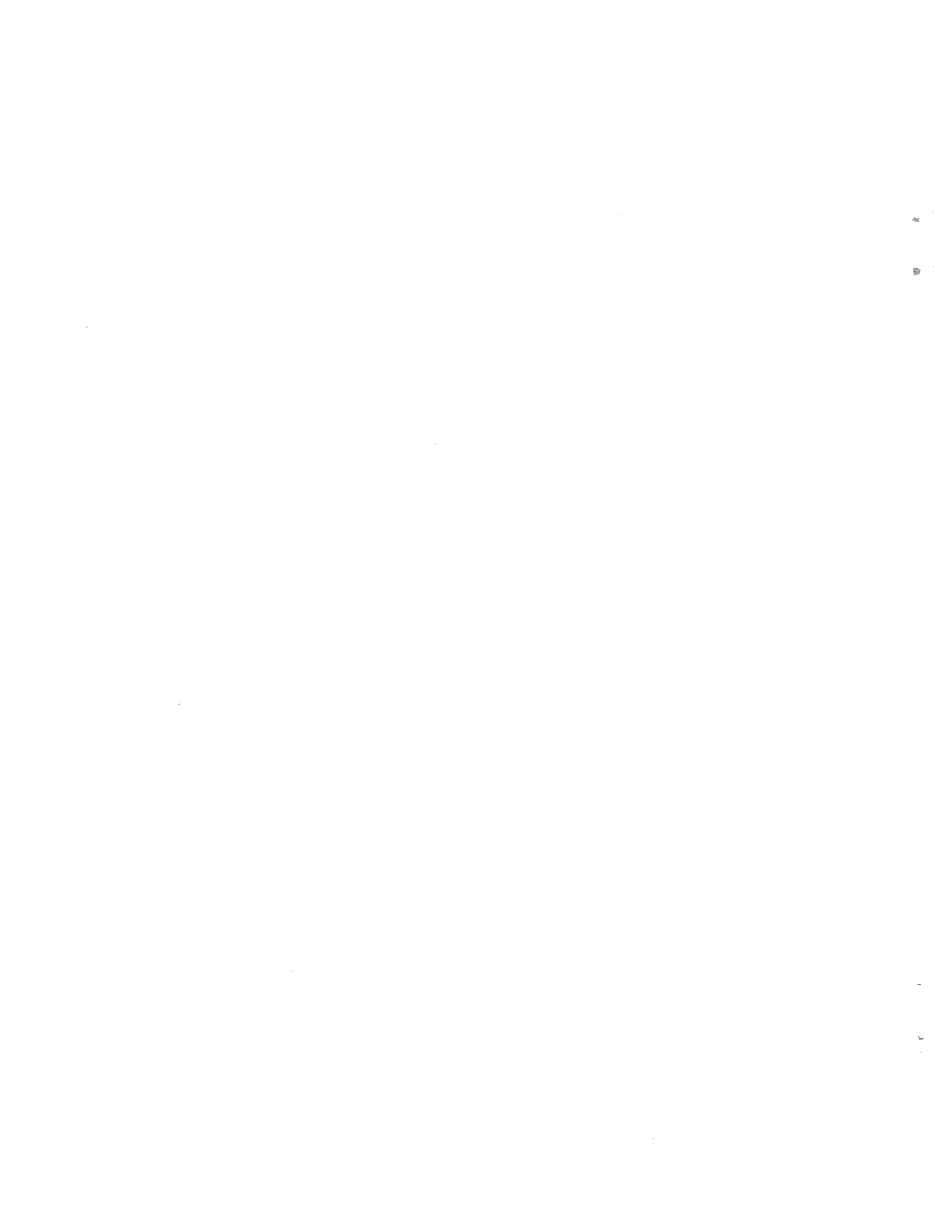
1. Protect the extant populations and their habitat.
2. Monitor extant populations.
3. Definitively identify the range and distribution of the species.
4. Continue investigations into the life history and ecology of *Helenium virginicum*.
5. Maintain seed sources for the species.
6. Develop informational materials to create more awareness of *H. virginicum* and its status.

Estimated Cost of Recovery (\$000):

<u>YEAR</u>	<u>NEED 1</u>	<u>NEED 2</u>	<u>NEED 3</u>	<u>NEED 4</u>	<u>NEED 5</u>	<u>NEED 6</u>	<u>TOTAL</u>
FY1	39	7	10	27	12	6	101
FY2	76	7	10	30	2	4	129
FY3	72	5	10	55	2	4	148
FY4-20	211	85	75*	144		35	550
TOTAL	398	104	105	256	16	49	928

* Most of this needed if the Missouri *Helenium* sp. is confirmed to be *Helenium virginicum*.

Date of Recovery: Delisting may be possible by the year 2020 if recovery tasks proceed on schedule.



* * *

The following draft recovery plan describes actions that should lead to recovery and/or protection of the Federally listed Virginia sneezeweed (*Helenium virginicum*). Recovery plans are published by the U.S. Fish and Wildlife Service and may be prepared with the assistance of recovery teams, contractors, State agencies, and others. Attainment of recovery objectives and availability of funds are subject to budgetary and other constraints affecting plan implementation, well as the need to address other priorities.

This draft plan does not necessarily represent the views or the official position of any individuals or agencies involved in its formulation, and it will represent the official position of the U.S. Fish and Wildlife Service *only* after it has been approved by the Regional Director. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and completion of recovery tasks.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 2000. Virginia Sneezeweed (*Helenium virginicum*) Recovery Plan. Technical/Agency Draft. Hadley, Massachusetts. 54 pp.

Additional copies of this draft plan may be obtained from:

U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, Maryland 21401
(410) 573-4537

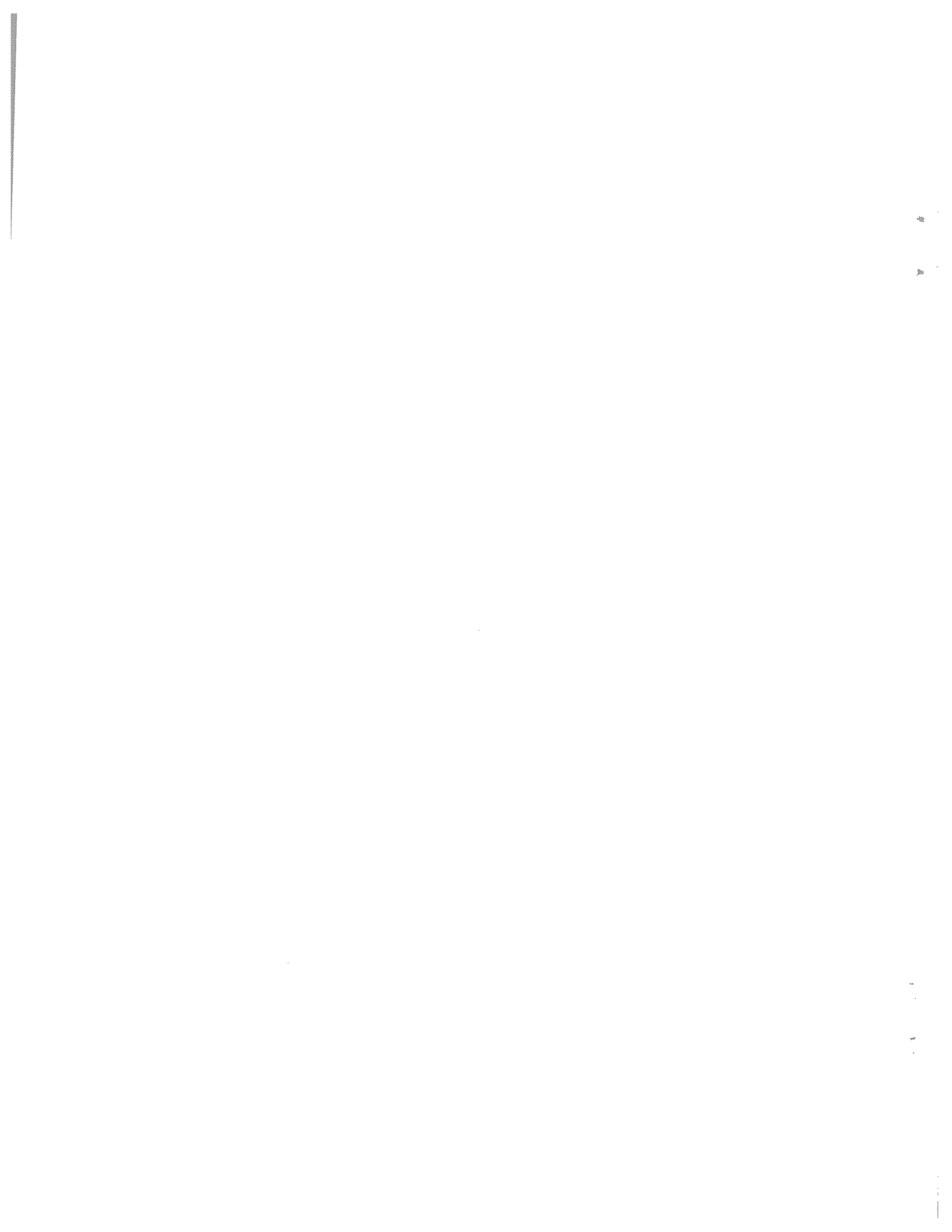


TABLE OF CONTENTS

PART I: INTRODUCTION	1
Description and Taxonomy	1
Distribution and Status	4
Life History and Ecology	5
Threats to the Species	12
Conservation Measures	15
Recovery Strategy	21
PART II: RECOVERY	23
Recovery Objective	23
Recovery Criteria	23
Recovery Tasks	24
Literature Cited	33
PART III: IMPLEMENTATION	37
APPENDIX: Summary of Occurrence Data for <i>Helenium virginicum</i> as of 2000	43

LIST OF TABLES AND FIGURES

Table 1.	Field morphological characters used to identify <i>Helenium virginicum</i> (Knox 1995)	4
Figure 1.	Current Distribution of <i>Helenium virginicum</i> in Virginia	6
Figure 2.	General locations of <i>Helenium virginicum</i> in Virginia and the <i>Helenium</i> sp. in Missouri under study	7



PART 1: INTRODUCTION

Helenium virginicum (Virginia sneezeweed), a rare herb in the Asteraceae (Aster family), is found in seasonally wet sinkhole pond habitat in two counties in the Shenandoah Valley of western Virginia. A single possible disjunct occurrence in Missouri is under investigation. Due to its restricted range, small number of occurrences, and increasing threats from loss and degradation of habitat, this species was listed on December 3, 1998, as threatened under the provisions of the Endangered Species Act of 1973, as amended (U.S. Fish and Wildlife Service 1998). It has been assigned a recovery priority number of 2 based on the high degree of threat, high potential for recovery, and its taxonomic standing as a species. Recovery priority numbers, which range from a high of 1C to a low of 18, affect scheduling and funding of recovery activities (Federal Register 48: 43103).

DESCRIPTION AND TAXONOMY

DESCRIPTION

Virginia sneezeweed (*Helenium virginicum* Blake) was first described in 1936 by S.F. Blake based on a collection made by E.T. Wherry from a site discovered by Lloyd Carr in Augusta County, Virginia (Blake 1936). Unless otherwise noted, descriptive data are based on Blake (1936). *Helenium virginicum* is a 7–11 dm high herb with a stem simple below the inflorescence, branched above, and winged (0.3–2.5 mm wide) throughout by the decurrent leaf bases. Basal leaves, gland-dotted, toothed or untoothed, widest in the upper half and tapering at both ends, are clustered in a rosette. The relatively few, mostly untoothed stem leaves, the middle and upper ones being narrowly linear or lance-linear, are progressively reduced up the stem. Rosette leaves, the lower stem, and some lower stem leaves are coarsely hairy. The inflorescence, loosely cymose (an inflorescence in which the terminal

flower or terminal flower of a branch blooms first), consists of 2-20 heads, each 2.5-3 cm wide. The central flower disk is nearly ball-shaped. Ray flowers are golden yellow, wedge-shaped and three-toothed, and disk corollas are yellow, turning purplish at the base with age. The fruit is an achene with hairs on its nerves. The pappus, consisting of 6-7 awn-tipped white scales that crown the achene, is 1.5 –2 mm long. The achene readily loses its corolla, resulting in a silvery appearance due to the long pappus scales (Knox 1995).

TAXONOMY

Fernald (1950) and Gleason (1952) recognized *H. virginicum* as being distinct from *H. autumnale* on the basis of cauline leaf and pappus distinctions and, in Gleason (1952), the presence of basal leaves, but recognition of this species has not been universal, as Rock (1956), Bierner (1972), and Cronquist (1980) placed *H. virginicum* in synonymy with *H. autumnale*. Roe (1977) distinguished *H. virginicum* from *H. autumnale* on the basis of cauline leaves not being numerous, reduced up the stem, and lanceolate to lance-linear; pappus scales 1.5-2.0 mm long; and basal leaves usually present at anthesis vs. cauline leaves numerous and not reduced up the stem, lanceolate to elliptic; pappus scales 1 mm long or less; and basal leaves usually absent at anthesis. Cronquist (1980) originally mentions *H. virginicum* as being only doubtfully distinct from *H. autumnale*, but after a visit to a *H. virginicum* population, Cronquist apparently became convinced that it was a distinct species (pers. comm., reported in Johnson and Porter 1991). Gleason and Cronquist (1991) distinguished *H. virginicum* from *H. autumnale* on the basis of the leaves being basally disposed rather than chiefly or all cauline and numerous. Kartesz (1999) treated *H. virginicum* as a separate species.

To resolve the questions about the taxonomic status of the entity *H. virginicum*, Knox (1987) conducted experimental garden tests to determine if the differences between *H. virginicum* and Virginia *H. autumnale* var. *parviflorum*, the variety growing in the general area where *H. virginicum* is found, are phenotypic or genotypic (Knox 1987). These tests showed *H. virginicum* to be significantly shorter (7.93 versus 12.34 dm), with a later bolting date (after May 12 vs. before May 1), an earlier flowering midpoint (August 10 vs. September 10), and longer pappus length (1.37 vs. 0.74 mm).

Knox's overall conclusion was that most of the characters previously used by others (Gleason 1952, Roe 1977) to distinguish the two *Helenium* species were genetically based (Knox 1987). The only finding that differed was concerning the presence of basal leaves when flowering: Roe (1977) and Gleason (1952) indicated that *H. virginicum* usually has basal leaves at flowering, but *H. autumnale* does not. Knox (1987) found that the presence of basal leaves at flowering in the experimental garden was similar between *H. virginicum* and *H. autumnale*, and this trait in field populations of *H. virginicum* was very variable.

Building on the 1987 investigations, Knox (1995) conducted additional experiments using common gardens and transplant studies to determine if *H. virginicum* is morphologically and ecologically distinct from *H. autumnale* collected outside Virginia. Populations from which achenes were collected and used in common gardens were found during herbaria searches for specimens of both narrow-leaved and broad leaved *H. autumnale* in eastern North America. These included sites in Vermont, New Jersey, Ontario, Missouri, and Virginia. Traits examined included achene length and width, and length of the longest pale (chaffy scale) of the pappus, corolla retention, dimensions of the tenth leaf, leaf shape and margin (entire or serrate), number of basal stems, presence of pubescence, presence of adventitious roots, number of branch forks in the upper 35 cm of the tallest flowering stem, total number of leaves in the upper 35 cm, and number of entire leaves in the upper 35 cm. *H. virginicum* was found to be distinct from broad-leaved *H. autumnale* and narrow-leaved New Jersey *H. autumnale* in 14 of 15 morphological characters, and distinct from narrow-leaved Canada *H. autumnale* in 12 of 15 characters. Based on these findings, Knox summarized the field characters that can be used to separate *H. virginicum* from *H. autumnale*, as shown in Table 1.

In the studies by Knox et al. (1995), *Helenium virginicum* differed from the *Helenium* sp. collected near Pomona, Missouri, by only three out of fifteen characters, with *H. virginicum* having shorter mean achene length, longer mean pappus length and fewer upper stem leaves. In further investigations of the relationship between *H. virginicum* and the Missouri *Helenium* using DNA sequence analyses, Simurda and Knox (in review) concluded that the Virginia populations of *H. virginicum* and the Missouri *Helenium* collected near Pomona, Missouri, had a monophyletic origin. Additional genetic research is warranted to strengthen this conclusion. It should be noted here that mixing of the Pomona, Missouri,

Table 1. Field morphological characters used to identify *Helenium virginicum* (Knox 1995).

Leaf shape:	lance-linear, mostly entire mid-stem leaves that scarcely taper to leaf base
Pubescence:	basal pubescence on stem and rosette leaves
Achenes:	readily lose corolla leaving the mature fruiting head with a silvery appearance resulting from the long pappus scales
Habitat:	shallow depression (sinkhole pond) with 6-8 months of inundation

Helenium sp. genes with the gene pool of *Helenium virginicum* is a possibility at the Element Occurrence (EO) 003 site. Before the listing of *H. virginicum*, a transplant study investigating the abilities of *H. autumnale* and *H. virginicum* to survive in each other's habitat was conducted at this site in 1990. This study included the introduction of 14 plants of the *Helenium* sp. from the Pomona, Missouri, site into the EO 003 site (Knox 1995). None of the Missouri plants flowered in the one-year study, and only five survived (J.S. Knox, Washington and Lee University, pers. comm.). The remaining five, however, were not removed at the end of the study, nor was their fate subsequently monitored. It may be possible in the future to determine if genes from the Missouri *Helenium* sp. are now present in the gene pool at the site of EO 003, or even nearby E0 001, if the plants are insect pollinated and the insects are moving between the sites.

DISTRIBUTION AND STATUS

First found in Augusta County, Virginia, in 1935 (Blake 1936), the known range of *Helenium virginicum* was expanded to Rockingham County by C.E. Stevens in 1967 (Roe 1977). Up until the late 1970's, fewer than ten occurrences were known, but six more occurrences were documented in the 1970's (Virginia Department of Conservation and Recreation's Division of Natural Heritage [VADCR-DNH] database). Surveys in 1987

(Knox 1987), 1990 (Van Alstine and Ludwig 1991), 1991 (Van Alstine et al. 1992), and 1995 (Longbottom and Van Alstine 1995) resulted in the discovery of 15 additional occurrences. Knox (1987), Van Alstine and Ludwig (1991), and Van Alstine (1995) also conducted status assessments of known occurrences.

As of 2000, 30 populations have been documented, with 23 in Augusta County and 7 in Rockingham County. Four of these populations have not been seen since the late 1970's to early 1990's and may be locally extirpated. The occurrences and status information are included in the Appendix. The distribution of *Helenium virginicum* is shown in Figure 1. Three other locations are described on herbarium labels from specimens collected in 1936, 1937, and 1940, but lack sufficient information to allow them to be relocated accurately and may well represent some of the currently known sites; these are not included in the Appendix, but are included in Figure 1 (VADCR-DNH database). In the 1990's, studies by Knox et al. (1995) and Simurda and Knox (in review) of a *Helenium* found in Missouri in 1957 by Steyermark (1960), suggest a disjunct occurrence of *Helenium virginicum* in one site in southern Missouri, but further genetic work is needed. The known global distribution of *Helenium virginicum* including the location of the Missouri *Helenium* species is provided in Figure 2.

LIFE HISTORY AND ECOLOGY

LIFE HISTORY

A fibrous rooted perennial herb, *H. virginicum* blooms from early July through October with a peak in late July to early August. Seed dispersal occurs in late fall, and dormancy is broken gradually with most germination delayed until the next growing season after the water has drawn down (J.S. Knox unpubl. data). Knox (1997) noted that seeds initially had low germination rates at temperatures (19-32° C) under which they later germinated well. But even at these warm temperatures and after dormancy has been broken, seeds do not germinate in the dark or under a column of water with a dense floating vegetation layer; however, seeds will germinate underwater if this vegetation layer is not present (J.S. Knox unpubl. data).

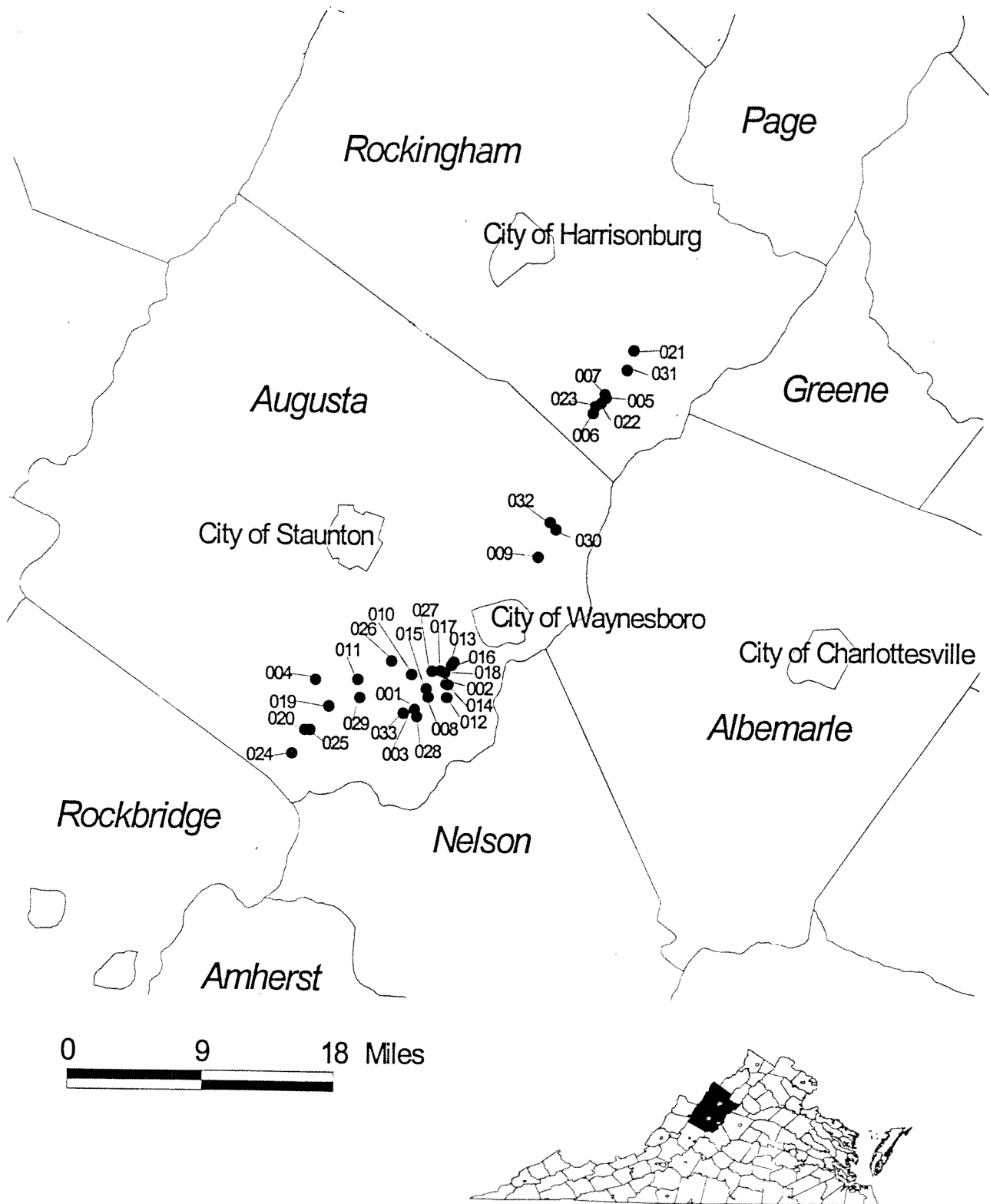


Figure 1. Current distribution of *Helenium virginicum* in Virginia.

Because plants have not been found at occurrences 005, 007, 010, and 019 over several visits, these may no longer be extant populations. Occurrences 026, 027, and 028 are approximate locations based on herbarium records and may represent currently known sites whose locations are more accurately plotted.



Figure 2. General locations of *Helenium virginicum* in Virginia (★) and the *Helenium* sp. (☆) in Missouri under study

Helenium virginicum appears as a basal rosette in the first year and then in its second year usually bolts, producing a single flowering stem. A single flowering stem can include 1-15 flowering heads (J.S. Knox unpubl. data). The production of new basal leaves continues year round, and leaves that have been growing under water are more slender than those that have grown above water (J.S. Knox unpubl. data). *H. virginicum* grown in an experimental garden have lived for at least four years and flowered more than once (Knox 1997); in a nine-year demographic field study at one population, plants were found to live up to five years and flower two to three times (Knox 1997). Knox has found limited evidence of vegetative reproduction in the form of rooted sprouts growing from fallen aerial stems and plantlets sprouting from roots growing out of pots under experimental conditions, but has not seen this in the field and states that individual plants, easily identified in the field, are nearly always genets (Knox 1997). The dense mats of rosettes seen in some populations, therefore, probably reflect seed dispersal patterns.

Nothing is known about the pollinators of *H. virginicum*, but Knox suspects that it is not a single pollinator based on casual observations of insect visitors (J.S. Knox pers. comm.). Research by Messmore and Knox (1997) on plants from EO 003 determined that the *H. virginicum* from at least this site has a sporophytic, self-incompatible breeding system. Successful mating, therefore, can occur only with other plants that differ by at least one allele at the S-locus (DeNettancourt 1977). This type of breeding system has been documented in other members of the Asteraceae family (DeMauro 1993, Reinartz and Les 1994).

POPULATION SIZE

Population sizes documented among the different occurrences range from a single vegetative rosette at EO 019 to estimates of 100,000–1,000,000 at EO 002 and 500,000 at EO 008 (VADCR-DNH database). Population size and/or distribution among flowering plants, vegetative plants, and seedlings within a *H. virginicum* occurrence may fluctuate widely from year to year. The history of EO 001 serves to demonstrate this: Although one observer noted a few stunted stems (vegetative rosettes were not counted) (VADCR-DNH database), Knox, counting all plants in quadrat plots, and determining a density/m², estimated a total of 23, 226 plants for the site in 1986 (Knox 1997). In 1987, 10,536 plants (4,300 flowering) were estimated (VDCR-DNH database). No vegetative plants were seen after

drawdown in 1990 after 16 consecutive months of inundation in 1989-1990, although two months later recruitment from the seed bank produced an estimated total of 37,394 rosettes (Knox 1997). In 1994, 1,279 plants (actual count) were counted, with 404 of those flowering (Knox 1997), whereas approximately 30 stems were seen in late flower in 1995, but the basin was still water-filled in early September, and Knox counted fewer than 100 rosettes in quadrats. And in 1997, 681 rosettes recruited from the seed bank were counted (VDCR-DNH database).

Due to the presence of a seed bank, at least some populations of *H. virginicum* are able to survive after adverse hydrological conditions (Knox 1997); viable seeds of *H. virginicum* can persist in the soil for at least 3.75 years and maybe longer (J.S. Knox pers. comm.).

HABITAT CONDITIONS

General:

Helenium virginicum is limited to the seasonal wetlands commonly referred to as sinkhole ponds. In Virginia, these natural wetlands are located along a 90-km (56-mi) band in the alluvial fan deposits at the foot of the west side of the Blue Ridge Mountains. The pond basins have formed by the local solution of underlying carbonate formations (dolomite and limestone) but are overlain by acidic alluvial material that has eroded from the Blue Ridge Mountains to the east and south. The wetlands are subject to fluctuating water levels that may vary from year to year, but in general the pond sites are inundated in winter and spring and drier during the summer months. However, drought and high rainfall can modify this pattern, and extended periods of inundation of up to 20 months have been documented at one site (J. S. Knox pers. comm.). Ponds supporting Virginia sneezeweed vary in size, basin depth and shape, and length of hydroperiod. While many of the wetlands appear pond-like, consisting of more or less circular water-filled depressions with concentric vegetation zones, others within shallow basins are more meadow-like in physiognomy with little well-defined vegetation zonation. The level of disturbance present at the sinkhole ponds includes relatively undisturbed ponds surrounded by forest, more meadow-like habitats around farm ponds actively used by cattle, a backyard seasonal wetland maintained in an open state by the

landowner, a seasonally wet mowed lawn, and a seasonal wetland degraded by severe cattle trampling and an ongoing attempt to fill the site.

Herbaceous species associated with these sinkhole ponds, some of which persist even in the disturbed sites, include *Panicum verrucosum*, *Hypericum boreale*, *Eleocharis acicularis*, *Panicum rigidulum*, *Viola lanceolata*, *Eleocharis melanocarpa*, *Lysimachia hybrida*, *Bidens frondosa*, *Boltonia asteroides*, and *Stachys hyssopifolia* (VADCR-DNH database). Other herbaceous species usually limited to the more disturbed sites include *Paspalum laeve*, *Trichostema dichotomum*, and *Diodia teres* (VADCR-DNH database). Woody species scattered within or bordering the wetland include *Quercus palustris*, *Nyssa sylvatica*, *Diospyros virginiana*, and *Cephalanthus occidentalis*.

The site of the Missouri population of *Helenium* was described as a “sinkhole pond” by Steyermark (1960, 1963). In 1994, it was being used for a cattle pasture and included a low meadow around a farm pond, a low-lying old field, and an outlier population along a ditch (Knox 1994). Associated species noted at the site include *Aster pilosus* and *Helenium flexuosum*.

Soil:

Soils in the Shenandoah Valley sinkhole pond habitat in Virginia have been described as a gray clay lens. Analyses of soil samples from 19 of the *H. virginicum* pond sites indicated that the soils are acidic (4.5) with high concentrations of aluminum and arsenic but low levels of boron, calcium, potassium, magnesium, and phosphorus (Knox 1997). The soil from the Pomona, Missouri, site is also a whitish gray clay (J.S. Knox pers. comm.). A soil sample taken from the Missouri site exhibited normal levels of aluminum, boron, phosphorus magnesium, calcium, potassium and arsenic, but copper levels seven times the normal maximum level. The pH was low (5.1) but six times higher than the average pH at the Virginia *Helenium virginicum* sites (Knox 1994).

Habitat Requirements:

Knox has conducted several experiments to determine what environmental factors control the distribution of *Helenium virginicum* and give it a competitive edge over other species (Knox 1995, 1997). When competitors were removed, *H. virginicum* was able to grow to reproductive maturity in both upland and seasonally inundated gardens and on a variety of soils (Knox 1997). Through transplant and common garden studies, Knox sought to determine if *H. virginicum* and *H. autumnale* were ecologically isolated. Although he found that survival rates for each species were significantly higher in their own habitats, both *H. autumnale* and *H. virginicum* grew equally well in a simulated *H. virginicum* habitat in a plastic tank. Hydroperiod alone, therefore, does not account for ecological differences between *H. virginicum* and *H. autumnale*.

In addition to stresses for plants created by extremes of fluctuating water levels, stressful soil conditions may play a role in giving *H. virginicum* a competitive advantage (Knox 1997). The high levels of aluminum and low pH (4.5) that Knox found in the soils of *H. virginicum* sites combine to limit plant growth by inhibiting macronutrient uptake and translocation (Foy 1974, Taylor 1988, Knox 1997). High arsenic levels and low calcium, magnesium, potassium, phosphorus, and boron also create stressful conditions for plants.

The data from nine years of study at EO 001 indicate that *H. virginicum* is shade intolerant; all measures of recruitment, survival, growth, and reproduction increased as overstory cover decreased (Knox 1997). In addition, after drawdown of this pond in August 1990, a heavy accumulation of floating aquatic vegetation (*Sphagnum*, *Eleocharis acicularis*, filamentous algae) developed, and no vegetative *H. virginicum* was found; however, no declines were seen in the 1989-1990 period in *H. virginicum* populations at other ponds with extended inundation but where no aquatic mat formed (Knox 1997). Knox also notes that two sites with large populations have had tree species removed (Knox 1997).

THREATS TO THE SPECIES

ANTHROPOGENIC

Habitat Loss:

The most serious threat to *H. virginicum* appears to be habitat loss, most often arising from changes in the natural hydrological regime of the sinkhole pond habitat. Four of the sites, EO 002, EO 008, EO 015, EO 016, three of which are grazed by cattle, have had a portion of the wetland deepened to create a permanent pond; prior to being excavated, much of this section once undoubtedly supported *H. virginicum* and so loss of some habitat has occurred. In contrast, actions have been taken at some other Virginia sites to stop or lessen the periodic inundation. Significant ditches have been dug at EO 013 and the EO 012, with smaller ditching at EO 011, 014, and 017 (see Appendix). Ditching and plowing occurred at EO 001 in the past, and some evidence of the ditch remains but does not significantly affect the hydrologic regime. Portions of the sites at EO 011 and EO 017 have been filled in. It is probable that the pressure to control seasonal flooding will increase, as the area of the Shenandoah Valley where the Virginia populations of *H. virginicum* are found is experiencing rapid growth, particularly in the building and expansion of residential subdivisions.

In addition to obvious hydrological alterations made directly to the sinkhole ponds, off-site actions may affect the hydrology of the ponds. Input from groundwater sources may be decreased by withdrawals for wells that serve adjacent developments such as subdivisions. Overland surface water flow may be altered by activities such as timber harvesting or road building in upslope areas. Little is known about the relative importance of groundwater versus surface flow to the hydrological regime of the sinkhole ponds, but preliminary research suggests that the relative importance of these water sources is unique for each pond (E. Knapp, Washington and Lee University, pers. comm).

A variety of site-specific threats to *H. virginicum* from habitat loss has appeared over the last ten years. The Virginia Department of Transportation (VDOT) has proposed to widen Route 340, currently a two-lane north-south corridor on the east side of the Shenandoah Valley, to four lanes, and a portion of the EO 009 site in Augusta County is immediately east

of Route 340. The Virginia Department of Conservation and Recreation's Division of Natural Heritage reviewed the proposal for this project in 1991 and recommended that the road not be widened in the area of the pond and that VDOT consult with the U.S. Fish and Wildlife Service (USFWS) before initiating any construction. Long-range plans still include widening of Route 340, and VDOT will coordinate with USFWS whenever the project becomes active (S. Stannard, Virginia Department of Transportation, pers. comm.)

Another *H. virginicum* population, EO 004, is near the site of silos built in the early 1990s that are used to store septic waste. Although this waste is eventually dumped on the ground elsewhere on the ridge-top property away from the *H. virginicum* site, during a 1995 site visit, VADCR-DNH noted a large pile of soil on the north side of the shallow basin that supports the *H. virginicum* population; fortunately, the landowner reconsidered a plan to push this soil into the seasonally wet basin to level it out. In a 1997 site visit, the pile was still present and larger than in 1995. In 1995 and 1997, it was noted that sediment from the pile had washed into the edge of the pond site, creating different soil conditions in that area and making it more favorable for weedy species (VADCR-DNH database).

Land Use Practices:

Mowing occurs in a number of the Virginia sites, including EO 013, EO 002, and EO 014. Continued mowing may provide beneficial effects to the species; EO 002, one of the largest if not the largest and densest population, has been periodically mowed and bush-hogged by the landowner for an extended period of time. However, repeated mowing before seed is set and the seed bank is replenished may lead to local extinction as vegetative plants die out and the seed bank ultimately becomes depleted.

Herbivory does not appear to be a problem, although the threat to *H. virginicum* from cattle grazing needs evaluation. Large populations of *H. virginicum* co-exist in several sites with cattle grazing (EO 015, EO 016, EO 008). This suggests that the species may respond favorably to limited amounts of disturbance. Knox et al. (1999) tested the hypothesis that *H. virginicum* is unpalatable to generalist herbivores in a common garden study; none of the *H. virginicum* plants were grazed by either vertebrate or invertebrate herbivores. Knox notes that this is consistent with reports of toxicity in other *Helenium* species associated with the

presence of sesquiterpene lactones (Hesker 1982, Anderson et al. 1983, Anderson et al. 1986, Arnason et al. 1987). *Helenium virginicum* has been shown to contain a sesquiterpene lactone, virginolide (Herz and Santhanam 1967). According to J.S. Knox (pers. comm.), the leaves of *H. virginicum* are bitter-tasting, and selective grazing by cattle of more palatable associated species therefore may eliminate plant competitors. However, other effects on *H. virginicum* from cattle grazing such as the increased nutrient loads, soil compaction, and trampling of plants are unknown. As the soils of the *H. virginicum* sites have been found to be nutrient-limiting (Knox 1997), long-term nutrient enrichment from cattle could ultimately create more favorable habitat for other plant species.

Inadequate Regulatory Mechanisms:

With federally listed wetland species, the permitting process carried out by the U.S. Army Corps of Engineers (USACOE) under authority of the Clean Water Act of 1977 is often the point at which proposed actions can be reviewed in light of their effect on the listed species and protective actions can be recommended. The isolated and often small seasonally wet habitat of *Helenium virginicum*, however, does not currently have direct federal protection. United States vs. Wilson 133 F. 3d 251(4th Cir. 1997) ruled that the USACOE has no jurisdiction over isolated water bodies that have no surface connection with any tributary stream that flows into traditional navigable waters or interstate waters. Nationwide Permit 26, under federal wetlands regulations (56 CFR 59134-59147, Part 330-Nationwide Permit Program), which has applied to headwater areas and isolated wetlands, is currently being revised including a lower minimum acreage (1/10 acre); the Norfolk District of the USACOE is proposing a regional minimum threshold of 1/4 acre (E. Gilinsky, Virginia Department of Environmental Quality, pers. comm.). These lower minimum acreages, however, will not apply to the *Helenium virginicum* habitat if the ruling in U.S. vs. Wilson stands.

Currently, so-called Tulloch ditching, i.e., draining by ditching in which excavation occurs by mechanical means that do not require placing excavated material into a wetland and in which the material is lifted and hauled to an upland disposal site, does not require that USACOE be notified or a permit obtained. Major ditching has been used at three of the *H. virginicum* sites to control the seasonal flooding, and more minor ditching has been used at another three sites.

As most of the populations of *H. virginicum* are on private lands, the current legal protections in place for this species will not be adequate to ensure the long-term survival of *H. virginicum*. The prospects of future regulatory changes are not known.

NATURAL

Extremes in the fluctuating hydroperiod of the sinkhole ponds could, when preceded by low investment in the seed bank, result in the local extinction of populations. Extended drought at a site could make it more favorable for colonization by other plants previously hampered by periodic inundation. This would include tree species, which could result in increased shading within the site and so reduce the areas favorable for *H. virginicum*. An extended period of inundation, coupled with development of a floating vegetation mat, such as occurred at EO 001 (Knox 1997), could lead to local extinction if an insufficient seed bank existed to recover from the death of the vegetative plants. Either of these extremes in hydroperiod could result from normal variability in weather patterns or from larger scale climate changes of either natural or human origin.

If found to hold true for other populations of *H. virginicum*, the self-incompatible breeding system of *H. virginicum* found in the EO 003 population may eventually lead to local extinction at sites with low population numbers as the chance of successful pollination decreases (Messmore and Knox 1997).

CONSERVATION MEASURES

CURRENT LEGAL PROTECTION

Federal:

Helenium virginicum's 1998 listing as a threatened species under the Endangered Species Act of 1973 (ESA), as amended, provides some measure of protection to those occurrences on federally managed lands or from actions where some federal action such as

permit issuance is involved. Under the terms of Section 7 (a)(2) of the ESA, each federal agency shall ensure that any action that it authorizes, funds, or carries out shall not jeopardize the continued existence of any endangered or threatened species. Any federal action that may adversely affect a listed species must result in a formal consultation between the federal agency and the U.S. Fish and Wildlife Service unless a biological assessment determines that there will be no adverse effect. The protections for endangered plant species listed in the ESA (including prohibitions against removing and reducing to possession from areas under federal jurisdiction and prohibitions against importing or exporting, selling or offering for sale, delivering, receiving, carrying, transporting, or shipping in interstate or foreign commerce) were extended to threatened plant species by regulation, 50 CFR 17.71, under authority of Section 4(d) of the ESA. A 1988 amendment to section 9 (a)(2) (B) of the ESA added the following prohibitions to endangered species: malicious damage or destruction on areas under federal jurisdiction; removal, cutting, digging up, damage or destruction to in any other area in knowing violation of any law or regulation of any state or in the course of violation of a state criminal trespass law. To date, however, no regulation has extended the prohibitions of the 1988 amendment to threatened plants. Seeds from cultivated specimens of threatened species are exempt from ESA prohibitions if containers are marked "Of Cultivated Origin". Under the ESA and 50 CFR 17.72, permits may be issued to allow otherwise prohibited activities including scientific research, activities to enhance propagation or survival of the species, botanical or horticultural exhibitions, educational purposes, or other purposes consistent with the Endangered Species Act.

Some protection may be afforded the isolated wetlands if a proposed project area that contains an isolated wetland also includes jurisdictional areas that require a permit (J. Brogdon, U.S. Army Corps of Engineers, pers. comm.). Corps of Engineers policy is that anyone considering filling an isolated wetland should contact the USACOE to allow a formal determination to be made (J. Brogdon pers. comm.). The habitat of *H. virginicum* on farms may be offered some protection by the Wetland Conservation provision of the Food Security Act (1985, 1990). This provision ties eligibility for U.S. Department of Agriculture farm program benefits to protection of wetlands on the farm in that producers are ineligible for benefits if they plant an agricultural commodity on a converted wetland that was converted by draining, leveling, or any other means after December 23, 1985 (Mandelker 1997).

State:

H. virginicum has been listed as endangered by the Commonwealth of Virginia since 1989 under the Endangered Plant and Insect Species Act (Title 3.1, Chapter 39). This law protects listed plant and insect species from take in the form of collection or translocation, except by the landowner, unless landowner permission and a state permit are obtained. The Act does not regulate destruction or alteration of habitat.

State wetland regulations that would relate to isolated wetlands, including acreage thresholds, are being developed and will not become effective until October 2001 (E. Gilinsky pers. comm.). Until that time, only wetlands recognized as jurisdictional by the USACOE will be recognized by the state. As of July 1, 2000, the state will also begin regulating the "Tulloch" ditching mentioned previously. The level of protection given to *Helenium virginicum* habitat by these future changes in state regulations is unclear.

CONSERVATION PLANNING

Site-specific conservation planning, funded by the U.S. Fish and Wildlife Service and the Virginia Department of Agriculture and Consumer Services, was conducted by the Virginia Department of Conservation and Recreation's Division of Natural Heritage at five privately-owned sites (Erdle 1996, Erdle 1997). These sites included EO 002 and EO 009 (Erdle 1996) and EO 004, EO 018, and EO 030 (Erdle 1997). The reports provided a site description, information on population status, land use, zoning, and threats, and identified *H. virginicum* ecological and conservation zones. Landowners received copies of the sections pertaining to the population on their land. In 1997, two meetings were held by representatives of the U.S. Fish and Wildlife Service, the U.S. Forest Service, the Virginia Department of Conservation and Recreation's Division of Natural Heritage, The Nature Conservancy, and academic institutions to discuss protection planning and conservation priorities for *H. virginicum*. The results of those meetings were integral to the development of this recovery plan.

SURVEYS

As mentioned under the Distribution and Status section, fewer than 10 populations of *H. virginicum* were known up to the late 1970s. Surveys in Augusta and Rockingham Counties from the late 1970s into the 1990s resulted in the discovery of 21 more populations. No surveys are underway at this time, and much of the highest potential habitat in Virginia has been searched, but additional habitat remains to be surveyed in Virginia. If the Missouri *Helenium* sp. is confirmed to be *H. virginicum*, sinkhole pond habitat in Missouri, intervening states, and other areas of Virginia will need to be targeted for surveys to determine the distribution of this species.

EDUCATION EFFORTS

A fact sheet on *Helenium virginicum*, funded in part by the U.S Fish and Wildlife Service, was developed by the Virginia Department of Conservation and Recreation's Division of Natural Heritage in 1995. This brief brochure discusses habitat, distribution, life history, conservation, and threats. In addition, a fact sheet on seasonal ponds, which includes depression ponds of both the Shenandoah Valley and the Coastal Plain, was developed, funded in part by the Virginia Department of Environmental Quality's Coastal Management Program. These fact sheets are available on the Internet under the Virginia Department of Conservation and Recreation's Division of Natural Heritage web site at <http://www.state.va.us/~dcr/dnh/helenium.htm> and <http://www.state.va.us/~dcr/dnh/wponds.htm>. They have been distributed to, among others, governmental agencies such as the U.S. Forest Service, the Planning Departments of Augusta and Rockingham Counties, the Central Shenandoah Planning District Commission, private conservation groups such as the Valley Conservation Council, and private landowners with *Helenium virginicum* populations. In August 1997, representatives of the Virginia Department of Conservation and Recreation's Division of Natural Heritage met briefly with the Augusta County Board of Supervisors at a *H. virginicum* site on private land for the purpose of bringing this plant to the attention of the county government. Board members were given fact sheets on *H. virginicum* and the seasonal pond habitat, and the significance of the plant was discussed.

SITE PROTECTION

Six of the sites that have been documented to support populations of *H. virginicum* are on land managed by the U.S. Forest Service (USFS). Five of these, EO 020, EO 025, EO 019, EO 003, and EO 033, are within areas designated as Special Interest Areas (SIA). SIA are designated to protect high quality natural communities or habitat for threatened, endangered, and sensitive species (George Washington National Forest 1993). The location of one of the populations on USFS land, EO 029, does not currently fall within any designated management area but is being recommended by VADCR-DNH for inclusion within a SIA. In the past, The Nature Conservancy has had a management agreement with the private owner of the EO 001 site; this agreement has lapsed and a new agreement is being renegotiated. All other sites are on private lands and currently unprotected.

RESEARCH EFFORTS

A number of studies are underway or planned for the near future by J.S. Knox and associates at Washington and Lee University. Brief descriptions of these studies follow:

Further demographic studies were begun by Knox and Hanlon in 1999 at three ponds on USFS land. Seeds from EO 003 were sown in two ponds not currently supporting *Helenium virginicum* and one pond that does, EO 003. Resulting plants will be studied in relation to water depth, associated species, and overstory cover at each planting microsite. The results will aid in understanding why *Helenium virginicum* occurs in some basins but not in others. The researchers speculate that hydroperiod and overstory cover are major determining factors (J. S. Knox pers. comm.).

Simurda and Knox plan to continue the phylogeographic study of the *Helenium autumnale* species complex. Another gene locus will be sequenced and more populations will be added to the sample in a continuing effort to understand the phylogeography of the complex and, in particular, the evolutionary history of *Helenium virginicum* (J.S. Knox pers. comm.)

Seed viability studies by Knox are ongoing (J.S. Knox pers. comm.) with seeds collected from EO 001 in 1996 and buried in vials at that site. Three vials are retrieved every three months and 33 achenes from each vial are tested for germination. Recent trials showed a germination rate of approximately 50%.

Work planned by Knox and Hanlon to begin in fall 2000 will investigate whether there is evidence in other populations for the self-incompatible breeding system found in EO 003 and if there is any evidence of increasing inbreeding depression with decreasing population size. Populations of varying sizes will be visited, seed heads collected, and percent seed set determined for each head.

A mowing experiment was begun in the site at Washington and Lee University where *Helenium virginicum* was grown for the herbivory study reported in Knox et al. (1999). Mowing was conducted in alternating lanes in order to determine if *H. virginicum* might survive competition from upland plants where mowing had occurred. Although the plants survived without watering for nearly a year, they died in spring 1999, possibly as a result of the drought. Plants from the study produced a large crop of seeds, however, and the study may resume if recruitment can be encouraged with watering. Knox hypothesizes that *H. virginicum* may be able to recruit and compete with weed species on ordinary red clay soil with sufficient water and mowing at the appropriate time of year.

Studies using the techniques of Population Viability Analysis (PVA) are planned by D. Marsh and Knox to begin in the fall of 2000 (D. Marsh, Washington and Lee University, pers. comm.). Using the extensive demographic and life-history data previously collected for *Helenium virginicum*, the population dynamics of this species will be modeled using a variety of methods. Planning for these studies is at a preliminary stage, and the results will be dependent on the nature of the available data, but the work will focus on three principal objectives: to project the likely risk of extinction at local sites and estimate the number of sites and configuration that may be necessary for long term persistence of *Helenium virginicum*; to assess the likely effectiveness of various recovery management strategies (e.g., transplantation vs. alteration of hydrology vs. removal of competitors); and to design a program to optimize the ability to monitor future changes in population density of *Helenium virginicum* at a number of sites.

In addition to the above studies, hydrological work, funded by the U.S. Forest Service, is being conducted by E. Knapp and associates from Washington and Lee University in some of the sinkhole ponds within the Maple Flats Special Interest Area in the George Washington and Jefferson National Forests (E. Knapp pers. comm.). This work includes the installation of shallow piezometers and rain and snow gauges. Preliminary work that has been done on sinkhole ponds in the Shenandoah Valley indicates that the hydrology of each pond is unique in terms of the relative importance of groundwater vs. surface flow (E. Knapp pers. comm.). As part of a larger study of water chemistry in the sinkhole ponds on U.S. Forest Service lands south of Stuart's Draft and Sherando in Augusta County, including two pond sections at the EO 003 site, pond water was analyzed for water quality parameters including pH, total aluminum, acid neutralizing capacity, and sulfate (Downey et al. 1999).

RECOVERY STRATEGY

The primary focus of the recovery program for *Helenium virginicum* will be maintaining the known distribution of this species through protection of the extant populations and their habitat and/or finding additional populations. The development pressures in the Shenandoah Valley and lack of legal protections for the mostly privately owned sites make protection of paramount importance. This will need to be accomplished using the full range of protection tools available and be based on an understanding of the ecological requirements of the species and what is needed to fully protect its habitat. Heightened public awareness through increased educational efforts may play a role in generating voluntary protection actions.

The results of research into the Virginia sneezeweed's life history and ecology, in addition to guiding protection actions, will also provide a basis for developing appropriate management tools for ensuring the long-term viability of each population. The resolution of the taxonomic status of the Missouri *Helenium* sp., if it is determined to be *H. virginicum*, will modify recovery priorities by necessitating the shifting of resources to conduct surveys between Virginia and Missouri.



PART II: RECOVERY

RECOVERY OBJECTIVE

The objective of the *Helenium virginicum* recovery program is to maintain and provide long-term protection for the species and its habitat, thereby enabling eventual removal of the species from the Federal list of Endangered and Threatened Wildlife and Plants.

RECOVERY CRITERIA

Delisting will be considered when the following criteria (subject to revision if warranted by new information) have been met:

1. Twenty self-sustaining populations and their habitats are permanently protected across this species' Virginia range. Minimal management actions may be occasionally required.
2. Monitoring over 15 years indicates that populations in the 20 sites have long-term viability.
3. Life history and ecological requirements are understood sufficiently to allow for effective protection, monitoring, and, as needed, management.
4. Seeds representing the range of genetic diversity in *H. virginicum* are placed in long-term storage to provide a source of genetic material in the event of *in situ* extinction.
5. The population and habitat of the Missouri *Helenium* sp., if it is determined to be *H. virginicum*, are permanently protected and seeds placed in long-term storage.

These criteria for recovery should be considered interim until additional genetic work resolving the relationship between *Helenium virginicum* and the Missouri *Helenium* sp. is completed. If the need for additional survey work in Missouri and intervening states is indicated, the number of populations to be protected will be reassessed.

RECOVERY TASKS

1. **Protect the extant populations and their habitat.** Due to the restricted and threatened status of the sinkhole pond habitat in Virginia's Shenandoah Valley, the increasing development pressures and associated pressures for wetland modifications, and the fact that the majority of *Helenium virginicum* populations are on privately owned lands, protection of the extant *H. virginicum* populations and their habitats is the most critical task to prevent the extinction of this species.
 - 1.1 **Seek permanent protection for known habitats.** The protection of the known sites will need to be accomplished through a combination of site specific management planning for those populations on federal lands, and a range of protection tools on private lands. Private and public conservation organizations need to actively seek out opportunities for protection using the full range of protection tools including fee acquisition, conservation easements, registry, and voluntary signed cooperative agreements.
 - 1.2 **Seek the cooperation and active support of private landowners and local governments.** The support of private landowners and local governments will be critical not only in achieving site protection, but also in obtaining permission to collect data needed for ecology and life history studies. Engendering such cooperation and support will be a goal of efforts to increase public awareness of Virginia sneezeweed (Task 6).
 - 1.3 **Identify essential habitat.** Essential habitat for *Helenium virginicum* should be identified and delineated in the ponds and watersheds which support *H.*

virginicum. Additional appropriate habitat that is not currently supporting *H. virginicum* but which would provide areas into which populations could expand should also be considered as essential habitat to avoid potentially restricting *H. virginicum* solely to its currently known locations.

1.4 Identify sinkhole pond habitat adjacent to the National Forest lands, but within the proclamation boundary, to target for future acquisition.

Protection of such ponds on public lands could provide some opportunity for *H. virginicum* to expand into new, more easily protected sites, through both natural means and artificial means, if needed, in the future.

1.5 Identify, monitor, and alleviate site-specific threats to each population.

Over the past 13 years, periodic but infrequent site assessments, including field observations on the site-specific disturbances, have been carried out at most of the *H. virginicum* sites. These periodic assessments should be continued and conducted on a more regular basis, provided landowners will allow more frequent visits. More rigorous research is needed to ascertain the degree of threat from many of the land uses.

1.51 Identify and monitor site-specific threats.

1.511 Identify the threats to the hydrology of each *Helenium*

***virginicum* site.** Protecting the hydrological regime at *H. virginicum* sites has been identified as the most important ecological factor in ensuring the long-term protection of *H. virginicum* habitat. Obvious hydrologic modifications within the population area such as ditching and filling can be readily assessed, but the effects of off-site land use activities, such as timber harvesting or well-drilling, will be less obvious without an understanding of the hydrology of each pond. As preliminary work on sinkhole ponds in the Shenandoah Valley indicates that the hydrology of each pond is unique in terms of the roles played by surface flow vs. groundwater flow,

extrapolation from a few studies may lead to the inaccurate identification of both the threats and the lands needed for site protection. At least some minimum level of hydrological data will need to be collected on all of the sites.

1.5111 Conduct a review of existing hydrological data.

The hydrological data that have been collected in the Shenandoah Valley by public and private agencies/corporations should be sought and used to determine where gaps in knowledge exist and so where to focus additional field work.

1.5112 Conduct studies to characterize environmental parameters of the sinkhole ponds. Data to be collected would include geochemical parameters, field measurements such as temperature, pH, and dissolved oxygen, and basin geometry. Data should be collected at all the *H. virginicum* sites, but sites that do not support *H. virginicum* should also be sampled to help in characterizing *H. virginicum* habitat.

1.5113 Conduct studies to characterize the hydrologic regime. These studies will include placement of piezometers and tracer testing, if appropriate, at selected *H. virginicum* sites. These methods can provide data on water table depth and the upstream recharge area that can be used in delineating management and protection zones for a pond site.

1.512 Determine the effects of cattle grazing. Several of the sites that support very large populations of *H. virginicum* are subject to cattle grazing. By means of exclusion studies at currently grazed sites, the effects of grazing on vegetation

composition, soil compaction, and nutrient loading should be studied. Potential funding sources include the Environmental Quality Incentive Program (EQIP), administered by the Natural Resources Conservation Service (NRCS) and the Farm Service Agency (FSA) and the Wildlife Habitat Incentive Program (WHIP), administered by NRCS.

1.513 Determine the effects of mowing. Several of the sites, one of which supports a very large population of *H. virginicum*, are subject to periodic mowing. Although mowing may reduce competition, inappropriately-timed mowing may ultimately result in a depleted seedbank. Studies in the currently mowed sites may provide data for management.

1.52 Alleviate site specific threats as the need and opportunity arise.

This will need to be accomplished by working cooperatively with all entities involved including private citizens and public agencies whose actions pose a threat to a *H. virginicum* population.

2.0 Monitor extant populations. All extant populations should be monitored to provide data on population trends and site-specific threats. Long-term data collected will be used to determine the “viability” of the population.

2.1 Develop a monitoring plan including standard monitoring methodologies. Standard monitoring methodologies will be developed in order to provide reliable and consistent long-term demographic data for comparison between years and between sites. Data collected should include number of plants, number of flowering plants, immediate and potential threats and other data to be determined. Standard methods for estimating large populations should be developed as well as a recommended monitoring frequency and site priorities.

2.2 Implement the monitoring plan. Frequency of monitoring may be determined based on landowner status. It may be possible to monitor populations on federal land on a frequent basis whereas a monitoring schedule for the privately owned sites will need to be negotiated site-by-site with each landowner.

3.0 Definitively establish the range and distribution of the species.

3.1 Conduct additional genetic research to firmly establish the relationship between *Helenium virginicum* and the *Helenium* sp. in Missouri. The final determination of whether the Missouri *Helenium* sp. should be considered as *H. virginicum* awaits the results of further genetic research. One outcome of this research may be the ability to distinguish between the Missouri *Helenium* sp. and the *Helenium virginicum* of E0 003 so that in the future the question of whether the Missouri *Helenium* sp. genes are present in the E0 003 population can be answered.

3.2 Conduct surveys for additional populations in Virginia. A number of surveys were conducted in Virginia in the 1980's and 1990's in Augusta and Rockingham Counties for additional populations, and most of the higher quality, less disturbed sites have been visited. However, more potential sinkhole pond habitat, albeit disturbed, exists in Virginia and should be surveyed for *Helenium virginicum*.

3.3 If additional genetic research confirms that the Missouri *Helenium* should be treated a *H. virginicum*, then the following two additional tasks should be conducted:

3.31 Conduct surveys for additional populations in Missouri.

Discussions with Missouri botanists indicate that most likely habitat in Missouri has been surveyed over the years but some potential habitat, particularly in Howell County, should be surveyed.

3.32 Conduct surveys for populations in appropriate habitat in states between Virginia and Missouri and in other areas in Virginia beyond its currently known range. Surveys in the intervening/adjacent states of Arkansas, Illinois, Indiana, Kentucky, Tennessee, Ohio, and West Virginia need to be conducted. Other areas of western Virginia should be evaluated for the presence of suitable sinkhole pond habitat and surveys conducted if warranted.

4.0 Continue investigations into the life history and ecology of *H. virginicum*.

Studies on the life history and ecology of *H. virginicum* have been conducted and are ongoing but additional work is warranted to more fully understand *H. virginicum* and be better able to develop appropriate management and conservation strategies.

4.1 Continue research into reproductive strategies, both sexual and vegetative. Additional research into the breeding system as was conducted at EO 003 is underway among other populations of *H. virginicum*. These studies should be continued until a full picture is obtained of the possible site-specific reproduction problems that could effect survival of each population. Expansion by the sprouting of rosettes from fallen aerial stems and roots has been observed in *Helenium virginicum*; could vegetative expansion by clones play some role under certain environmental conditions?

4.2 Conduct research to determine relative seed dispersal distances and continue to investigate seed banking capabilities. The seed dispersal research, conducted by means of gene flow studies, would be conducted among pond clusters that support *Helenium virginicum*. Seed bank studies, some of which are ongoing, might also be extended to sites where *H. virginicum* has been documented, but has not been found in recent years, to see if a seed bank can be detected.

4.3 Continue studies of germination and seedling recruitment. The results of past research by J.S. Knox into germination and seedling recruitment, some

of which remains to be analyzed and published, should be used to determine what additional research is needed.

- 4.4 Conduct research into *H. virginicum*'s stress tolerance and adaptations to habitat conditions in relation to germination, growth, and maturity.** Habitat conditions to be investigated include variable hydroperiods, shading, and stressful soil conditions. Basic ecological research into the role of hydroperiod and overstory cover involving field germination studies are underway at three ponds on US Forest Service lands. Additional studies using methods of plant physiology should be conducted to provide insight into how Virginia sneezeweed is adapted to its habitat conditions.
- 4.5 Determine the effects of changes in soil and water pH on *Helenium virginicum*.** What range of pH can *H. virginicum* withstand? Will changes due to acid rain or eutrophication from cattle grazing affect germination, growth, and reproduction?
- 4.6 Determine the effects of fire on *H. virginicum* and the seasonal wetland communities.** Experiments with fire are needed to determine if fire can be used as a management tool to control the invasion of woody or possibly exotic species in cases where disturbance of the hydrologic regime has allowed changes in species composition.
- 4.7 Develop guidelines as to what constitutes a self-sustaining population.** Based on the results of studies into the life history and ecology of *H. virginicum*, criteria for defining a self-sustaining population will be established. Completion of this task should help in further refining recovery criteria number 1 and 2, under the recovery objective.
- 4.8 Model the population dynamics of *H. virginicum* using the techniques of Population Viability Analyses (PVA).** Using previously collected data on demographics and life-history, models should be developed to assist in answering questions about site specific extinction risks, the numbers of sites

and configuration needed for the persistence of *H. virginicum*, and the effectiveness of management strategies.

5.0 Maintain seed sources for the species. Seeds should be collected from each population that can sustain such harvesting and deposited in a national seed bank in order to preserve the full range of genetic diversity and provide materials for reintroduction, if necessary. This will be particularly important for what may be the single Missouri population, if the additional genetic research conducted in Task 3.0 confirms that this population should be treated as *H. virginicum*. The Center for Plant Conservation (CPC), a network of gardens and arboreta, stores seed from its Collection of Endangered Plants in the USDA's National Seed Storage Laboratory in Ft. Collins, Colorado (www.mobot.org/CPC/seed.html). Inclusion of *H. virginicum* in this Collection should be pursued.

6.0 Create and disseminate informational materials to foster more awareness of *Helenium virginicum* and its status. Increased knowledge about the status and conservation needs of Virginia sneezeweed among a broad spectrum of citizens is an important component of the species long-term protection.

6.1 Develop educational activities to reach a wider audience in Augusta and Rockingham Counties. Expand upon educational actions that have been taken -- creation of the *Helenium virginicum* and Seasonal Pond fact sheets -- to reach a wider audience in Augusta and Rockingham Counties. These additional actions, including educational talks, should target landowners, county planning groups, schools, and local conservation groups.

6.2 Write articles for scientific and popular publications. Scientific papers reporting on research on *Helenium virginicum*, mostly by J.S. Knox and co-workers at Washington and Lee University, have been published in scientific journals. Based on the current and future research outlined under Research Efforts, scientific publications will continue. In addition, articles geared to the general public should be written and submitted to publications with wider circulation.

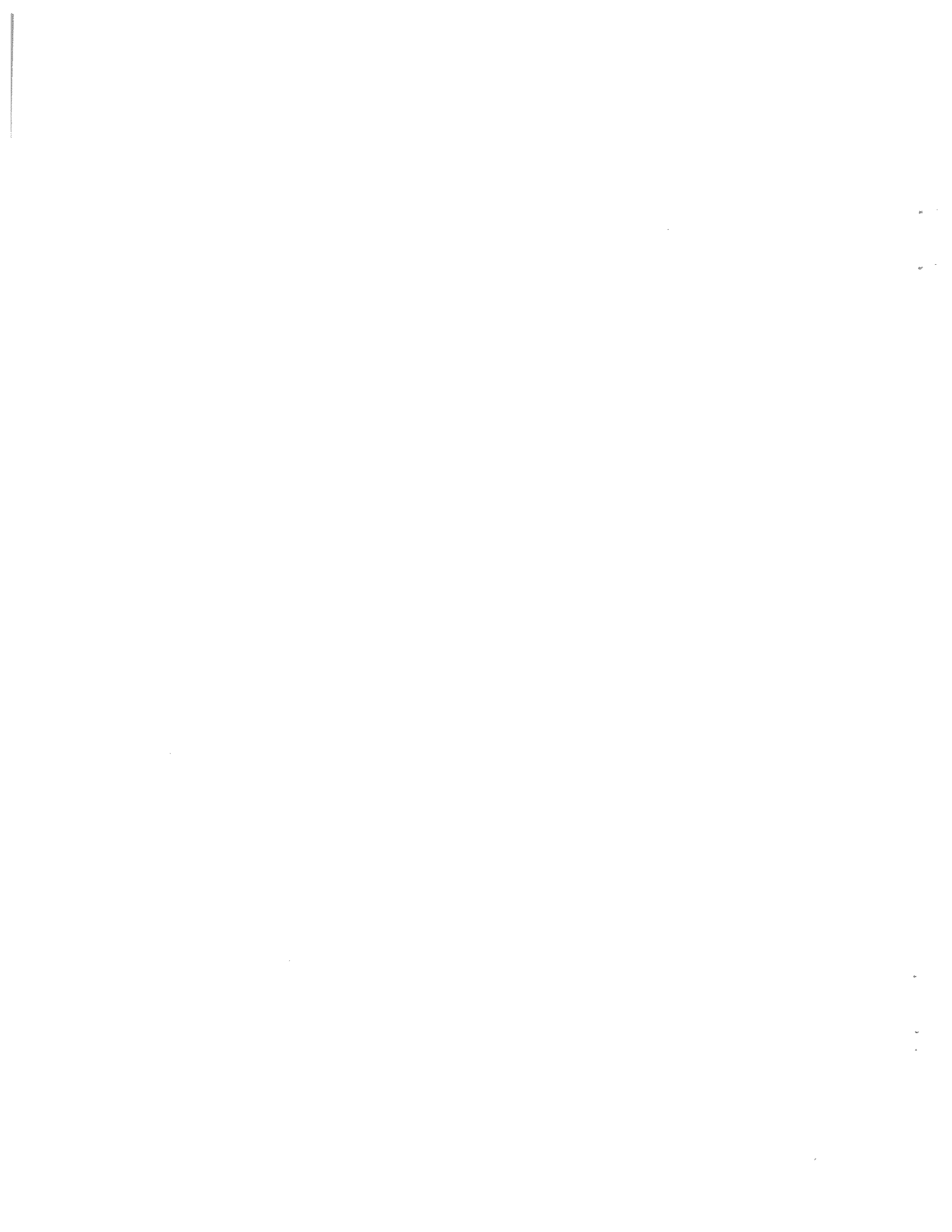
- 6.3 Expand current information available on the Internet.** The *H. virginicum* fact sheet on the Virginia Department of Conservation and Recreation's web site should be expanded to include more photos, more detailed habitat information, and a bibliography.
- 6.4 Provide information on the species to botanists in the states between Virginia and Missouri.** If the Missouri *Helenium* sp. is confirmed to be *H. virginicum*, the dissemination of information relating to identification and habitat will be important to alerting botanists in the states between Virginia and Missouri. These efforts should include the creation of a list of botanists to whom information packets would be sent and the conducting of workshops on identification and habitat requirements.

LITERATURE CITED

- Anderson, A.C., A.C. Jones, L.P. Wilson, R.D. Kim, and H.L. Bailey. 1983. Acute toxicity of smallhead sneezeweed in sheep. Sheep and Goat, Wool and Mohair –Texas Agricultural Experiment Station, Research Reports, pp. 118.
- Anderson, A.C., L.P. Jones, and H.L. Kim. 1986. Acute helenalin toxicity in sheep. Sheep and Goat, Wool and Mohair-Texas Agricultural Experiment Station, Research Reports. pp.21.
- Arnason, J.T., M.B. Isman, B.J.R. Philogene, and T.G. Waddell. 1987. Mode of action of the sesquiterpene lactone, tenulin from *Helenium amarum* against herbivorous insects. Journal of Natural Products 50: 690-695.
- Biernier, M.W. 1972. Taxonomy of *Helenium* sect. *Tetrodus* and a conspectus of North American *Helenium* (Compositae). Brittonia 24: 331-355.
- Blake, S.F. 1936. A new *Helenium* from Virginia. Claytonia 3(2): 5-6.
- Cronquist, A. 1980. Vascular flora of the southeastern United States. Vol. 1: Asteraceae. University of North Carolina Press, Chapel Hill, NC. 261 pp.
- DeMauro, M.M. 1993. Relationship of breeding system to rarity in the Lakeside Daisy (*Hymenoxys acaulis* var. *glabra*). Conserv. Biol. 7:542-550.
- DeNettancourt, D. 1977. Incompatibility in angiosperms. Springer Verlag, New York.
- Downey, D.M., S. Wirtz, K.R. Kruer, and S.P. Douglas. 1999. Water chemistry assessment of the Shenandoah Valley Sinkhole Ponds in Virginia. Banisteria 13: 53-65.
- Erdle, S.Y. 1996. Conservation planning for two priority Virginia sneezeweed (*Helenium virginicum*) sites. Natural Heritage Technical Report 96-25. Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond. 21 pp.
- Erdle, S.Y. 1997. Conservation planning for three priority Virginia sneezeweed (*Helenium virginicum*) sites. Natural Heritage Technical Report 97-15. Virginia Dept. of Conservation and Recreation, Division of Natural Heritage, Richmond. 23 pp. + appendices.
- Fernald, M.L. 1950. Gray's manual of botany. Eighth edition. Dioscorides Press, Portland, OR. 1632 pp.
- Foy, C.D. 1977. 1974. Effects of aluminum on plant growth. p. 601-642. In E.W. Carson (ed.) The Plant Root and its Environment, University Press of Virginia, Charlottesville.
- George Washington National Forest. 1993. Final revised land and resource management plan. US Department of Agriculture, George Washington National Forest.

- Gleason, H.A. 1952. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. Vol. 3. The New York Botanical Garden, New York. 595 pp.
- Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. Second edition. The New York Botanical Garden, Bronx, New York, NY. 910 pp.
- Herz, W. and P.S. Santhanam. 1967. Constituents of *Helenium* species. XX. Virginolide, a new guaianolide from *Helenium virginicum* Blake. *Journal of Organic Chemistry* 32:507-509.
- Hesker, K. 1982. Orange sneezeweed: "beautiful flower of death" *Helenium hoopesii*, poisonous to sheep. *Rangelands* 4: 210-211.
- Johnson, M.F. and D.M. Porter. 1991. Virginia Sneezeweed, *Helenium virginicum* Blake Pp. 145-146 *In* Virginia's Endangered Species, Proceedings of a Symposium, The McDonald and Woodward Publishing Co., Blacksburg, VA.
- Kartesz, J.T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada and Greenland. First edition. *In*: Kartesz, J.T. and C. A. Meacham, Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.
- Knox, J.S. 1987. An experimental garden test of characters used to distinguish *Helenium virginicum* Blake from *H. autumnale* L. *Castanea* 52 (1): 52-58.
- Knox, J.S. 1994. Report on Distribution of *Helenium virginicum*-like plants in Missouri and Further Assessment of the taxonomic relationship of the Missouri plants to *H. virginicum*. Unpublished report of November 23, 1994 to the US Fish and Wildlife Service, Annapolis, MD. 6 pp.
- Knox, J.S., M.J. Gutowski, D.C. Marshall, and O. G. Rand. 1995. Tests of the genetic bases of character differences between *Helenium virginicum* and *H. autumnale* (Asteraceae) using common gardens and transplant studies. *Systematic Botany* 20: 120-131.
- Knox, J.S. 1997. A nine year demographic study of *Helenium virginicum* (Asteraceae), a narrow endemic seasonal wetland plant. *J. of the Torrey Botanical Society* 124 (3): 236-245.
- Knox, J.S., F.W. Stearns Jr., and C.K. Dietzel. 1999. Factors controlling the distribution and abundance of the narrow endemic, *Helenium virginicum* (Asteraceae): antiherbivore defense? *Banisteria* 13: 95-100.
- Longbottom, W.D. and N.E. Van Alstine. 1995. A search for *Helenium virginicum* Blake in unsurveyed sinkhole ponds in the Shenandoah Valley of Virginia. Natural Heritage Technical Report 95-21. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 18 pp.

- Mandelker, D.R. 1997. Primer on sources of federal wetlands law.
http://www.wvlaw.wustl.edu/~mandelke/Land_USE/wetlands.html
- Messmore, N.A. and J.S. Knox 1997. The breeding system of the narrow endemic, *Helenium virginicum* (Asteraceae). *J. of the Torrey Botanical Society* 124 (4): 318-321.
- Reinartz, J.A. and D.H. Les. 1994. Bottleneck-induced dissolution of self-incompatibility and breeding system consequences in *Aster furcatus* (Asteraceae). *Amer. J. Bot.* 81:446-455.
- Rock, H.F.L. 1956. A revisional study of the decurrent-leaved species of the genus *Helenium* L. (Compositae). PhD. dissertation, Duke University, Durham, North Carolina.
- Roe, G.F., 1977. *Helenieae* (Asteraceae) in Virginia. *Castanea* 42 (1): 42-50.
- Simurda, M.C. and J.S. Knox. In review. ITS sequence evidence for the disjunct distribution between Virginia and Missouri of the narrow endemic *Helenium virginicum* (Asteraceae). *J. of the Torrey Botanical Society*.
- Steyermark, J. 1960. An unusual hybrid *Helenium*. *Rhodora* 62: 343-346.
- Steyermark, J. 1963. *Flora of Missouri*, Iowa State University Press, Ames, Iowa. 850 pp.
- Taylor, G.J. 1988. The physiology of aluminum toxicity. Metal ions in biological systems p. 123-163. *In*. H. Siegel, A. Siegel [ed.] *Aluminium and its Role in Biology*, Vol. 24, Marcel Dekker, New York.
- U.S. Fish and Wildlife Service. 1998. Endangered and threatened wildlife and plants: determination of threatened status for Virginia sneezeweed (*Helenium virginicum*), a plant from the Shenandoah Valley of Virginia. *Federal Register* 63: 59239-59244.
- Van Alstine, N.E. and J.C. Ludwig. 1991. *Natural Heritage Inventory: Helenium virginicum*. Final Report on 1990 field work. Unpublished report to the Virginia Department of Agriculture and Consumer Services. 50 pp.
- Van Alstine, N.E., A. Belden, and J.C. Ludwig. 1992. A natural heritage inventory for unknown *Helenium virginicum* S.F. Blake populations. *Natural Heritage Technical Report #92-19*. Department of Conservation and Recreation, Division of Natural Heritage. Richmond, VA. 1 May 1992. 36 pp.
- Van Alstine, N.E. 1995. A reassessment of the status of the *Helenium virginicum* populations in the Shenandoah Valley of Virginia. *Natural Heritage Technical Report 96-6*. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. 36 pp.



PART III: IMPLEMENTATION

The Implementation Schedule lists and ranks tasks that should be undertaken within the next three years in order to implement recovery of *Helenium virginicum*. This schedule will be reviewed annually until the recovery objective is met, and priorities and tasks will be subject to revision. Tasks are presented in order of priority.

Key to Implementation Schedule, Column 1:

Task priorities are set according to the following standards:

- Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
- Priority 2: An action that must be taken to prevent a significant decline in species population, or some other significant impact short of extinction.
- Priority 3: All other actions necessary to provide for full recovery of the species.

Key to Agency Designation in Columns 5 and 6:

- | | | |
|---------|---|--|
| USFWS | - | U.S. Fish and Wildlife Service |
| R3 | - | Region 3 Ecological Services, U.S. Fish and Wildlife Service |
| R5 | - | Region 5 Ecological Services, U.S. Fish and Wildlife Service |
| GWJNF | - | George Washington and Jefferson National Forests |
| DCR-DNH | - | Virginia Department of Conservation and Recreation, Division of Natural Heritage |
| SCA | - | State Conservation Agencies |
| TNC | - | The Nature Conservancy, Virginia Field Office |
| CPC | - | Center for Plant Conservation and cooperating institutions |
| CO | - | Other conservation organizations |
| AI | - | Academic institutions |

IMPLEMENTATION SCHEDULE
Virginia Sneezeweed Draft Recovery Plan

September 2000

Priority	Task Description	Task Number	Duration	USFWS	Responsible Agency		Cost Estimate (\$000)			Comments
					Other	Other	FY1	FY2	FY3	
1	Seek permanent protection for known populations.	1.1	Ongoing	R5	DCR-DNH TNC CO GWJNF		30	30	30	Approximately \$200K total if mostly easements are secured on population sites and buffer lands.
1	Seek cooperation and support of private landowners and local governments.	1.11	Ongoing	R5	DCR-DNH TNC CO					Standard operating costs
1	Identify essential habitat.	1.12	Ongoing	R5	DCR-DNH TNC GWJNF		1	1	1	
2	Identify sinkhole pond habitat adjacent to the National Forest lands, but within the proclamation boundary, to target for future acquisitions by GWJNF.	1.4	2 years	R5	GWJNF DCR-DNH		2	2		Costs only for the evaluation process. Actual acquisition costs dependent on results and it is impossible to determine those at this time.
2	Conduct a review of existing hydrological data.	1.5111	1 year	R5	DCR-DNH		1			
2	Conduct studies to characterize environmental parameters of the sinkhole ponds.	1.5112	2 years	R5	AI DCR-DNH GWJNF			5	5	Data to be collected at all of the sites.
2	Conduct studies to characterize the hydrologic regime at selected sinkhole ponds.	1.5113	5 years	R5	AI DCR-DNH GWJNF			25	25	\$60K total in FY 4-7. In-depth studies at selected sites.
2	Determine the effects of cattle grazing.	1.512	4 years	R5	AI			4	3	\$3K in FY4-8
2	Determine the effects of mowing.	1.513	4 years	R5	AI			4	3	\$3K in FY4-8
2	Alleviate site specific threats as the need and opportunity arise.	1.52	Ongoing	R5	GWJNF DCR-DNH TNC		5	5	5	\$5K/yr. Up to \$50K. Most funds will be needed in early years until protection secured.

Virginia Sneezeweed Draft Implementation Schedule, September 2000

Priority	Task Description	Task Number	Duration	Responsible Agency		Cost Estimate (\$000)			Comments
				USFWS	Other	FY1	FY2	FY3	
2	Develop a monitoring plan including standard monitoring methodologies.	2.1	2 years	R5	DCR-DNH TNC GWJNF AI	2	2		
2	Implement the monitoring plan.	2.2	Ongoing	R5	DCR-DNH TNC GWJNF	5	5	5	\$85K in FY4-20
2	Conduct additional genetic research to firmly establish the relationship between <i>H. virginicum</i> and the Missouri <i>Helanium</i> sp.	3.1	5 years	R5/R3	AI	5	5	5	\$10K in FY 4-20 to determine if genes of the Missouri <i>Helanium</i> sp. are present in EO 003.
2	Conduct surveys for additional populations in Virginia.	3.2	3 years	R5	DCR-DNH GWJNF	5	5	5	
2	Conduct surveys for additional populations in Missouri.	3.31	1 year	R3	SCA	*	*	*	*\$5K in FY unknown - Will occur only if the <i>Helanium</i> sp. is determined to be <i>H. virginicum</i> .
2	Conduct surveys for populations in states between Virginia and Missouri and in other areas in Virginia beyond its currently known range.	3.32	5 years	R3/R5	SCA	*	*	*	*\$60K in FY's unknown - Will occur only if the Missouri <i>Helanium</i> sp. is determined to be <i>H. virginicum</i> .
2	Develop guidelines as to what constitutes a self-sustaining population.	4.7	1 year	R5	DCR-DNH AI TNC GWJNF	2			
2	Model the population dynamics of <i>H. virginicum</i> using techniques of Population Viability Analyses (PVA).	4.8	5	R5	AI	10	10	10	\$20K in FY4-5
2	Maintain seed sources for the species.	5	Ongoing	R5	CPC AI DCR-DNH GWJNF	12	2	2	Includes a one time \$10K cost for acceptance into CPC's collection of Endangered Plants and funding for seed collection.

Virginia Sneezeweed Draft Implementation Schedule, September 2000

Priority	Task Description	Task Number	Duration	Responsible Agency		Cost Estimate (\$000)			Comments
				USFWS	Other	FY1	FY2	FY3	
3	Continue research into reproductive strategies, both sexual and vegetative.	4.1	8 years	R5	AI	5	5	5	\$20K in FY4-8
3	Conduct research to determine relative seed dispersal distances and further investigate seed banking capabilities.	4.2	5 years	R5	AI			10	\$40K in FY 4-8
3	Continue studies of germination and seedling recruitment.	4.3	5 years	R5	AI	5	5	5	\$10K in FY4-5
3	Conduct research into <i>H. virginicum</i> 's stress tolerance and adaptations to its habitat conditions in relation to germination, growth, and maturity.	4.4	8 years	R5	AI	5	10	10	\$25K in FY4-8
3	Determine the effects of changes in soil and water pH on germination, growth, and reproduction.	4.5	4 years	R5	AI			5	\$25K in FY4-6
3	Determine the effects of fire on <i>H. virginicum</i> and the seasonal wetland communities.	4.6	2 years	R5	AI DCR-DNH			10	\$4K in FY 4
3	Develop educational activities to reach a wider audience in Augusta and Rockingham counties.	6.1	Ongoing	R5	DCR-DNH	3	2	2	\$10K in FY 4-20
3	Write articles for scientific and popular publications.	6.2	Ongoing	R5	DCR-DNH AI	2	2	2	\$10K in FY 4-20
3	Expand current information available on the Internet.	6.3	Ongoing	R5	DCR-DNH	1			\$5K in FY 4-20
3	Provide information on the species to botanists in the states between Virginia and Missouri.	6.4	1	R3/R5	DCR-DNH	*	*	*	*\$10K after determination of the Missouri <i>Helianthus</i> sp. identity.

APPENDIX

Summary of occurrence data for *Helenium virginicum* as of 2000

(arranged by county)

APPENDIX. Summary of occurrence data for *Helenium virginicum* as of 2000.

Data on the Missouri *Helenium* sp. is included at the end. USFS = US Forest Service; PR = private landowner; TNC = The Nature Conservancy; DCR-DNH = Virginia Department of Conservation and Recreation's Division of Natural Heritage.

ELEMENT OCCURRENCE NUMBER	COUNTY	DATE FIRST OBS.	DATE LAST ASSESSED	OWNER STATUS	DESCRIPTION OF OCCURRENCE	THREATS	PROTECTION STATUS
VIRGINIA EO 001	Augusta	1935	1997	PR	1986: few stunted plants noted by one observer but vegetative plants were estimated at 23,226 by a researcher. 1987: ca. 10, 536 plants of which 4,300 flowered. 1990: All mature plants died after extended (16 months) inundation, but in the 2 months following the crash 189 plants were counted in quadrats and total count estimated at 37, 394. 1991: at least hundreds of rosettes, ca 100 flowering stems. 1994: 1279 plants with 404 of these flowering. 1995: ca. 30 stems in late flower, but site still filled with water in late summer. Plants not healthy-looking. Fewer than 100 rosettes counted in quadrats. 1997: 681 plants, none flowering. Open shallow meadow-like basin within forest. Wetland disturbed by past-ditching and plowing. Extended demographic study conducted here.	None known.	TNC has had management agreement with land owner. Currently being renegotiated.
EO 002	Augusta	1987	1995	PR	1987: exceptionally dense cover (up to 416 per sq meter) estimated at 100,000-1 million plants mostly in rosette stage in a broad seasonally wet area around an excavated pond behind owner's house. 1990: Continues to be an enormous population, mostly rosettes, but 200+ flowering stems in unmowed strips. 1995: large population continues, many in late flower/fruit, but many appeared dead. Many more flowering stems than in 1990 and fewer rosettes probably due to less mowing this year, a consequence of extended inundation. Owner mows/bush-hogs site which may maintain high density.	Increased residential land use in area may increase pressure on landowner to change the hydrology. Property, including section of wetland, subdivided in 1996?	None

ELEMENT OCCURRENCE NUMBER	COUNTY	DATE FIRST OBS.	DATE LAST ASSESSED	OWNER STATUS	DESCRIPTION OF OCCURRENCE	THREATS	PROTECTION STATUS
EO 003	Augusta	1967	1995	USFS	1986: None seen following extended period (18 months) of inundation. 1987: ca. 6000 plants. 1990: Transplant studies conducted including introduction of Missouri <i>Helonium</i> sp. 1991: ca. 20-30 flowering stems and 100 rosettes within the north and northeast upper slope of the western lobe of this sinkhole pond. 1995: More than 400 flowering stems and hundreds of young rosettes on the thin strip of exposed shoreline and in the water. A relatively undisturbed sinkhole surrounded by forest.	None known.	On federal land within SIA and proposed RNA.
EO 004	Augusta	1979	1997	PR	1987: many plants in small area. 1990: thousands of rosettes in a range of sizes over 0.7 acre, only a few plants in flower/fruit. 1995: many hundreds of rosettes, perhaps a thousand, but only 1 flowering stem. Site had been mowed. Large soil pile present on edge of site. 1997: Thousands of rosettes and a few flowering plants in a grazed/mowed shallow basin.	Large soil pile on the edge of the wetland has been present since at least 1995 and appeared to have grown in 1997. In 1995 owner intended to push the soil into the site. After visit by DCR-DNH, the owner was agreeable to not fill the pond, however pile had grown by 1997. Some <i>Helonium</i> may have been buried by the pile and movement of soil into the site has made this section more favorable for weedy plants.	None.

ELEMENT OCCURRENCE NUMBER	COUNTY	DATE FIRST OBS.	DATE LAST ASSESSED	OWNER STATUS	DESCRIPTION OF OCCURRENCE	THREATS	PROTECTION STATUS
EO 008	Augusta	1977	1995	PR	1987: Ca. 500, 000 plants. This population appears to have remained the same over past 10 years (1977-87). 1990: at least hundreds of plants, mostly flowering, scattered over a 2 acre area. Many may have been missed due to the size and density of the herbaceous vegetation, but doubtful there are 500,000 plants. Site not mowed or grazed this year. 1995: 120 rosettes and 100 flowering/fruited stems scattered over several acres of seasonal wetland around a dug-out pond. Site has history of grazing and is adjacent to a cornfield.	1995: Owner expressed desire to fill and level site. Site is in area of increasing residential land use.	None
EO 009	Augusta	1986	1995	PR	1986: ca. 30 plants, severely stunted possibly due to drought. 1989: hundreds of flowering stems. 1990: thousands of seedling rosettes, no flowering. 1991: 80-90 flowering stems, at least hundreds of rosettes. 1995: hundreds to (low) thousands of rosettes and several hundred flowering stems. A seasonal pond relatively undisturbed despite being situated immediately adjacent to roads.	Site is immediately adjacent to a major road which is slated for widening.	None currently, but landowner wants to donate land to conservation group to protect site.
EO 010	Augusta	1990	1990	PR	1990: Ca. 20 plants in small area of a seasonally wet meadow. 1991: general area where the plants grew was disturbed by cattle grazing. 1995: Not seen. 1999: Not seen.	1991: Site has undergone inundation caused by beaver activity. Disturbed by cattle grazing.	None

ELEMENT OCCURRENCE NUMBER	COUNTY	DATE FIRST OBS.	DATE LAST ASSESSED	OWNER STATUS	DESCRIPTION OF OCCURRENCE	THREATS	PROTECTION STATUS
EO 011	Augusta	1936	1995	PR	In 1987: ca. 300 plants. Observer noted plant is dying out here, correlated with addition of fill. 1990: 44 rosettes within the ungrazed section, 15 rosettes in fenced grazed area. 1995: 80-90 rosettes in a highly disturbed seasonal wetland near a landowner's trailer, with half in the disturbed meadow and half in the pasture. Less than 10 flowering plants, all located along ditch.	Portion of site being filled in by owner since at least 1987. Trash being dumped in filled area. New ditch noted in 1995. Other section is a small pasture with severe soil disturbance from cattle trampling.	None
EO 012	Augusta	1978	1995	PR	1990: thousands of plants, mostly rosettes, over 5 acres. 1995: only 22 rosettes seen in one area of site. The site was formerly a seasonally wet meadow behind houses, now grassy pasture. A drainage ditch was dug through it in 1987.	Drainage ditch put in 1987 has changed the hydrology of the site. Most of site probably no longer favorable habitat.	None
EO 013	Augusta	1978	1995	PR	1978: handful of plants. 1990: 2 flowering plants seen but dense vegetation in meadow may have obscured rosettes. 1992: 250 vigorous flowering plants. 1995: 100 rosettes scattered in and along sides of a shallow depression running through a recently mowed field. A seasonally wet periodically mowed meadow adjacent to railroad tracks and houses.	A large ditch built on the far north side of field since the 1992 visit will change the hydrology of the site, although area with plants seen in 1995 still seasonally floods. If mowing twice a year prevents seed dispersal, seed bank will be eventually depleted.	None

ELEMENT OCCURRENCE NUMBER	COUNTY	DATE FIRST OBS.	DATE LAST ASSESSED	OWNER STATUS	DESCRIPTION OF OCCURRENCE	THREATS	PROTECTION STATUS
EO 014	Augusta	1978	1995	PR	<p>1978: Many thousands of plants.</p> <p>1987: 200-500 plants in a few small (1m diameter) patches where formerly many thousands of plants grew over a 1200 sq. meter area. 1990: None seen.</p> <p>1995: 350 rosettes along a shallow ditch in seasonally wet mowed lawn behind a church. Plants had not been documented here since 1987 and were probably responding to high rainfall in summer 1995.</p>	<p>1987: Addition of drainage ditch has adversely impacted the <i>Helonium</i>. Site has also experienced fire and "chemical" application. Plants unable to flower and replenish seed bank due to frequent mowing.</p>	None
EO 015	Augusta	1977	1995	PR	<p>1986: Estimated 58,000 plants. Casual observation over past 10 years (1976-86) reveals little change in population. 1990: hundreds of rosettes scattered in a 1-2 meters wide strip on the upper shoreline around a farm pond, plus a denser patch 60 sq meters west of the pond, and 100 scattered in depression running north from the pond. 8 flowering stems. 1995: Ca. 400 rosettes, only 4 flowering stems, mostly in the broad seasonally flooded area west of the farm pond. Site is actively used by cattle.</p>	<p>Soil disturbance by cattle trampling may be detrimental to establishment and/or persistence of plants. Drainage control measures (culvert under adjacent road, possibly deepening of area between pond and culvert to promote draining. If low flower/seed production seen in 1990 and 1995 is true of other years, then seedbank not being replenished.</p>	None

ELEMENT OCCURRENCE NUMBER	COUNTY	DATE FIRST OBS.	DATE LAST ASSESSED	OWNER STATUS	DESCRIPTION OF OCCURRENCE	THREATS	PROTECTION STATUS
EO 016	Augusta	1987	1995	PR	<p>1987: ca. 10,000 plants over 2800 sq. meters. Many produced seeds despite having been mowed. 1990: thousands of plants around a farm pond with greatest numbers in low areas south of the pond and overwhelming in the form of rosettes Density averaging 5 plants per sq. meter (casual estimate). 6 flowering/fruited stems in the higher mowed/ungrazed areas west and east of the pond. 1995: ca. 140 dead flowering/fruited stems, 130 rosettes. High water in 1995 from heavy summer rains may have kept numbers significantly lower than in 1990 and may be responsible for the condition of the flowering stems.</p>	Area is grazed and mowed. Long-term effects of these practices need evaluation.	None
EO 017	Augusta	1987	1995	PR	<p>1987: very low density, perhaps 200 all in rosette stage. Backyard for a mobile home. 1990: area behind trailer had recently been filled, graded, and ditched. No plants seen. 1995: ca. 70 rosettes and 2 flowering stems over 0.4 acre of a narrow disturbed seasonal wetland upstream from the area visited in 1990.</p>	<p>Unclear if area visited in 1987 is same as that seen in 1995. Area visited in 1990 behind trailer had recently been filled and graded and ditch had been dug. In 1995 an area upstream from the south end of a ditch was surveyed and plants were found there. Contains paths, vehicle trail, and is downslope from residences.</p>	None

ELEMENT OCCURRENCE NUMBER	COUNTY	DATE FIRST OBS.	DATE LAST ASSESSED	OWNER STATUS	DESCRIPTION OF OCCURRENCE	THREATS	PROTECTION STATUS
EO 018	Augusta	1987	1997	PR	1987: ca. 2000 plants, all rosettes. 1995: 21 flowering stems and 5 rosettes within southern 3/4 of seasonal wetland. 1997: only a small number of rosettes were seen on a mid-November visit. Northern 1/4 not visited is owned by someone else who did not respond to requests for access. Site formerly used for cattle pasture, but no recent evidence of grazing or soil disturbance.		None. The total wetland, including a more forested section is jointly owned by 3 owners. Owner of section with <i>Helentium</i> has expressed interest in conservation of site.
EO 019	Augusta	1990	1991	USFS	1990: 1 rosette in outer, sparsely vegetated zone of pond. 1991: single rosette present did not look healthy. Possibly suffering from drought stress. 1995: no plants seen.	None known.	On federal land within SIA.
EO 020	Augusta	1990	1995	USFS	1990: thousands of rosettes, 5 bolted plants lacking inflorescences (browsed?). 1991: ca. 100 flowering stems, hundreds if not thousands of rosettes. 1995: several hundred dead flowering stems in inundated pond and 100+ small rosettes where pond had drawn-down. Large sinkhole pond within cut-over forest.	Vehicle trail leads into pond.	On federal land within SIA.
EO 024	Augusta	1991	1991	PR	1991: tens of thousands of rosettes over ca. 1.4 acres, ca. 200 living flowering stems and many more dead (current year). A large shallow meadow-like sinkhole pond within cut-over forest.	Unable to contact landowner to initiate conservation action.	None
EO 025	Augusta	1991	1995	USFS	1991: 1 flowering stem and three other rosettes. 1995: none seen, but dried algae layer covered pond shore. A deep sinkhole pond within forest.	None known.	On federal land within SIA.

ELEMENT OCCURRENCE NUMBER	COUNTY	DATE FIRST OBS.	DATE LAST ASSESSED	OWNER STATUS	DESCRIPTION OF OCCURRENCE	THREATS	PROTECTION STATUS
EO 029	Augusta	1992	1995	USFS	1992: 7 plants, vigorous and in flower. 1995: 43 rosettes and 1 flowering stem. Shallow sinkhole pond within cut-over forest. 1998: No plants seen despite intensive search.	Vehicle trail leads to site, but it is unclear if vehicles can currently get to this site. If so vehicle use should be discouraged within the pond. 1992: large clearcut was present within 0.1 mile on the south and north west.	On federal land.
EO 030	Augusta	1994	1997	PR	1994: 6 clumps with numerous rosettes and a few stems in late flower. 1995: ca. 40 flowering stems in late flower or fruit. 1997: ca. 150 rosettes. Plants in narrow draw-down zone of a deep sinkhole pond in cut-over oak flatwoods.	None known.	None
EO 032	Augusta	1995	1999	PR	1995: several plants. 1999: no plants seen in year of severe drought.	May be hydrologic impacts from nearby houses.	None
EO 033	Augusta	1999	1999	USFS	1999: several dozen rosettes in a small mucky sinkhole surrounded by forest. Site had suffered soil disturbance caused by deer.	1999: Soil disturbance caused by deer could affect survival of rosettes, seed bank, germination.	On federal land.
EO 005	Rockingham	1979	1979	PR	Historical? 1979: Small probably ephemeral population. Not seen in 1990 and 1995.	None known.	None

ELEMENT OCCURRENCE NUMBER	COUNTY	DATE FIRST OBS.	DATE LAST ASSESSED	OWNER STATUS	DESCRIPTION OF OCCURRENCE	THREATS	PROTECTION STATUS
EO 006	Rockingham	1967	1994	PR	1967: scattered. 1987: rosettes under 30-40 cm water estimated to be a few thousand plants. 1990: thousands of seedling rosettes scattered over much of a 0.4 acre pond. No flowering. 1994: Several thousand plants over 0.4 acre in high quality sinkhole. 2000: (January visit to site) Many overwintering rosettes seen in dry pond. Growing season assessment needed.	None known.	None
EO 007	Rockingham	1986	1986	PR	Historical? 1986: Three stunted plants. Not seen in 1987, 1990, 1995. Disturbed sinkhole pond.	None known.	None
EO 021	Rockingham	1991	1995	PR	1991: 4 groups of plants within a 9 sq meter area, consisting of 60-75 rosettes, 18 flowering stems. 1995: ca. 120 rosettes and 50 flowering stems. A very small seasonal wetland within cut-over flatwoods.	No known immediate threat, but pond 45 meters to north was dug out between 1991 and 1995 to provide water for cattle (different landowner).	None
EO 022	Rockingham	1991	1991	PR	1991: 12 rosettes, no flowering stems. Predation on leaves of one rosette; others appear healthy. A very small shallow seasonal wetland within cut-over forest.	None known.	None
EO 023	Rockingham	1991	1991	PR	1991: 2 groups of plants. 65 rosettes of varying sizes with 7 flowering stems within a 1 sq. meter area; 10 rosettes within 0.1 sq. meter. All healthy-looking. Moderate-size sinkhole pond within cut-over forest.	Trail leads into pond. Possible threat from off-road vehicles.	None

ELEMENT OCCURRENCE NUMBER	COUNTY	DATE FIRST OBS.	DATE LAST ASSESSED	OWNER STATUS	DESCRIPTION OF OCCURRENCE	THREATS	PROTECTION STATUS
EO 031	Rockingham	1995	1996	PR	1995: large population with many rosettes and flowering plants. 1996: thousands of rosettes along a more open "pathway" and several hundred bolted plants in openings in the scrubber portions of a sinkhole. A moderate size sinkhole pond within cut-over forest but not far from owner's extended driveway, residences.	The more open habitat suitable for <i>Helenium</i> is limited to the artificially-maintained pathway area and openings in the scrubber vegetation (button bush and young persimmon).	None
MISSOURI EO 001?	Howell	1957	1994?	PR	1957: collection made from open margins of dried sink-hole pond. 1994: several thousand plants in 4 locations. 500-1000 plants, mostly rosettes but 50 flowering, in a low meadow used for cattle pasture around a farm pond; a few thousand in old field, 400 in flower; 10 in low-lying meadow; and 20 in a ditch 1.4 km N of the others.	Cattle-trampling in area of 500-1000 plants may be hindering bolting, as most flowering plants were outside fence.	None

•
•
•

•
•

10

11