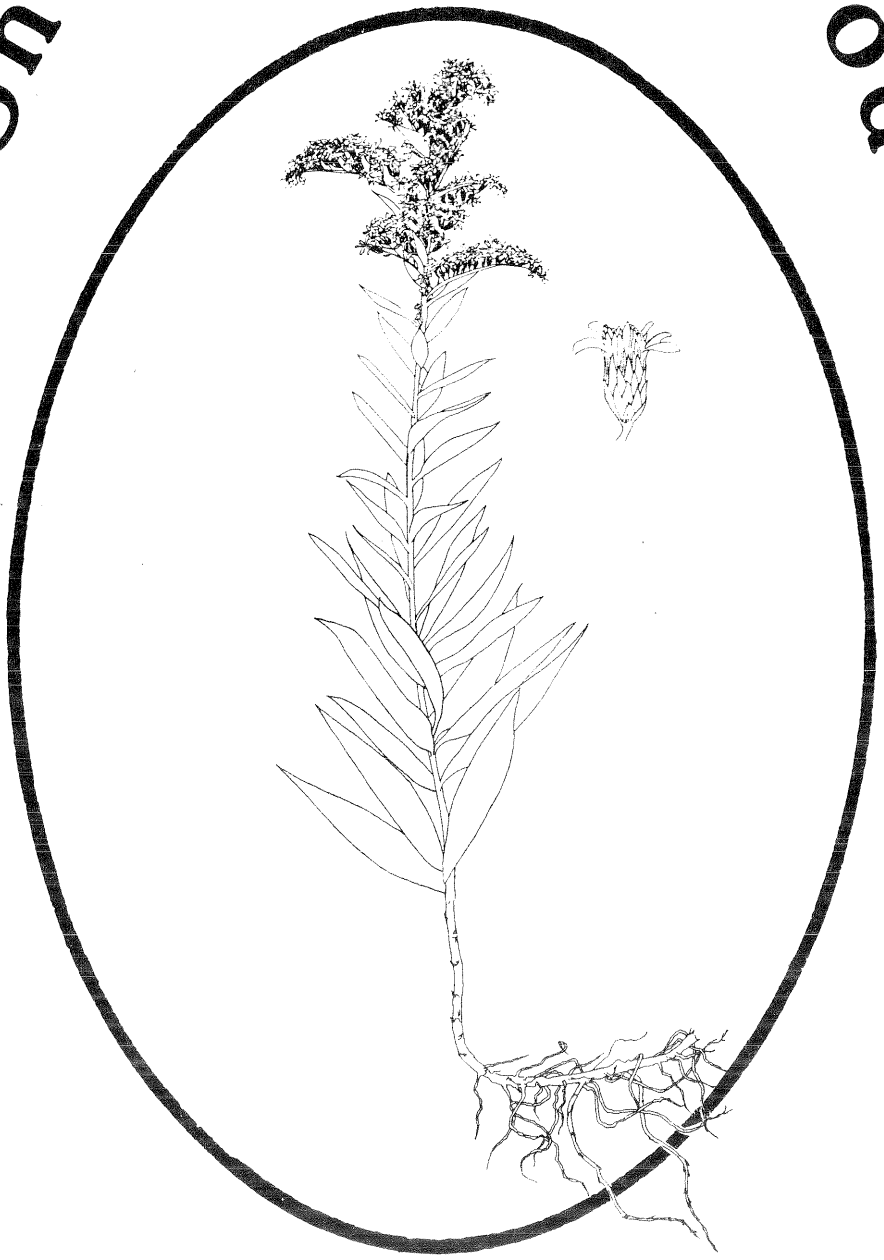
Short's Goldenrod



Recovery Plan

RECOVERY PLAN

for

Short's Goldenrod (*Solidago shortii*)

Prepared by

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Southeast Region, Atlanta, Georgia

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Date: 5/25/88

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ACKNOWLEDGEMENTS SHOULD READ AS FOLLOWS:

U. S. Fish and Wildlife Service. 1988. Short's Goldenrod Recovery Plan. U. S. Fish and Wildlife Service, Atlanta, Georgia. 27 pp.

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FOR

SHORT'S GOLDENROD (*SOLIDAGO SHORTII*)

I. INTRODUCTION

General Background Information

Short's goldenrod (*Solidago shortii*) is endemic to Kentucky and is presently known from only one population with 13 occurrences located in a small area around Blue Licks Battlefield State Park, in the north-central part of the state (Evans 1987). Historically, it was known from only one other area, the "Falls of the Ohio," which is approximately 160 km west of the Blue Licks population (Braun 1941).

Because of its extremely limited known range, relatively small population and potential threats to its habitat, *S. shortii* was listed as a federally endangered species on September 5, 1985 (United States Fish and Wildlife Service 1985). In Kentucky, *S. shortii* has been considered endangered since 1981 by the Kentucky Academy of Science and the Kentucky Nature Preserves Commission (Branson et al. 1981, Warren et al. 1986).

Solidago shortii was first collected in 1840 by Dr. Charles Wilkins Short at the Falls of the Ohio, Jefferson County, Kentucky (Braun 1941), but it has not been observed there since the late 1860's and is considered to be extirpated from the county (Medley 1980). In 1939, E. L. Braun (1941) discovered *S. shortii* growing in the vicinity of Blue Licks, Kentucky, located near the junction of Robertson, Nicholas, and Fleming counties, approximately 160 km to the east of the type locality at the "Falls." At that time, she reported numerous populations growing on rocky slopes and in pastures. In 1980, a status survey of *Solidago shortii* conducted for the United States Fish and Wildlife Service reported only one extant population, located in Blue Licks Battlefield State Park (Medley 1980). The survey reported that a major segment of the Park population was almost completely destroyed by campground construction in the mid-1970's. After the status survey was completed, several new occurrences were documented in the Blue Licks vicinity by Marc Evans and Baskin and Baskin (1984). A recent survey conducted for the United States Fish and Wildlife Service has identified several additional occurrences in the area (Evans 1987).

Despite the discovery of these additional occurrences, the range of the plant and the number of individuals has not been greatly expanded. The new occurrences, which exist in the same general vicinity as the previously known occurrences, are threatened by the same factors and do not significantly alter the species' status.

Description and Taxonomic Status

Solidago shortii is a perennial herb with one to several erect or ascending stems 0.5 to 1.3 m tall, arising from a creeping rhizome. Stems are terete in

cross section, slightly ribbed, and minutely scabrid-puberulent at least above the middle. Leaves are alternate, crowded, 5-10 cm long and 0.6-1.5 cm wide. Individual leaves are firm, oblong-lanceolate to narrowly elliptic, remotely serrulate and glabrous on both sides. The leaves are largest near the middle of the stem and become progressively smaller towards the inflorescence. Lower leaves are reduced and usually absent during flowering time. The inflorescence is terminal and ranges from racemose to paniculate with divergent, secund branches. Heads are 10-14 flowered on puberulent stalks usually 5 mm or less in length. The involucre is 4-6 mm long and 3 mm wide with imbricate, coriacious and glabrous phyllaries. Ray florets number 4-8 and are 2.5-3.0 mm long. The corollas are elliptic-linear with bright yellow ligules about 2 mm long. The disc florets are also bright yellow with a short tube, funnelform throat and five linear spreading lobes about equaling the throat in length. The white pappus is capillary and about 2 mm long. Achenes are cuneate-cylindric, about 2 mm long, and pale brown with appressed, silky pubescence (Gleason 1952, Fernald 1950, Cronquist 1979).

Solidago shortii was first described in 1842 by Torrey and Gray and named in honor of its discoverer, Dr. C. W. Short (Torrey and Gray 1842). Solidago shortii T. & G. is the accepted and only known binomial for this species (Kartesz and Kartesz 1980). No other synonyms are known to exist, and there are no known disagreements on species nomenclature. The type specimens (holotype and three isotypes) are deposited at the New York Botanical Gardens, Bronx, New York. One other isotype is deposited in the University of Kentucky Herbarium. Additional collections of S. shortii are known to exist at the following herbaria: U. S. National Herbarium (Smithsonian Institution), Washington, D. C. (USA); Missouri Botanical Gardens, St. Louis, Missouri (MO); Vanderbilt University Herbarium, Nashville, Tennessee (VDB); University of Tennessee Herbarium, Knoxville, Tennessee (TENN); West Virginia University Herbarium, Morgantown, West Virginia (Medley 1980); and Kentucky Nature Preserves Commission Reference Herbarium, Frankfort, Kentucky.

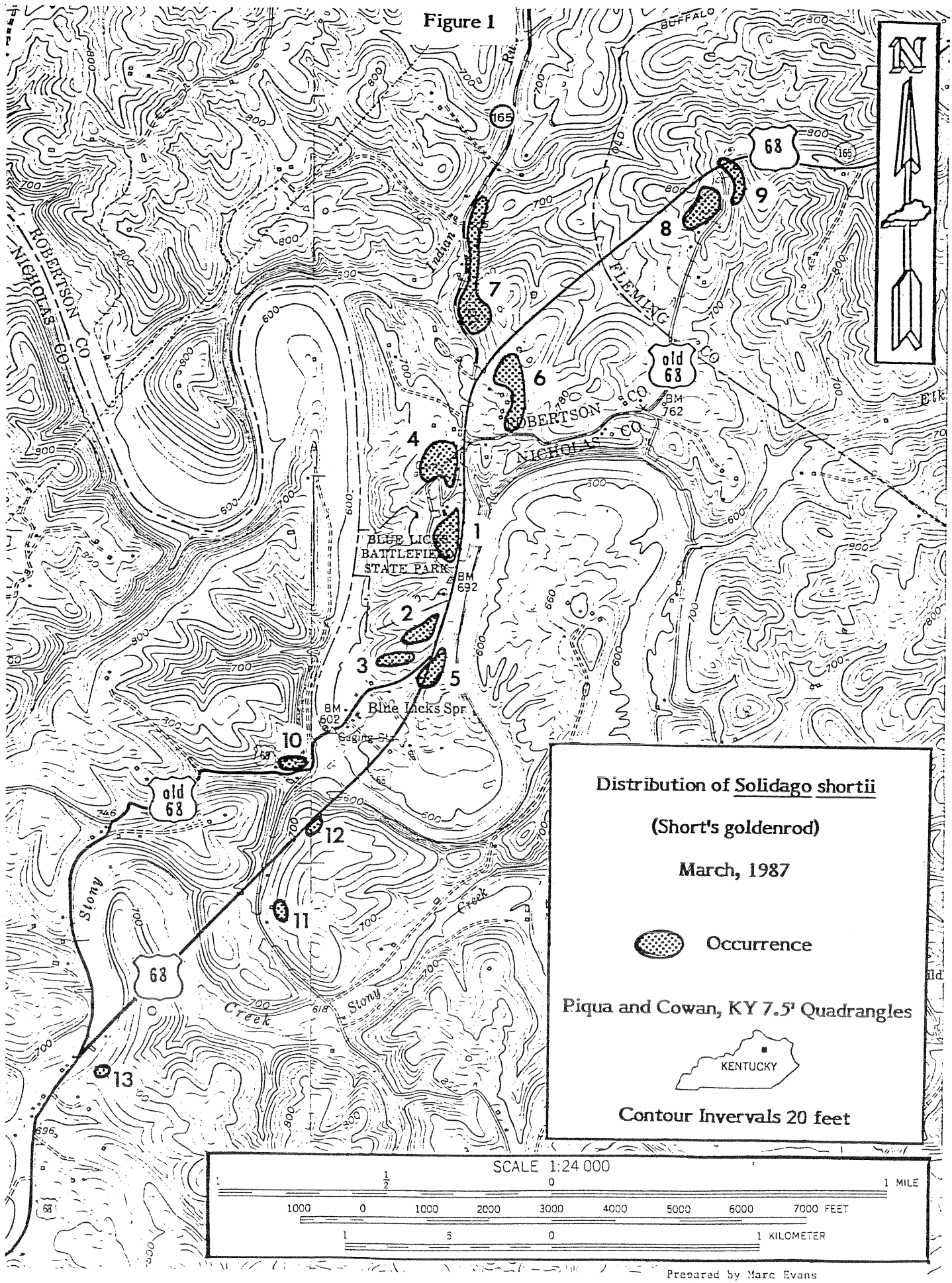
Distribution

Present distribution

The present known distribution of S. shortii is extremely limited with the entire known range occupying about 270 hectares in an area about 5.4 km long and 0.5 km wide (Evans 1987). The plant occurs in extreme southeastern Robertson, northeastern Nicholas, and northwestern Fleming counties where the three counties converge. All known occurrences are within 2.7 km of Blue Licks Battlefield State Park, which appears to be the center of its known range. Although 13 occurrences are known, it is probable that most of the occurrences were originally part of one contiguous population which has been greatly fragmented due to land use changes (Evans 1987). Figure 1 shows the known distribution of S. shortii with all occurrences indicated.

It is difficult to speculate on the present possible distribution of S. shortii since no information is known to exist that may indicate the species occurs outside of its currently known range. However, since S. shortii was known to occur at the Falls of the Ohio as well as at its current location at Blue Licks about 160 km to the east, it is possible that the species may occur somewhere between the two points. Solidago shortii occurs in open glade-like areas along the remains of an old buffalo trace (a trail or road made by bison but historically called a "buffalo trace") at Blue Licks Battlefield State Park and may have been

Figure 1



Prepared by Marc Evans

associated with the bison that made these traces (Braun 1941, Evans 1987). Since a major buffalo trace historically ran from Blue Licks Spring to the Falls of the Ohio (Sames 1985), it is plausable that S. shortii could occur somewhere along the route of the trace. A buffalo trace also ran north from Blue Licks Spring to the Ohio River where Maysville, Kentucky is now located (Sames 1985). On the same line of reasoning, it is possible that S. shortii may occur somewhere along this route. Since both the Falls of the Ohio and Maysville were major areas where herds of bison crossed the Ohio River, it is possible that S. shortii could occur or did occur in Indiana across from the "Falls" and in Ohio, across from Maysville.

The above speculation assumes, of course, that suitable habitat still exists in other areas along the routes of the old buffalo traces and that there is a correlation between the plant and the animal. Many buffalo traces occurred throughout large parts of central and western Kentucky as well as adjoining states, but to date, S. shortii has not been reported elsewhere. Baskin and Baskin (1985) consider S. shortii to be a glade endemic or near endemic. Although, many glades and glade-like areas occur in other parts of Kentucky, S. shortii has never been reported from any of these areas.

Historic Distribution

The known historic distribution of S. shortii consisted of only two widely separated population areas in Kentucky. The population in the vicinity of Blue Licks was previously described under present distribution. The Blue Licks population was first discovered in 1939 (Braun 1941) and has remained extant in that area till the present. The past distribution or range in the Blue Licks area is not known, since all specimen label data and published information about the species do not mention specific locations other than occurring a short distance north, south, and west of Blue Licks.

The second area of historic distribution was at the Falls of the Ohio, Jefferson County, Kentucky. This population of S. shortii was first discovered in 1840 (Braun 1941) and last reported in the 1860's (Medley 1980). The "Falls" is a large outcrop of Devonian limestone in the Ohio River lying between Louisville, Kentucky, and New Albany, Indiana. In the past, prior to construction of locks and dams, the Falls consisted of a series of rapids and chutes with scattered, large rock outcrops and several rocky islands. The extent of the historic population at the Falls is not known since the original collection data is very general and only mentions, "Rock Island," "Rocky Islands," or "Falls of the Ohio" as locations. The Falls have been greatly altered due to the construction of locks and dams and most of the islands have been destroyed or inundated.

It is not possible to determine the past distribution of S. shortii with any degree of certainty. No information is known to exist indicating that S. shortii occurred elsewhere than the two known populations. However, it is possible that S. shortii previously occurred in other locations between the two documented populations, as well as along other connecting buffalo traces or in other open areas with suitable habitat. Due to the natural conditions that prevailed historically, it is more likely that suitable habitat did exist in the past; however, no documentation exists to indicate S. shortii was more widespread.

Habitat Associations and Limiting Factors

Solidago shortii is a species of full sun or partial shade and occurs in a variety of dry, mostly open habitats (Evans 1987, Baskin and Baskin 1985, Kral

1983, Medley 1980). These include limestone cedar glades, open eroded areas, edges of dry, open oak-hickory woods, cedar thickets, pastures, old fields, power line rights-of-way, and rock ledges along highway rights-of-way (Evans 1987).

Cedar glades, open eroded areas and woodland edges appear to be the natural habitats for S. shortii and support the largest and healthiest populations. Baskin and Baskin (1985) consider S. shortii to be a cedar glade endemic or near-endemic. Kral (1983) reports that S. shortii occurs in large, glady clearings or in open woodlands composed of various oaks and hickories. The glade habitat within Blue Licks Nature Preserve in Blue Licks Battlefield State Park occupies two areas. One area is approximately 1,300 m^2 (Baskin and Baskin 1985) and is characterized by a sparse covering of grasses and forbs with scattered individuals or "islands" of woody species. The substrate consists mainly of shallow clay soils with much limestone cobble and shale intermixed. The other glade-like area of the nature preserve occupies approximately 1,200 m^2 (Baskin and Baskin 1985) and is located along both sides of an old buffalo trace. Vegetation and substrate are very similar to the adjacent cedar glade except more weed species occur. Solidago shortii also occurs in a power line right-of-way which bisects this habitat.

Common associates of S. shortii in the glade and along the buffalo trace include grasses such as Aristida longispica, A. oligantha, Danthonia spicata, Panicum flexile, and Sporobolus vaginiflorus. Common forbs include Aesclepias viridiflora, Ambrosia artemesiifolia, Aster laevis, Cassia fasiculata, Desmodium marilandicum, D. procumbens, Gaura biennis, Gentiana quinquefolia, Hedyotis purpurea, Helianthus hirsutus, Hypericum dolabriforme, Isanthus brachiatus, Lobelia spicata, Polygala verticillata, Ruellia humilis, Sabatia angularis, and Solidago nemoralis. Weedy species invading these areas include Daucus carota, Melilotus alba, Symphiocarpos orbiculatus, Lespedeza cuneata, and Medicago lupulina.

Common woody vegetation within and along the edges of the open areas include Cercis canadensis, Cornus florida, Fraxinus americana, Juniperus virginiana, Quercus muhlenbergii, Q. shumardii, Q. stellata, Q. velutina, Rhus copallina, and Viburnum rufidulum. Within the glade habitat, S. shortii also associates with two other plants considered rare or endangered in Kentucky, Scutellaria leonardii and Spiranthes magnicamporum (Warren et al. 1986).

Historically, open habitat for S. shortii was probably maintained through natural disturbances such as periodic fires and trampling and grazing by large herbivores such as bison, elk, and deer (Braun 1941, Medley 1980, Kral 1983, Evans 1987). Bison, which were attracted to the nearby Blue Licks salt springs, were very common historically, and large herds roamed the vicinity following the traces during their migrations. It is well documented (Wilson 1927, Jillson 1949) that at the time of discovery in 1751 and subsequently until about 1800, many of the hills surrounding Blue Licks Spring were essentially devoid of trees. The area where Blue Licks State Park now lies was described as a desert, covered with a pavement of rocks and stripped of herbage, due to the effects of the bison. Some slopes adjacent to Blue Licks were described as open woodland and were probably savanna-like. The only densely forested areas reported in the immediate Blue Licks vicinity were in the ravines and steep slopes along the Licking River. One of the largest occurrences of S. shortii exists in open eroded areas along the remains of an old buffalo trace and in the adjacent cedar glade within Blue Licks Nature Preserve.

Solidago shortii also occurs in and along the edge of open oak-hickory woods (Evans 1987). Common trees in this habitat include Carya glabra, C. ovalis, Cercis canadensis, Cornus florida, Fraxinus americana, Juniperus virginiana, Quercus alba, Q. muhlenbergii, Q. stellata, and Q. velutina. At several sites S. shortii occurs along the edge of woods adjacent to highway rights-of-way. These sites are being invaded by exotics such as Coronilla varia, Festuca elatior and Lespedeza cuneata which appear to be spreading from the highway rights-of-way where they were probably planted. Lonicera japonica has also been found invading these sites.

Scattered individual plants occur along the top and upper edge of large limestone rock-cuts within a highway right-of-way. These cuts were created when the hillsides were excavated to accommodate the new highway. Here the plants grow in thin soils and in cracks in the limestone. On these sites, there is much competition from both planted and invading weed species such as Coronilla varia, Dacus carota, Festuca elatior, Lespedeza cuneata, and Melilotis alba.

Solidago shortii also occurs in cedar thickets and in dense, young second-growth woods. These sites were probably open in the past and some may have been glades. Lack of natural disturbance has caused the cedars and hardwoods to encroach upon these sites, resulting in the thickets found there today. If left alone, the trees will probably shade out these plants.

Solidago shortii is also known to occur in pastures. In 1939 S. shortii was reported as numerous in pastures (Braun 1941), but only a few small colonies are known from pastures today. It is not known whether S. shortii invaded the pastures or if it was there before the land was converted to pasture. Plants in over-grazed pastures appear stunted and depauperate, while plants in pastures not recently grazed are much healthier and vigorous.

Several small colonies of S. shortii occur in old fields. The old fields are in various stages of succession with some invading woody species such as Rhus copallina, Rosa multiflora, Rubus spp., and Sassafras albidum. Herbaceous plants surrounding these occurrences include several grasses dominated by fescue and various weedy plants such as Daucus carota, Lonicera japonica, Melilotis alba, and Solidago canadensis. The old fields were probably in pasture at some time in the past.

Very little information is available on the specific environmental parameters required by S. shortii. It appears, however, that natural disturbance and edaphic factors are important in maintaining the open habitat required by this species (Braun 1941, Medley 1980, Kral 1983). Solidago shortii appears to favor dry, open areas with rocky and droughty soils, such as cedar glades. Sites range from relatively flat to steeply sloping and most have a west or south exposure, although some sites have an east exposure. Solidago shortii does not appear to compete well and does best in areas with a low density or percent cover of other plants. It is not shade tolerant and apparently will not grow in low light situations such as in a closed canopy woods. The few individuals found growing in dense shade appear depauperate; however, the plant does appear to tolerate light shade.

Geologically, the known range of S. shortii is underlain by Ordivician bedrock, mainly of the Lexington Limestone Formation (Blade 1978, Wallace 1978). Also represented, though to a lesser extent, are the Kope and Clays Ferry Formations and the Tanglewood and Grier members of the Lexington Formation.

The bedrock is composed of interbedded layers of limestones, shales and siltstones which break down into a heavy, clay soil.

The soils on which S. shortii occur are classified as being of the Eden Series (Richardson et al. 1982) and are described as having a flaggy, silty clay texture with 20-30 percent rock fragments. This soil has lost most of its original surface through erosion and is composed mostly of subsoil material. Although depth to bedrock is generally from 50-100 cm, areas with shallow soil are common. The soil is firm and sticky when wet and shrinks and cracks when dry. Fragments of limestone, shale and siltstone are common. Permeability is slow and runoff is rapid. Available water capacity is moderate, organic matter is low, and the soil is slightly acid to moderately alkaline with a pH of 5.6-8.4 (Richardson et al. 1982).

The climate of north-central Kentucky is temperate, mid-continental with hot, humid summers and moderately cold winters with precipitation fairly well distributed throughout the year. Snow falls almost every winter but usually lasts for only a few days. Periodic droughts can occur, especially during the late summer and fall months. Average yearly rainfall is about 112 cm with about 55 percent, or 61 cm, falling during the growing season of April through September. In winter the average daily temperature is 0^{o} C and in summer 22^{o} C. Extremes range from a low of -36^{o} C f to a high of 40^{o} C (Richardson et al. 1982).

Reproductive Status

Little is currently known about the reproductive status of S. shortii. A study of the species' life history and ecological requirements, funded by the United States Fish and Wildlife Service, is currently being conducted by Drs. Jerry and Carol Baskin of the University of Kentucky through the Kentucky Nature Preserves Commission. However final results of the research are not available at the time of this writing.

Solidago shortii produces flowers from mid-August to early November. Achenes (fruits) mature several weeks after the flowers wither (Kral 1983). Germination rates of S. shortii seeds are reported to be almost 100 percent under greenhouse conditions (Dr. Jerry Baskin, pers. comm.); however, germination rates in the wild are not known. Although specific pollinators have not been documented, sweat bees (probably Halictidae) were observed visiting flowers of this species on numerous occasions. The common black blister beetle (Epicauta pennsylvanica), was also observed in large numbers on the flowers; however, these insects were probably feeding on the flowers (Marc Evans, personal observation). Although goldenrod fruits are normally wind dispersed, there is no evidence that this species is expanding its range by this method. Braun (1941) suggests that bison may have been a dispersal vector, and that the historic distribution may have been correlated with movement patterns and disturbance caused by bison.

Population Status and Threats

The primary reasons for the current endangered status of Solidago shortii appears to be habitat destruction or alteration, and possibly other natural or man-made factors such as fire suppression and the elimination of bison (Braun 1941, Kral 1983, Medley 1980, Evans 1987). Based on the few historic records, it appears that S. shortii may never have been a widespread or common plant. The limited known population has been further reduced by human activities.

The exact reason for the extirpation of the Falls of the Ohio population is unknown; however, it apparently disappeared during the rapid growth of the city of Louisville, and habitat destruction or alteration can be assumed. Today the Falls are greatly altered with most of the rocky islands having been destroyed in the past during construction of the several locks and dams which were built adjacent to and across the Falls on the Ohio River.

When first discovered in the Blue Licks vicinity in 1939, numerous populations of S. shortii were reported to occur on rocky slopes and in pastures (Braun 1941). Today only 13 occurrences are known to exist in the Blue Licks vicinity. It is not known how the present population compares with that found by Braun, but it is suspected that a substantial decline has occurred. This suspected decline was probably the result of the numerous land-use changes that have occurred in the area.

Continued heavy grazing and improvement of pastures through grading and sowing of Kentucky fescue 31 may have been a factor in the decline and disappearance of S. shortii from the pastures which are still common around Blue Licks. Managing and clearing of woodlands for pasture and other uses has also undoubtedly had a negative impact on S. shortii due to elimination of woodland edge habitat and subsequent pasture "improvement." It is likely that road construction impacted S. shortii in the Blue Licks vicinity. Several colonies appear to have been fragmented or possibly destroyed by highway construction. On the other hand, creation of rock-cuts during road construction may have created habitat into which S. shortii has spread. Several colonies which occur along road rights-of-way may be negatively impacted by road maintenance practices such as mowing during late summer and fall and spraying of herbicides. The construction of powerlines may have negatively impacted portions of two occurences. Periodic maintenance of the rights-of-way may cause further damage to the population, especially if herbicides are used, or may benefit the species by opening up additional habitat. In the 1970's a major occurrence in Blue Licks Battlefield State Park was almost completely destroyed during construction of a campground (Medley 1980). Currently, recreational use may pose threats to remaining occurrences of S. shortii in Blue Licks Battlefield State Park. Competition with aggressive exotic plants such as Festuca elatior, Coronilla varia, and Lonicera japonica is presently impacting and possibly eliminating some occurrences of S. shortii.

The historic distribution of S. shortii may have been correlated with disturbance caused by bison which helped maintain open habitat and may have played a role in the dispersal of its fruit (Braun 1941). It has also been suggested that fire may have influenced its past distribution by maintaining woodland openings which provided habitat for S. shortii (Medley 1980, Kral 1983). With the elimination of bison and the suppression of fire following the settlement of Kentucky, secondary succession may have caused changes in the vegetational composition of these openings until a closed canopy woodland developed, thus eliminating the shade intolerant S. shortii. Succession is currently a problem in several sites where S. shortii occurs.

Because of the few known occurrences and relatively small number of individuals, a depressed gene pool may be a factor affecting current populations. Additional unknown factors may also be influencing the status of S. shortii.

Future threats to the remaining population of S. shortii will probably consist of the same threats that currently plague the species. Increased visitor usage of Blue Licks Battlefield State Park will undoubtedly place more pressure on those plants, both directly through possible trampling and through possible development of additional recreational facilities. Further changes in land use, such as more intensive agricultural activities and additional road or other construction could impact or eliminate other occurrences of S. shortii.

Recovery Actions Taken to Date

Significant efforts to protect S. shortii have already been accomplished and are still in progress. The Kentucky Nature Preserves Commission (KNPC) and the Kentucky Chapter of The Nature Conservancy (TNC), working together and independently, have taken a number of positive steps towards protecting this species.

To date, two preserves, one public and one private, have been established to protect S. shortii. In 1981, KNPC, in cooperation with the Kentucky Department of Parks, dedicated a portion of Blue Licks Battlefield State Park as the Blue Licks Nature Preserve. This nature preserve protects one of the largest occurrences and the best natural habitat of S. shortii. In 1986, TNC purchased a 5.4-acre tract of land called the Buffalo Trace Preserve to protect the northernmost occurrence of S. shortii.

In addition to establishing these preserves, six of nine private landowners have been contacted through the Kentucky Natural Areas Registry Program and notified of the presence of S. shortii on their property. A local utility company and the state and county transportation departments have also been notified. To date, three private landowners have signed Registry Agreements and two have verbally registered their occurrences. Table 1 shows the ownership, current protection status, and intended protection status of the 13 known occurrences of S. shortii.

The registry program, established in 1983, is a cooperative effort between KNPC and TNC. It is a program whereby landowners who own significant natural areas or have rare species on their property are contacted and asked to voluntarily protect their significant feature and to register their site as a Kentucky Natural Area. The program is voluntary, non-binding and non-regulatory and therefore relies upon the integrity of the landowner to follow through on their commitment. Landowners who agree to register are asked to 1) protect the natural area to the best of their abilities; 2) notify KNPC/TNC of any threats to the natural area; and 3) notify KNPC/TNC of any intent to sell their property. Because Registry does not constitute legal protection, it cannot be considered adequate for long-term protection. However, it does offer limited short-term protection by eliminating accidental destruction of natural areas due to ignorance, and it is an important step towards more permanent protection such as management agreements, leases, acquisition, or dedication. The Registry Program provides a "shopping list" of natural areas and allows KNPC/TNC to develop an important working relationship with the landowners.

Both TNC and KNPC intend to continue to acquire and dedicate important S. shortii tracts as they become available. TNC is currently negotiating to acquire the Craig tract (occurrence 2); however, it is not known whether this effort will be successful.

Table 1. Ownership, name, current protection status and intended protection status of occurrences of S. shortii.

Occurrence Number*	Ownership	Tract or Site Name	Current Protection Status	Intended Protection Status
1	Dept. of Parks	Blue Licks Nat. Pre.	Dedicated	Same
2	a. Private	Craig tract	Verbal Registry	Acquire/ Dedicate
	b. Dept. of Parks	BLBSP**	Notified	Mgt. Agreemt.
3	Private	Hunter tract	Signed Registry	Acquire/ Dedicate
4	Dept. of Parks	BLBSP	Notified	Mgt. Agreemt.
5	Private	--	None	Notify
6	Private	Rice tract(I)	Signed Registry	Acquire/ Dedicate/ Mgt. Lease
7	a. State Hwy. Department	Highway 165 Site	Notified	Mgt. Agreemt.
	b. Private	Rice tract (II)	Notified	Mgt. Agreemt./ Dedicate(?)
8	a. Private (TNC owned)	Buffalo Trace Pre.	Private Preserve	Dedicate
	b. Private	Frey tract	Signed Registry	Acquire/ Dedicate
9	Private	--	None	Notify
10	Private	Allison tract	Notified	Register(?)
11	Private	Abnee tract(I)	Verbal Registry	Signed Registry/ Mgt. Lease
12	a. State Hwy. Department	Right-of-way	Notified	Mgt. Agreemt.
	b. Private	Abnee tract (II)	None	Notify
13	Private	--	None	Notify/Register/ Mgt. Lease(?)

* Occurrence numbers correspond to Map (Figure 1)
** BLBSP - Blue Licks Battlefield State Park

In addition to dealing with private landowners, KNPC is negotiating management agreements with the Kentucky Department of Parks to protect occurrences in the park outside of the nature preserve. The Department of Parks, and particularly Mr. Sam Devine, park superintendent of Blue Licks Battlefield State Park, have been extremely cooperative and expressed strong interest in protecting the plant. KNPC has also notified, and is negotiating management agreements with, the local Rural Electric Cooperative, which has a power line bisecting a portion of occurrence 1 (the Blue Licks Nature Preserve) and occurrence 9. KNPC has also notified the Kentucky Department of Highways and the Robertson County Highway Department of the presence of S. shortii on rights-of-way and intends to develop management agreements with these agencies.

Research is currently underway to try to determine what management practices are needed to perpetuate and enhance the habitat of S. shortii. Drs. Jerry and Carol Baskin of the University of Kentucky, under contract with KNPC, are conducting research to determine the life history and ecological requirements of S. shortii. Their study is being funded by the United States Fish and Wildlife Service through a Limited Authorities Cooperative Agreement for Plants with KNPC. Research was initiated on September 1, 1986 and is expected to be completed soon. Because this research is still underway, no definitive data are available. When results do become available, they should be incorporated into this recovery plan.

Recovery Actions Needed

The unprotected occurrences of S. shortii that are considered high priority for the species survival should be acquired and/or dedicated. These occurrences then need to be managed to provide optimal habitat to insure long-term survival. Before S. shortii habitat can be managed, life history and ecological requirement studies need to be completed to determine appropriate management practices. Additional surveys for new occurrences or populations need to be conducted both in the Blue Licks vicinity and in other areas of Kentucky where glades and/or buffalo trace remnants are known to occur. The needed recovery actions are presented in more detail in the step-down narrative in the Recovery Section.

II. RECOVERY

Recovery Objective

The primary recovery objective of this plan is to delist Solidago shortii from the Federal endangered and threatened species list. This objective can be accomplished when 1) adequate protection is obtained for the nine high priority occurrences and the habitat they occur in; 2) protected occurrences are determined to be self-sustaining and maintaining current population levels or above; 3) species biology and ecological requirements are sufficiently understood to determine and implement long-term management strategies; and 4) at least nine additional protected occurrences, equal in size and significance to the high priority occurrences mentioned above, are discovered in the vicinity of the Blue Licks population or at a currently unknown location. Available data are insufficient to actually determine what population level is adequate to consider S. shortii recovered enough to delist it. Until such a determination is made, recovery criterion number 4 should be sufficient to meet the recovery objective.

Reclassification to threatened status can be considered when the first three criteria above are met.

Step-down Outline

1. Protect existing occurrences and essential habitat.
   - 1.1. Prioritize occurrences for protection.
   - 1.2. Contact landowners and negotiate highest or most appropriate level of protection possible.

2. Conduct systematic searches for additional occurrences and populations.
   - 2.1 Identify potential habitat.
   - 2.2 Conduct ground searches.

3. Conduct studies of life history and ecological requirements.
   - 3.1. Delineate existing occurrences.
   - 3.2. Establish permanent study plots.
   - 3.3. Analyze physical habitat.
   - 3.4. Characterize habitat factors.
   - 3.5. Study phenology, pollination and seed dispersal.
   - 3.6. Perform ex situ germination study.
   - 3.7. Long-term demographic study
   - 3.8. Determine management practices and develop recommendations to maintain health, vigor, and survivability of species.

4. Develop management plan and implement recommended management practices if determined beneficial.
   - 4.1. Develop management plan.
   - 4.2. Conduct controlled burns, if determined beneficial.
   - 4.3. Remove overstory and/or aggressive competing vegetation, if determined beneficial.
   - 4.4. Implement controlled rotational grazing system, if determined beneficial.

4.5 Monitor results of management practices and re-evaluate management needs as data on management results are obtained.

5. Maintain viable seeds.
   5.1. Collect and deposit seeds into seed banks.
   5.2. Make seeds available to organizations or institutions for propagation.

Narrative

1. Protect existing occurrences and essential habitat
Because of the extremely limited known range, relatively small population, and possible threats to S. shortii, it is imperative that a sufficient number of occurrences be protected to insure that the sites they occur on are not negatively impacted by human activities.

   1.1. Prioritize occurrences for protection
   Occurrences should be prioritized to determine which are the most important to protect. Prioritization should be based upon the size and vigor of each occurrence, the existing habitat quality, and threats to each occurrence. Based upon these criteria, the following nine occurrences are considered high-priority for protection: Occurrence number 1, 2, 3, 4, 6, 7, 8, 11, and 13. Occurrence numbers 5, 9, 10, and 12, because of their small size and poor quality habitat, are considered lower-priority and not absolutely essential to protect the existence of the population. However, some level of protection should be attempted for all sites.

   1.2. Contact landowners and negotiate highest or most appropriate level of protection possible
   All landowners who have known occurrences of S. shortii on their property should be contacted and some level of protection, depending upon the priority of the occcurrence, should be negotiated. Representatives of the Kentucky Natural Areas Registry Program, administered jointly by the Kentucky Nature Preserves Commission and the Kentucky Chapter of The Nature Conservancy, have already met with six of nine private landowners and intend to contact the remaining three. In addition to contacting private landowners, KNPC has and is contacting public landowners such as the Kentucky Department of Parks, the Kentucky Department of Highways, and the County Highway Department. A public utility, which manages two power line rights-of-way with occurrences of S. shortii, has also been contacted.

   High priority occurrences should be afforded the highest level of protection through acquisition and/or dedication. Two of the nine high priority occurrences are already protected this way. Occurrence 1 is protected in the Blue Licks Nature Preserve in Blue Licks Battlefield State Park. This dedicated state nature preserve is administered by the Kentucky Nature Preserves Commission. The majority of occurrence 8 is now protected in the Buffalo Trace Preserve, a 5.4-acre private preserve recently

acquired by The Nature Conservancy. It is anticipated that this preserve will also be dedicated into the state nature preserves system. Of the remaining seven high priority occurrences, all but one currently have some level of protection, although none have been acquired or dedicated. Occurrence 2, the Craig tract, is verbally registered; however, the owner has been only partially cooperative. TNC has negotiated with the owner to acquire the land but so far has been unsuccessful. A portion of occurrence 2 is on state park property. The Department of Parks has agreed to protect the plants on their property. Occurrence 3, the Hunter tract, is officially registered as a natural area. The owners are very cooperative and have indicated they may sell this important tract of land in the future or donate it to the Park. Occurrence 4 is also in Blue Licks Battlefield State Park. As with the other occurrences in the park, they have agreed to protect the species. Occurrence 6, the Rice tract, is a large and important occurrence. The owner has signed a registry agreement and has agreed to help protect the plants on his land. Occurrence 7 is on right-of-way land administered by the Robertson County Highway Department. Negotiations are currently underway to develop a management agreement to protect this site. Because this site is a right-of-way, it is unlikely that acquisition or dedication will be a practical protection alternative. A formal protection agreement with the county should be sufficient to protect this occurrence. Part of this occurrence exists on adjacent private land owned by Mr. Rice (occurrence 6) but is not included in the Registered Natural Area and has no level of protection at this time. Occurrence 11, the Abnee tract, is currently verbally registered. The owner has agreed not to impact the site but does not indicate any interest in a higher level of protection at this time. Occurrence 13, the southernmost site, was the most recently discovered, and the landowner has not yet been notified. Depending upon future surveys of this site to determine its importance, the site should be registered and a management lease developed.

Lower priority occurrences should also be afforded some level of protection through not necessarily through acquisition or dedication. Portions of the low priority occurrences (5, 9, 10, 12) occur on highway or powerline rights-of-way. KNPC is negotiating management agreements for these occurrences with the appropriate agencies. Portions of these four occurrences are also located on private property adjacent to the rights-of-way. Two of the private landowners (occurrences 10 and 12) have been notified. The other two private landowners (occurrence 5 and 9) have not been identified yet. At minimum, all private landowners with low priority occurrences should be notified and possibly registered.

2. Conduct systematic searches for additional occurrences and populations

Because S. shortii has such a limited known range with relatively few occurrences, it is important to continue searching for new occurrences to expand the population and increase its range. New occurrences or populations must be found to consider completely delisting it. Since

all but one of the 13 known occurrences have been discovered in the past few years, it is conceivable that others remain to be found.

2.1. Identify potential habitat

Because S. shortii occurs in a variety of natural and man-made habitats, it is difficult to identify potential habitat through remote interpretation. However natural habitats such as glades and eroded areas along bison traces are easily discernable on aerial photos and sometimes on soil maps. Potential habitat should be looked for not only in the Blue Licks vicinity, but in other more distant areas as well. Since S. shortii historically occurred 160 km to the west of Blue Licks, there is a chance it still occurs elsewhere. Further inquiries with knowledgeable individuals and historians may reveal unknown sections of intact bison traces. Also, many other "licks" occurred in north-central Kentucky as well as other sections of the state and may be areas in which to concentrate searches. The results of the life history and ecological requirements study (3.) may turn up previously unknown factors that will aid in locating potential habitat.

2.2. Conduct ground searches

Areas of potential habitat identified in 2.1. should be systematically searched during late summer and fall. Since all known occurrences are clustered around Blue Licks, additional searches should be attempted there because of the likelihood of greater success. As time and money allows, other areas of potential habitat in Kentucky should be surveyed.

3. Conduct studies of life history and ecological requirements

Very little is known of the life history or ecological requirements of S. shortii. It is important to obtain this basic information to understand the life cycle and limiting factors of the plant before appropriate management techniques can be determined and a management plan developed. Information resulting from this research will hopefully provide the data necessary to allow development of a management strategy for protected occurrences and thus ensure a successful recovery and perpetuation of the species. Research on life history and ecological requirements has recently been initiated; however, results are not available at this time.

3.1. Delineate existing occurrences

Each of the 13 known occurrences should be visited and the boundaries determined. Each occurrence should be marked and appropriately labelled on a 7.5-minute topographic map. Additionally, a 1:200-scale map should be developed for each occurrence, and all overstory or cultural features such as telephone poles, fences, and/or roads indicated. Two iron stakes should be driven into the ground to ground level marking the center of the occurrence and at the true north location on the occurrence boundary. The locations of the iron stakes should be accurately marked on the 1:200-scale maps. The surface area in m^2 should be calculated for each occurrence and the number of S. shortii stems counted or estimated during a mid-September visit. Permanent study plots located in occurrences (3.2.) should be indicated on the 1:200-scale maps.

3.2. Establish permanent study plots

The Blue Licks Nature Preserve occurrence which grows in a natural situation will be the focus of research efforts into the life history of Solidago shortii. Randomly placed 1 m^2 permanent plots should be established along transects crossing the glade area and old buffalo trace in the preserve. Permanent numbered iron stakes should be utilized to mark each plot and positioned in a manner to facilitate consistent plot placement.

In an effort to gain information on this species in disturbed habitats, at least one other population should be identified for the establishment of additional permanent study plots. The number and placement of the plots should be discussed with the Commission. Permanent study plots should be used in the assessment of physical habitat characterizations (3.3.), characterization of habitat factors (3.4.), and the long-term demographic study (3.7.).

3.3. Analyze physical habitat

The investigator should be required to document the character and depth of the soil substrate within or adjacent to each of the permanent study plots established in 3.2. and at a minimum of two locations in the other occurrences not sampled by permanent plots. Measurements of soil depth and soil samples should be taken utilizing standard field techniques. Soil samples should be analyzed for mineral composition, soil texture, pH, organic content, and soil moisture using standard laboratory techniques.

3.4. Characterize habitat factors

Each of the 13 known occurrences should be visited during the study and habitat factors characterized. Occurrences should be identified by latitude and longitude coordinates. Slope characteristics of steepness, position, aspect and elevation should be documented. The soils should be classified according to the Soil Conservation Service's classification system and the geological substrate identified. An ocular estimate of overstory coverage or basal area of woody species should be made for each occurrence. The plant associates of each occurrence should be determined by visiting each at least four times during the growing season. Frequency information on vegetative associates should be developed. Light measurements should also be taken at permanent plots throughout the growing season using a light meter.

3.5. Study phenology, pollination, and seed dispersal

Observations on the phenology of Solidago shortii should be made through regular visits to the permanent study plots during one full growing season. Data should be collected regarding dates of flower bud development, anthesis, seed set, and senescense. Observations should be made on pollination biology. Efforts should be made to find and collect insect visitors to flowering S. shortii plants. Whenever an insect visitor is collected, information should be noted concerning the date, time of day, and flower condition.

Observations of flowering plants should include representative portions of daylight hours. Observations concerning seed dispersal should be made while in the field. Detailed drawings or scanning electron micrographs should be made of pollen grains and fully developed seeds to assist the investigator in understanding the potential for pollen transfer and seed dispersal. Data on plant height, leaf shape and size, root characteristics, flower number, and any other life history data should be collected to provide for a more complete understanding of this species.

3.6. Perform ex situ germination study
Seeds of Solidago shortii should be collected from known occurrences. Seeds should be treated to artificial temperature and moisture conditions as well as conditions simulating those occurring in natural populations. The design of the ex situ germination study should be such that data will be collected regarding factors influencing germination, germination seasonality, germination percentages, and seedling survival.

3.7. Long-term demographic study
Solidago shortii plants within the permanent study plots located in the Blue Licks Nature Preserve and the second study area should be mapped carefully so that each individual or clone can be followed over time. Additionally, an ocular estimate of percent cover by species of all plants in the plot should be made. Permanent plots should be mapped and percent cover determined in September. Monitoring of plots should allow assessment of the stability and vigor in these occurrences.

3.8 Determine management practices and develop recommendations needed to maintain health, vigor and survivability of the species
Using data and observations generated in the completion of 3.1., 3.2., 3.3., 3.4., 3.5., 3.6., and 3.7., sound recommendations and a rationale for managing Solidago shortii populations to maintain the health, vigor, and survivability of this species should be developed. Experimental controlled burns should be conducted and the results monitored. The correct time of year to burn should be taken into consideration and determined. Experimental removal of overstory and competing vegetation should be performed and the results monitored. Experimental cattle grazing rotations should be performed and the results monitored. The results of these experiments will allow for the development of a comprehensive management plan.

4. Develop management plan and implement recommended management activities if determined beneficial
This is an extremely important objective if the recovery of S. shortii is to occur. Even if all occurrences are protected, it by no means insures the survival of the species. All occurrences have been negatively impacted to various degrees either through man's activities or natural succession and are in need of some type of management. Habitat manipulation is required at most sites to control succession and competition, and maintain the open habitat required by the species.

4.1. Develop management plan
Using the data and management recommendations obtained in 3.8. a comprehensive management plan should be developed to the specific management needs determined for each occurrence.

4.2. Conduct controlled burns, if determined beneficial
Fire may have been a factor in maintaining open habitat for S. shortii (Kral 1983, Medley 1980) but has not been documented as a presettlement occurrence in the Blue Licks vicinity. If it is determined through research (3.) that fire is an important factor in helping to maintain optimal habitat and reduce competition, then controlled burns should be implemented where and when it is appropriate.

4.3 Remove overstory and/or aggressive competing vegetation, if determined beneficial
Many S. shortii occurrences are in various stages of secondary succession and may be impacted through shading and/or competition. If it is determined through research that overstory or vegetation removal is important in maintaining optimal habitat and reducing competition, then this practice should be implemented where and when it is appropriate. Selective mowing may be a method of controlling competing vegetation.

4.4. Implement controlled rotational grazing system, if determined beneficial
Bison are suspected to have played an important role in maintaining habitat for S. shortii and possibly in dispersal of its seeds. If it is determined through research that controlled grazing is important in maintaining habitat and reducing competition, then this management practice should be implemented where and when it is appropriate. Due to the small acreage currently under protection for S. shortii, it may not be feasible at this time to implement controlled grazing as a management tool.

4.5. Monitor results of management practices and re-evaluate management needs as data on management results are obtained
Once management practices are initiated, results should be monitored to determine if they are positive. Monitoring should be conducted as in 3.1., 3.2., and 3.7. and should be done over many years to determine long-term effects. As results are obtained management policies should be re-evaluated and modified as the results indicate.

5. Maintain viable seeds
Viable seeds from wild plants should be maintained to help insure survival of the species in case of a catastrophic event. If the wild population should, for some reason, become extinct, then new populations could possibly be established from the stored seeds. Seeds of S. shortii readily germinate under cultivated conditions (Dr. Jerry Baskin, pers. comm.), and plants have been grown in gardens (KNPC unpublished data). This element is secondary to achieving the primary recovery objective of this plan.

5.1. Collect and deposit seeds into seed banks

Seeds of S. shortii should be collected from several different occurrences to help maintain genetic variability. These seeds should then be deposited at an established seed bank with appropriate long-term storage facilities.

5.2. Make seeds available to organizations or institutions for propagation

Stored seeds should be made available to institutions or organizations that propagate and maintain cultivated populations of endangered plant species. Several programs to propagate endangered species have been established in recent years and should be utilized for this purpose.

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III. KEY TO IMPLEMENTATION SCHEDULE COLUMNS 1 AND 4

General Category (Column 1):

Information Gathering -
I or R (Research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depradation control
7. Other management

Priorities within this section (Column 4) have been assigned according to the following:

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/habitat quality or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency*1			Estimated Fiscal Year Costs			*2
					FWS						
					Region	Division	Other	FY 1	FY 2	FY 3	Comments/Notes
I14	Prioritize occurrences for protection.	1.1	1	1 year	4	SE	KNPC**	1,000	---	---	*1. Other agencies' responsibilities would be of a cooperative nature on projects funded under a FWS contract or grant program. In some cases contracts may be let to universities or private enterprises.
A1-7	Contact landowners and negotiate highest or most appropriate level of protection possible.	1.2	1	3 years	4	SE	KNPC, TNC***	Unknown	---	---	
R3, 14	Identify potential habitat.	2.1	2	2 years	4	SE	KNPC	---	1,000	1,000	*2. NOTE: All cost estimates are for FWS funds only.
R14	Conduct ground searches.	2.2	2	3 years	4	SE	KNPC	5,000	3,000	3,000	
R1	Delineate existing occurrences.	3.1	2	1 year	4	SE	KNPC	1,000 or 500	---	---	1.1 and 3.1 completed in FY 87. 1.2 initiated in FY 87.
R6	Establish permanent study plots.	3.2	1	3 years	4	SE	KNPC	2,000	---	---	3.2 completed in FY 87.
R6 1,2,3	Analyze physical habitat.	3.3	1	1 year	4	SE	KNPC	2,000	---	---	3.3 completed in FY 87.
R1,2, 3,6	Characterize habitat factors.	3.4	1	1 year	4	SE	KNPC	2,000	---	---	3.4 Initiated in FY 87.
R6	Study phenology, pollination, and seed dispersal.	3.5	1	2 years	4	SE	KNPC	2,000	2,000	---	3.5 Initiated in FY 87.
R6	Perform ex situ germination study.	3.6	1	1 year	4	SE	KNPC	1,000	---	---	3.6 Completed in FY 87.
R6	Long-term demographic study.	3.7	1	3 years	4	SE	KNPC	3,000	3,000	3,000	

Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency			Estimated Fiscal Year Costs			Comments/Notes
					FWS						
					Region	Division	Other	FY 1	FY 2	FY 3	
R4	Determine management practices and develop recommendations to maintain health, vigor, and survivability of species.	3.8	1	2 years	4	SE	KNPC	---	300	1,000	
I4	Develop management plan.	4.1	1	1 year	4	SE	KNPC	---	1,000	---	
M3	Conduct controlled burns, if determined beneficial.	4.2	1	2 years	4	SE	KNPC	---	1,500	500	
M3	Remove overstory and/or aggressive competing vegetation, if determined beneficial.	4.3	1	2 years	4	SE	KNPC	---	2,000	500	
M3	Implement controlled rotational grazing system, if determined beneficial.	4.4	1	2 years	4	SE	KNPC	---	3,000	500	
M3,R14	Monitor results of management practices, and reevaluate management needs as data on management results are obtained.	4.5	1	2 years	4	SE	KNPC	---	1,500	1,500	
M7	Collect and deposit seeds into seed banks.	5.1	1	1 year	4	SE	KNPC	500	---	---	
M1	Make seeds available to organizations or institutions for propagation.	5.2	3	continuing	4	SE	KNPC	100	100	100	

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APPENDIX

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