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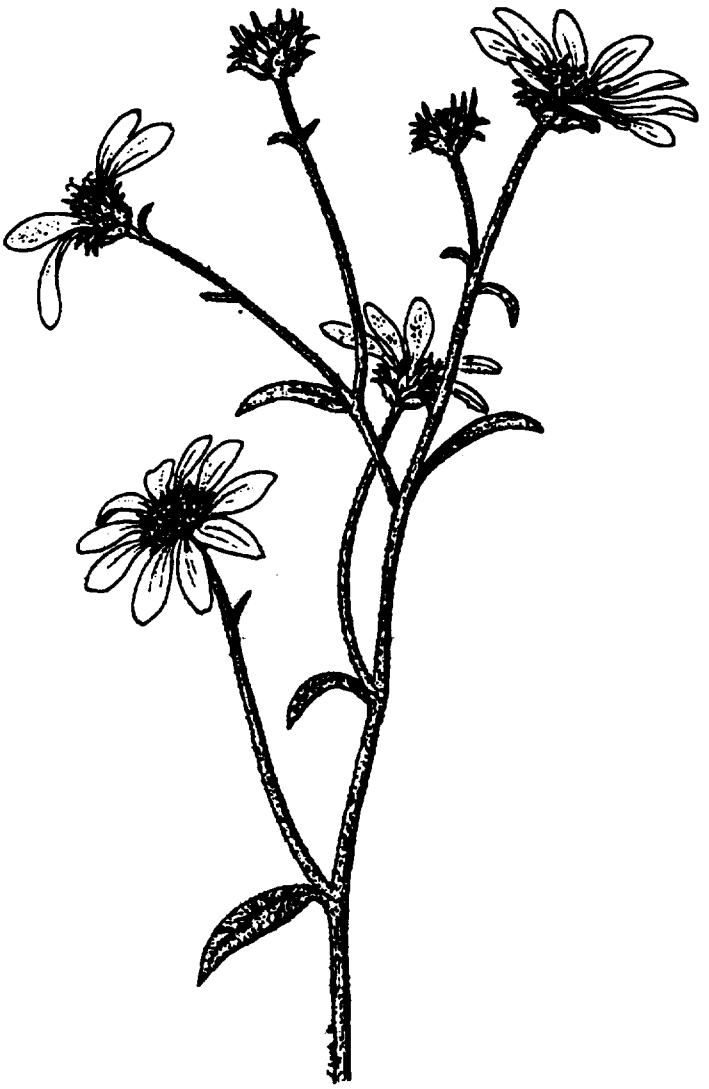
RECOVERY PLAN

Schweinitz's sunflower

(*Helianthus schweinitzii*)



U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

RECOVERY PLAN

for

Schweinitz's Sunflower (*Helianthus schweinitzii*)

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Atlanta, Georgia

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Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1994. Schweinitz's Sunflower Recovery Plan. Atlanta, GA. 28 pp.

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The cover sketch of Schweinitz's sunflower was done by freelance artist Julia Lark.

EXECUTIVE SUMMARY

Current Species Status: *Helianthus schweinitzii* is listed as endangered. Thirty-five populations are known--nineteen from North Carolina and sixteen from South Carolina. All occurrences are centered around Charlotte, North Carolina, and Rock Hill, South Carolina.

Habitat Requirements and Limiting Factors: Schweinitz's sunflower is currently known from roadsides, power line clearings, old pastures, woodland openings, and other sunny to semi-sunny situations. It is generally located on poor, clayey (montmorillonitic), and/or rocky soils, especially those derived from mafic rocks. Formerly, it probably occurred in prairielike habitats or post oak-blackjack oak savannas maintained by fires set by lightning and native Americans. Loss of this open habitat to fire suppression and urbanization has resulted in the decline of the species and its reduction to marginal and very vulnerable sites.

Recovery Objective: Reclassification to threatened, followed by delisting.

Recovery Criteria: *Helianthus schweinitzii* will be considered for reclassification from endangered to threatened when 10 geographically distinct, self-sustaining populations are protected in at least four counties in North Carolina and one county in South Carolina; managers have been designated for each population; management plans have been developed and implemented; and populations have been maintained for 5 years. Furthermore, at least seven of these populations must be in natural habitats, in permanent conservation ownership and management. Delisting the species will be considered when at least 15 geographically distinct, self-sustaining populations are protected in at least four counties in North Carolina and one county in South Carolina; management plans have been implemented; populations (as measured by number of adult plants) have been stable or increasing for 10 years; and permanent conservation ownership and management of at least 10 populations is assured by legally binding instruments.

Actions Needed:

1. Implement emergency protective management of known remnant populations.
2. Survey suitable habitat for additional populations and potential reintroduction sites.
3. Protect viable populations through a range of protection tools (management agreements, acquisition, registry, cooperative agreements, etc.).
4. Monitor existing populations.
5. Conduct research on the biology of the species and on suitable management tools for maintaining the natural ecosystem in which it occurred.
6. Implement management on protected populations.

Total Estimated Cost of Recovery ($000's): It is not possible to determine costs beyond estimates for the first few years; future costs will depend on the results of research conducted early in the recovery plan.

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Total
1994	15.0	15.0	40.0	20.0	20.0	15.0	125.0
1995	15.0	20.0	35.0	10.0	10.0	15.0	105.0
1996	20.0	25.0	35.0	10.0	10.0	20.0	120.0
TOTAL	50.0	60.0	110.0	40.0	40.0	50.0	350.0

Date of Recovery: Impossible to determine at this time.

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PART I

INTRODUCTION

Description

Schweinitz's sunflower (*Helianthus schweinitzii*) was federally listed as endangered on May 7, 1991 (U.S. Fish and Wildlife Service [Service] 1991). This species, endemic to the piedmont of North Carolina and South Carolina, is endangered by the loss of historic levels of natural disturbance from fire and grazing by native herbivores, residential and industrial development, mining, encroachment by exotic species, highway construction and improvement, and roadside and utility right-of-way maintenance.

Schweinitz's sunflower (*Helianthus schweinitzii* Torrey and Gray) is a perennial species of the sunflower genus (*Helianthus* Linnaeus), a large genus of the aster family (*Asteraceae*), which is one of the largest and most familiar families of flowering plants. Like some other members of the genus, Schweinitz's sunflower has thickened, tuberous rhizomes (resembling sweet potatoes), which store starch and are the perennating structure for the species. Generally, the species is about 2 meters in height but can be substantially shorter if young, stressed, or injured (mowed plants can flower at less than 0.5 meters) or substantially taller (plants in full sun and with little competition frequently reach 3 meters and, exceptionally, 5 meters). The stem is usually unbranched in its lower portion (unless the stem apex is injured or removed, as by mowing), but the terminal one-third of the stem (in the inflorescence) is freely branched, with the branches departing from the stem at about a 45-degree angle. The stem is usually pubescent but can be nearly glabrous; it is often purple (Kral 1983, Radford 1968).

Heiser *et al.* (1969), in the most recent monograph of the genus *Helianthus*, placed *H. schweinitzii* in Section *Divaricati*, Series *Gigantei*. Its closest relatives include other members of the *Gigantei* series, such as *H. giganteus* Linnaeus, *H. maximiliani* Schrader, *H. resinosus* Small, and *H. grosseserratus* Martens. The small heads, however, make *H. schweinitzii* anomalous in the Gigantei. Partly as an explanation of its small heads, Heiser *et al.* (1969) mentioned the possibility that *H. schweinitzii* is an allohexaploid, involving *H. giganteus* and a small-headed species, such as *H. microcephalus* Torrey and Gray, a member of Section *Divaricati*, Series *Microcephali*. Anashchenko (1979) also suggested the allohexaploid nature of *H. schweinitzii*, considering it to reflect allopolyploidization between two rather distantly related protogenomes, the "*angustifolius*" protogenome (two gene complements) and the "*mollis*" protogenome (one gene complement), but this hypothesis has not been tested. In any case, the placement of *H. schweinitzii* in established series in *Helianthus* is problematic, owing to its probable allohexaploid evolution. Based on data currently available, it would appear that the closest relatives of *H. schweinitzii* are *H. giganteus*, *H. microcephalus*, *H. smithii*

Heiser, and *H. laevigatus* Torrey and Gray. Characteristics that distinguish *H. schweinitzii* from these species are given below.

The leaves are opposite on the lower stem, changing to alternate above. Characteristically, they are borne at a right angle to the stem, with the tip often drooping. In shape, they are lanceolate, wider near their bases, but variable in size, being generally larger on the lower stem, and gradually reduced upward. Lower stem leaves average 10 to 20 centimeters (cm) long and 1.5 to 2.5 cm wide, about 5 to 10 times as long as wide. Upper stem leaves (subtending branches of the inflorescence) average about 5 cm long and 1 cm wide. Leaf margins are entire or with a few obscure serrations and are generally also somewhat revolute. The leaves are rather thick and are stiff in texture. The pubescence of the leaves is distinctive and is one of the best characters to distinguish Schweinitz's sunflower from its relatives. The upper surface of the leaf is scabrous (rough), with the broad-based spinose hairs directed toward the tip of the leaf. The lower surface is more or less densely pubescent, with soft white hairs nearly obscuring the leaf surface.

Compared to most sunflowers in eastern North America, Schweinitz's sunflower has relatively small heads (as the apparent "flowers," which are actually aggregates of many small, specialized flowers, are called). The disk is 6 to 15 millimeters (mm) across and the disk/flowers are yellow. The involucral bracts are narrow and acute, with their tips spreading to some degree. Toward the tip, the bracts have ciliate margins, and they are pubescent on the exposed surface. The nutlets are 3.3 to 3.5 mm long and are glabrous, with rounded tips. The pappus consists of two awns, 1 to 1.7 mm long (shorter than in most other species of the genus in the area), which usually drop from the nutlet before its maturity.

The following combination of characters separates *H. schweinitzii* from all other species of *Helianthus* in eastern North America: heads small (the involucre less than 1.5 cm across), stems at least sparsely strigose or hirsute below the inflorescence, leaves sessile to short-petiolate (petiole less than 1.5 cm long, very rarely to 3 cm long), scabrous above, with dense soft white hairs below, lanceolate, broadest near base, 5 to 10 times as long as wide. *H. schweinitzii* is a distinctive species, with a unique combination of characteristics, and its taxonomic validity is unquestionable. *Helianthus* is a fairly difficult genus, however, and misidentifications or confusion involving *H. schweinitzii* and some other members of the genus have occurred. A direct comparison of *H. schweinitzii* to the most similar species may therefore prove useful.

Helianthus laevigatus Torrey and Gray is very similar in architecture, head size, and leaf size and shape. It differs from *H. schweinitzii* in having the stems smooth (rather than strigose), leaves slightly scabrous above (rather than strongly scabrous), leaves nearly glabrous beneath (rather than densely pubescent with

soft white hairs), and a short rhizome or fibrous roots (rather than a rhizome with a cluster of tuberous roots).

Helianthus microcephalus Torrey and Gray often occurs with *H. schweinitzii*. It differs in having the stems smooth and often glaucous (rather than strigose); leaves petiolate, with the petiole 1 to 3 cm long (rather than sessile to short-petiolate, with the petiole up to 1.5 cm long); leaves broadly lanceolate, 2 to 6 cm wide (rather than lanceolate, generally 1 to 2 cm broad); and a long rhizome (rather than a rhizome with a cluster of tuberous roots).

Helianthus smithii Heiser is sometimes submerged in *H. microcephalus* (as by Cronquist 1980) but was considered a valid species by Heiser *et al.* (1969) and by Kartesz (in press). It resembles *H. schweinitzii* in the size of the heads and the size and shape of its leaves and the short petioles. It differs in lacking the tuberous-thickened roots, in having the stem glabrous and glaucous (rather than at least sparsely hirsute or strigose), and in having the leaves glabrous or sparsely pubescent beneath. It is apparently allopatric to *H. schweinitzii*, known only from a few sites in the Mountains and Piedmont of Georgia and Alabama.

Helianthus angustifolius has narrow leaves, rarely more than 1 cm wide, and 10 to 30 times as long as wide (rather than 1.5 to 2.5 cm wide; 5 to 10 times as long as wide); the heads are somewhat larger, 1.5 to 2 cm wide (rather than 1 to 1.5 cm wide); and the disk/flowers are normally red, rarely yellow (rather than always yellow).

Helianthus glaucophyllus D. M. Smith, endemic to the mountains of North Carolina and Tennessee, is allopatric to *H. schweinitzii*. It can be distinguished by its leaves, which are glabrous and glaucous beneath and lack resin dots.

Helianthus divaricatus Linnaeus is sympatric with *H. schweinitzii*. It has a smooth stem beneath the inflorescence (rather than strigose); leaves broadly lanceolate, 1 to 8 cm wide (rather than 1.5 to 2.5 cm); leaves 3 to 6 times as long as wide (rather than 5 to 10 times); leaves opposite (rather than opposite below, alternate above); and leaves scabrous above and sparsely pubescent beneath (rather than scabrous above and densely pubescent beneath).

Other *Helianthus* species are readily distinguished by a variety of characters. Nearly all other species of eastern North America have larger heads (more than 1.5 cm wide)

In surveying for *H. schweinitzii* during its blooming period (September through October), one will encounter other genera in the aster family with yellow flowers superficially resembling a sunflower. In addition to technical characters, they may be distinguished in the following ways (useful even at a distance and from a moving car): (1) Species of *Bidens* and *Coreopsis* occurring in the range of *H. schweinitzii* all have lobed or divided leaves;

(2) *Bidens aristosa* (Michaux) Britton is frequently seen, but occupies wetter sites (occurring in roadside ditches or wet pastures) than *H. schweinitzii* and has a shorter and bushier habit (rarely more than a meter tall); (3) *Coreopsis major* Walter occurs in similar sites but is a smaller plant, less than a meter tall, and has the leaves opposite, with each leaf divided into three leaflets (looking like a whorl of six leaves); (4) Yellow-flowered *Verbesina* are of similar height but occur in denser stands in more mesic sites, lack the open branching in the inflorescences, have flowers of a richer yellow (the color of egg yolks), and have winged stems.

Distribution

Schweinitz's sunflower is presently believed to occur only in the lower Piedmont of south-central North Carolina and north-central South Carolina. The currently recognized range centers around Charlotte, North Carolina; all extant populations are within a radius of about 100 kilometers (60 miles) of that city. There have been, however, past reports of the species from other parts of North and South Carolina, including Columbus County, North Carolina, and Horry County, South Carolina (both in the outer Coastal Plain), and Stokes County, North Carolina (in the upper Piedmont of North Carolina near the Virginia border). The alleged North Carolina Coastal Plain populations were relocated, and they proved to be narrowleaf sunflower (*Helianthus angustifolius* Linnaeus). Because the alleged South Carolina population was found by the same collector, it is very likely that it also is narrowleaf sunflower. The alleged Stokes County population has not been relocated; it appears to have been extirpated, and its correct identity may remain obscure. The species has also been reported from Georgia and Alabama (Small 1933), but these reports have been determined to be erroneous (Service 1991).

Excluding erroneous or dubious records, the known county distribution is Montgomery, Rowan, Stanly, Cabarrus, Mecklenburg, Davidson, and Union Counties, North Carolina, and York County, South Carolina.

Habitat

Schweinitz's sunflower is documented to occur only in a relatively small area approximately centered around Charlotte, North Carolina. The geology and soils of this area appear to be an important determining factor in the occurrence of Schweinitz's sunflower.

Two main geologic belts cross the area of occurrence of *H. schweinitzii*--the Charlotte Belt and the Carolina Slate Belt. The Charlotte Belt, the more western of the two belts, consists largely of intrusive igneous rocks, ranging widely in age (from Late Proterozoic to Permian) and composition (from granite to gabbro). Most of the occurrences of Schweinitz's sunflower in the Charlotte Belt are on mafic plutons, including gabbro of the Concord Plutonic Suite (Silurian in age) and metagabbro (of Late Proterozoic to Cambrian age).

The Carolina Slate Belt consists of sedimentary and volcanic rocks of Late Proterozoic to Cambrian age that have been mildly deformed and metamorphosed. This belt is also geologically complex, containing a variety of ages and compositions of rocks. Schweinitz's Sunflower appears to occur on a number of formations within the belt, including the Cid Formation (thin-bedded metamudstones), the Flat Swamp Member of the Cid Formation (felsic and basaltic lava flows and mud flows), the Uwharrie Formation (felsic and locally mafic metavolcanic rocks), the Floyd Church Formation (siltstones and mudstones), phyllites, mafic tuffs and flowrock, and on metagabbro and metabasalt intrusions. Although *H. schweinitzii* substrates in the Carolina Slate Belt are primarily mafic rocks (of either volcanic, plutonic, or sedimentary origin), the species also appears to occur on intermediate and even felsic rocks.

A unifying characteristic of all these rock types is that they are highly weatherable, generally contain low amounts of resistant minerals such as quartz, and generally weather to fine-textured soils (often with a large percentage of montmorillonitic clays having a high shrink-swell capacity) occurring in a landscape of subdued topography. Schweinitz's sunflower appears to be notably absent from granite, metamorphosed granite, metamorphosed quartz diorite, quartzite, and other granitic rocks present in some abundance in parts of most of the counties in the species' range.

On upland flats and gentle slopes where *H. schweinitzii* generally occurs, soils are generally shallow and clayey and, when weathered from metasedimentary rocks, often contain large quantities of slaty rock fragments. *Helianthus schweinitzii* is known from a variety of soil types, including Iredell (Fine, Montmorillonitic, Thermic Typic Hapludalf); Enon (Fine, Mixed, Thermic Ultic Hapludalf); Badin (Clayey, Mixed, Thermic Typic Hapludult); Cecil (Clayey, Kaolinitic, Thermic Typic Hapludult); Misenheimer (Loamy, Siliceous, Thermic Shallow Aquic Dystrochrept); Gaston (formerly known as Lloyd--Clayey, Mixed, Thermic Humic Hapludult); and Zion (Fine, Mixed, Thermic Ultic Hapludalf). It may also occur on other soils, including Tatum, Cid, Secrest, Georgeville, Mecklenburg, and Uwharrie (it occurs in proximity to mapped units of these series). Additionally, some of the soils mapped in soil surveys may be incorrect or may have inclusions of other soil types on which Schweinitz's sunflower actually occurs. Also, some changes in soil taxonomy have occurred (such as the splitting of the Zion Series from Iredell), such that older soil surveys will not have used the same series definitions as newer series.

Though it is found primarily on soils derived from mafic rocks, *H. schweinitzii* apparently also occurs on soils derived from intermediate or felsic rocks. The main unifying factors in all the soils appears to be that they are thin, occur on upland interstream flats or gentle slopes, are clayey in texture (and often also with

substantial rock fragments), and (because of their topographic position and texture) vary over the course of the year from very wet to very dry..

This set of conditions makes these soils (and sites) poor for agricultural use. Schweinitz's sunflower's preference for these poor soils has probably helped it, over the past two centuries, to survive the general conversion of the landscape of the Carolina Piedmont to agricultural uses. Many of these soils also present difficulties for various urban and suburban uses because of their high clay content. For these reasons, Schweinitz's sunflower has not been as severely affected as it might have been by the more recent urbanization and suburbanization of the region in which it occurs.

This same set of soil conditions also has a bearing on the likely natural habitat of *H. schweinitzii*. Many early accounts of the Charlotte area described open prairies and blackjack oak-post oak savannas and woodlands (Service 1991, Nelson 1992). Following the settling of the area by Europeans, historical accounts referred to the increasing amount of dense forest and brush. It is almost certain that fire was the primary force that maintained the openness of the prairies and oak savannas found in the Charlotte area in the eighteenth century and earlier. The primary ignition source for the fires was probably lightning, striking upland areas during summer and fall droughts. In much of the Charlotte Belt and parts of the Carolina Slate Belt, the nature of the underlying rock has resulted in the weathering of a landscape consisting of very broad upland flats. In other words, the "natural fire compartments" would have been relatively large, in some cases up to 20 to 30 square kilometers uninterrupted by stream valleys that would serve as "firebreaks." Under conditions in which fires could have been ignited by lightning strikes, fires would likely have burned over these fairly extensive areas, and could also have jumped to other "fire compartments."

Native Americans living in the area probably used fire as a land management and hunting tool, and they may have significantly augmented the natural fire frequency in the area. The Waxhaws, a Siouxan group closely related to the Catawbas, apparently occupied the Charlotte area at the time of early European contact. During the mid-eighteenth century, the area around Charlotte became a refuge for remnant tribes decimated by disease and cultural disintegration (Dan Simpkins, Idaho State University, personal communication, 1992). Any Native American traditional use of fire (for hunting, land management, removal of undergrowth, promotion of berry crops or fresh plant growth) may have continued longer in the area of Union and Mecklenburg Counties, North Carolina, and York County, South Carolina, than in most other parts of the Carolina Piedmont (Simpkins, personal communication, 1992). Evidence of Native American use of fire in the Carolinas is, however, largely circumstantial.

Grazing by native herbivores may also have played a role in maintaining the open structure of the plant communities. Historical accounts refer to bison in the Charlotte area, and a number of creeks in that part of the Piedmont are known as "Buffalo Creek." Elk also grazed in this area (Service 1991).

Because these soils also present difficulties for the rapid and dense growth of vegetation, they have tended to remain somewhat sparsely vegetated, even in the absence of forces which naturally operated to keep them open, such as fire and grazing. Probably the single most important habitat characteristic of Schweinitz's sunflower is its need for protection from shade and excessive competition from other vegetation (Larry Barden, University of North Carolina at Charlotte, personal communication, 1992; Meredith Bradford-Clebsch, Native Gardens, personal communication, 1992; Jim Matthews, University of North Carolina at Charlotte, personal communication, 1992). With fire operating in the landscape to maintain open and semi-open habitats (Piedmont prairies and oak barrens or oak savannas), it is possible that Schweinitz's sunflower had a wider ecological amplitude than is apparent to us in the modern landscape. In other words, the remnant sites in which the species now occurs may not be representative of the full range of situations in which it would have occurred 200 years ago. In addition to the difficult sites in which it has been able to persist in the absence of fire, Schweinitz's sunflower may formerly have occupied sites with moister, more fertile, and loamier soils that are more hospitable to plant growth.

As discussed above, *H. schweinitzii* is usually found in open habitats not typical of the current general landscape in the Piedmont of the Carolinas. It is associated with a variety of plants, some also rare or uncommon, some with affinities to glade and prairie habitats of the Midwest, some associated with fire-maintained sandhills and savannas of the Coastal Plain, and other generalist species also found in wooded situations of the Piedmont. The habitat of *H. schweinitzii* tends to be dominated by members of the families *Asteraceae*, *Fabaceae*, and *Poaceae*, an association emphasizing affinities of the habitat to both longleaf pine-dominated sandhills and savannas of the Southeastern Coastal Plain and to glades, barrens, and prairies of the Midwest and Plains. Typical associates include: *Andropogon gerardii* (big bluestem), *Andropogon* spp., *Aster concolor*, *A. georgianus* (Georgia aster), *A. linariifolius*, *A. patens*, *A. paternus*, *A. solidagineus*, *Baptisia tinctoria* (wild indigo), *Coreopsis major* (coreopsis), *Danthonia sericea* (oat grass), *Desmodium lineatum* (tick trefoil), *Desmodium* spp., *Gnaphalium helleri* var. *helleri* (cudweed); *Juniperus virginianus* var. *virginiana* (eastern red cedar); *Lotus helleri* (birdsfoot trefoil), *Muhlenbergia capillaris* (muhly grass), *Parthenium integrifolium* (wild quinine), *Quercus stellata* (post oak), *Q. marilandica* (blackjack oak), *Ratibida pinnata* (coneflower), *Schizachyrium scoparium* (little bluestem), *Silene caroliniana* (wild pink); *Sorghastrum nutans* (Indian grass), *Taenidia integerrima* (yellow pimpernell), and *Tephrosia virginiana* (goat's rue); other sunflowers, including *Helianthus atrorubens*,

H. divaricatus, *H. microcephalus*, and *H. strumosus*; blazing stars, including *Liatris graminifolia* and *L. squarrosa* var. *squarrosa*; rosin weeds, including *Silphium compositum* and *S. terebinthinaceum*; and goldenrods, including *Solidago nemoralis*, *S. ptarmicoides*, and *S. rigida* ssp. *glabrata*.

In the few sites where Schweinitz's sunflower occurs in relatively natural vegetation, the natural community would be considered a Xeric Hardpan Forest (Schafale and Weakley 1990). As stated by Schafale and Weakley (1990):

> The natural structure and dynamics of these communities is uncertain. Most now have a nearly closed canopy. Reproduction occurs in canopy gaps...Succession is slowed by the unfavorable site conditions. Although the natural fire frequency is not known, it was certainly greater than now. With normally dry conditions and a grassy herb layer, these sites would have been susceptible to fire almost any time there was ignition. Fire of even moderate frequency would likely have combined with the dry site conditions to reduce tree reproduction and increase grass dominance, producing a more open, or even prairie-like, vegetation structure than is now seen. Fire would have had greater effects on the vegetation structure on these unfavorable sites than in adjacent, more mesic hardwood forests...The occurrence of a number of species associated with Xeric Hardpan Forests but occurring largely in pastures, roadsides, and other chronically disturbed areas supports the idea of a naturally more open vegetation structure.

Life History/Ecology

Limited information is currently available on the life history or species biology of Schweinitz's sunflower. It is a long-lived perennial, with individuals probably living for decades. The species blooms from late August to frost. The relative importance of sexual (by seed) and asexual (by rhizome) reproduction is not known in this species. From observations, it seems that populations are generally fairly stable in numbers and area, as would be expected of a species with a conservative strategy.

A demographic study of two populations is currently in progress, with Larry Barden as principal investigator and funded by the Service and The Nature Conservancy. This study involves the detailed mapping and measurement of height of individuals of *H. schweinitzii*. Because active management of parts of both sites is ongoing, data gathered should provide information on the demographics, establishment, and vigor of *H. schweinitzii* under a variety of conditions (Barden, personal communication, 1992; Margit Bucher, The Nature Conservancy, personal communication, 1992). An additional study, funded by the South Carolina Natural Heritage Trust, is being initiated; the second author of this recovery plan is the principal investigator. The

study will focus on monitoring and detailed mapping of populations in South Carolina, experimental work on growing the species from seed, and developing voluntary conservation and management agreements with the landowners.

The fact that most extant populations are on road rights-of-way might lead one to conclude that the species is weedy; i.e., able to colonize new sites through mobile seeds. Nearly 10 years of careful observations of populations by staff of the North Carolina Natural Heritage Program (many populations visited yearly for that period) indicate, however, that populations do not spread under the generally prevailing conditions. Most newly discovered populations appear to be well-established and are old; they were simply unknown. There is some recent information that suggests that Schweinitz's sunflower can colonize recently disturbed ground immediately adjacent to an existing population, but this requires confirmation (Roy Coomans, North Carolina Agricultural and Technical University, personal communication, 1992). The second author of this plan believes that at least a few of the populations he has found in South Carolina are the result of either the establishment of an entirely new population from a distant seed source or the result of the colonization of a newly created open habitat (such as a new road bank or power line right-of-way) by plants in the immediate vicinity which had been suppressed by shade. Our current knowledge does not allow us to distinguish between these two hypotheses.

Schweinitz's sunflower produces viable seeds, which germinate readily in a greenhouse. There appears to be no dormancy requirement, and stratification is not necessary (Robert McCartney, Woodlanders, personal communication, 1992; John Nelson, University of South Carolina, personal communication, 1992). Under greenhouse or nursery conditions, a flowering plant of 1 to 2 meters in height can be raised from seed within a year (Bradford-Clebsch, personal communication, 1992; Mike Creel, South Carolina Wildlife and Marine Resources Department, personal communication, 1992; McCartney, personal communication, 1992; Nelson, personal communication, 1992). Plants do best in full sun and, where shaded to a significant degree, seem to lose vigor, though they can persist for many years in partial shade (Barden, personal communication, 1992; Bradford-Clebsch, personal communication, 1992; McCartney, personal communication, 1992). They also appear to be detrimentally affected by growing in dense competing vegetation, even if the other vegetation does not shade them (Bradford-Clebsch, personal communication, 1992). The mechanism of this would presumably be root competition for scarce and limiting resources, such as water and nutrients. The largest plants of this species seen (about 5 meters tall) were in full sun on a south-facing railroad embankment with bare clay soil and essentially no competing vegetation.

Seedling establishment has not yet been studied under field conditions. Experiments are underway, funded by the University of North Carolina at Charlotte and conducted by Larry Barden, to study

seedling establishment in the field at the Gar Creek and Mineral Springs populations (Barden, personal communication, 1992; Bucher, personal communication, 1992). The second author will also study seed germination and seedling establishment in an artificial population established on the grounds of Winthrop University.

Small plants transplanted to a power line right-of-way from greenhouse conditions had poor survivability, but the reasons for this are unknown (Nelson, personal communication, 1992). The plants used were root-bound, and the transplantation was done when soils at the site were waterlogged (Bradford-Clebsch, personal communication, 1992). It is also probable that the seedlings were physiologically poorly prepared for the difficult conditions into which they were transplanted. While it is difficult to determine how significant the results of this experiment are, it appears that reintroduction efforts involving transplantation may not be easy and may require more than ordinary efforts to assure their success. Seedlings appear to grow very slowly under at least some natural field conditions (Barden, personal communication, 1992).

Schweinitz's sunflower can also be propagated from pieces of the tubers. New plants readily sprout from entire or partial tubers (Creel, personal communication, 1992). The second author has grown plants from tubers that remained unplanted for a month.

Threats and Conservation Measures

The reasons for listing Schweinitz's sunflower were carefully enumerated by the Service (1991). They include habitat destruction, curtailment of range, loss of known populations, fire suppression and alteration of native habitat, highway right-of-way maintenance, urbanization and suburbanization of the area of occurrence of the species, inadequacy of existing protection afforded by State laws, small population size, and lack of formal protection for all but a few of the known populations.

Schweinitz's sunflower has been afforded endangered status by both the Service and the North Carolina Department of Agriculture's Plant Conservation Program (Sutter 1990, Weakley 1991). However, such listing, in and of itself, provides only limited protection to the species. For instance, neither Federal nor North Carolina law protects the species from destruction by the landowner himself. Moreover, Schweinitz's sunflower does not occur in a static habitat that can be left alone; it requires active management to maintain optimal habitat.

Despite its listing, *H. schweinitzii* continues to be detrimentally affected by a variety of forces. The Charlotte metropolitan area continues to grow at a rapid rate, and more and more of the habitat of *H. schweinitzii* is being converted to suburban and urban uses. Several populations have been bulldozed in recent years for road improvements, pasture development, and clearing for building sites.

At least one North Carolina population has apparently succumbed in the last few years to a lack of management, being shaded out under a power line by various shrubs, including nonnative and aggressive weed species such as *Ligustrum sinense* (privet). In addition to the direct impacts of urban and suburban development, future management of populations of *H. schweinitzii* by fire (likely the management tool of choice) is made more difficult (or even impossible) by the proximity of developed land and/or roads because of fire safety and smoke dispersion regulations.

Most of the remaining populations are on highway rights-of-way, in both North Carolina and South Carolina. While mowing serves to maintain the open habitat needed for the sunflower, mowing at certain seasons can limit seed production and thus the potential reproduction and recovery of the species. For instance, in 1991 nearly all South Carolina populations were mowed in August or September, severely limiting seed production because the mowed plants did not flower or fruit. Most populations were mowed again in early August of 1992; it is anticipated that these individuals also will not produce seeds.

In 1988, the North Carolina Natural Heritage Program initiated a cooperative effort with the North Carolina Department of Transportation (NCDOT) and the Service to prevent the mowing of *H. schweinitzii* populations during the flowering and fruiting period of August through October. Biologists from the three agencies visited and marked with stakes a "no-mow" zone to be observed by NCDOT mowing operations during the reproductive period for the species. These efforts have (to date) been almost totally unsuccessful, with mowing of nearly all populations occurring annually during the "no-mow" period. This has resulted in reduced seed production of populations in North Carolina. At least one population was also bulldozed by NCDOT as part of a paving project, and other roadside populations (though on an NCDOT right-of-way) were partially or completely destroyed by bulldozing by adjacent private landowners. Although efforts to provide protection and appropriate management for *H. schweinitzii* populations persisting on highway rights-of-way have been redoubled and will (it is hoped) result in at least partial success, the experience of agencies so far indicates that such populations are inherently highly vulnerable. The recovery of *H. schweinitzii* cannot be based on remnant populations persisting on highway rights-of-way.

In North Carolina, one population and a portion of another are on land managed by The Nature Conservancy. A management agreement with private landowners at Gar Creek, Mecklenburg County, provides limited protection for one population. The long-term protection of this population is not, however, assured. The Nature Conservancy established the management agreement in 1988. Management of the site, an old field, was initiated in 1992, after monitoring revealed a decline in the population of *H. schweinitzii*, apparently resulting from old-field succession. Initial management has consisted of the cutting of encroaching trees and shrubs to eliminate or reduce

shading and competition. Follow-up management will consist of controlled burns to further reduce encroaching woody vegetation. Management techniques used at this site are being carefully monitored and studied to determine their effectiveness (Barden, personal communication, 1992; Bucher, personal communication, 1992). Preliminary results show a great increase in the vigor of individual *H. schweinitzii* plants following the cutting of competing woody vegetation (Barden, personal communication, 1993).

One of the largest known populations of *H. schweinitzii* occurs at Mineral Springs Barren, near Mineral Springs, Union County, North Carolina. The population occupies a series of semi-natural, glady openings in the heart of the site and extends along an adjacent railroad right-of-way and adjacent road rights-of-way. A portion of the site, consisting of most of the glady openings, has been recently (1992) acquired by The Nature Conservancy. Management, cooperatively funded by the Service and The Nature Conservancy, by controlled burn was initiated at the site in August 1992, and results at this site will also be monitored and studied.

In South Carolina, no populations have formal protected status (Nelson, personal communication, 1992). One population is subject to an informal management agreement whereby Duke Power has agreed to mow a power line right-of-way, only after frost, in order to allow flowering and fruiting of *H. schweinitzii*.

The North Carolina Botanical Garden plans to collect seeds from all North Carolina populations of *H. schweinitzii*, following the Center for Plant Conservation's guidelines for *ex situ*. conservation of genetic material (Rob Gardner, North Carolina Botanical Garden, personal communication, 1992). If, as seems likely, currently extant populations of *H. schweinitzii* are extirpated in the future, propagules gathered and stored could be used to reintroduce the species to sites where it has been extirpated. Although such a method of conservation of the species is not ideal, it serves as a prudent backstop for a highly vulnerable species such as Schweinitz's sunflower.

Strategy for Recovery

The recovery strategy should involve further inventory for viable populations of Schweinitz's sunflower. Particularly important will be locating or establishing additional populations in natural habitat or in sites where natural habitat can be successfully and realistically restored and then managed and maintained.

PART II

RECOVERY

A. Recovery Objectives

Helianthus schweinitzii will be considered for reclassification from endangered to threatened when 10 geographically distinct, self-sustaining populations are protected in at least four counties in North Carolina and one county in South Carolina; managers have been designated for each population; management plans have been developed and implemented; and populations have been maintained for 5 years. Furthermore, at least seven of these populations must be in natural habitats in permanent conservation ownership and management. Delisting the species will be considered when at least 15 geographically distinct, self-sustaining populations are protected in at least four counties in North Carolina and one county in South Carolina; management plans have been implemented; populations (as measured by number of adult plants) have been stable or increasing for 10 years; and permanent conservation ownership and management of at least 10 populations are assured by legally binding instruments.

This recovery objective is considered an interim goal because of the lack of data on the biology and management requirements of the species. The number of self-sustaining populations required for the species' survival may require reassessment as we learn more about the species' biology, former and current range, and habitat requirements.

B. Narrative Outline

1. Implement emergency protective management of known remnant populations. Only 35 populations of Schweinitz's sunflower are currently known, all in a small area of North Carolina and South Carolina in the general vicinity of Charlotte, North Carolina. Many of these are highly vulnerable to destruction or detrimental management. In fact, nearly all populations have been subject to some form of detrimental management in 1991 or 1992, or both years, ranging from bulldozing, mowing in late summer through fall leading to partial or total failure of seed production, or unmanaged succession leading to excessive competition. Continuation of these forms of detrimental management may easily lead to extirpation of some of the few populations remaining, the further endangerment of the species, and, potentially, its extinction from the wild. It is critical to provide better protection for remnant populations. The great majority of these populations is on land owned and managed by the Departments of Transportation of the States of North Carolina and South Carolina. Mowing of these populations at inappropriate times of the year should be prevented, while assuring that yearly burning or bush-hogging of the sites (at appropriate times) does take place in order to control competing vegetation. In addition, collection of seeds or rhizomes (using the Center for Plant Conservation's standards) from all known populations should be accomplished in order to preserve the full genetic diversity of the species and provide material for reintroductions in the event of the extirpation of populations.

2. Survey suitable habitat for additional populations and potential reintroduction sites; reestablish populations within the species' historic range. Detailed and comprehensive surveys for additional populations are needed. The focus should be on locating remnant populations or suitable reintroduction sites in natural or semi-natural conditions where populations will be viable and can be managed practically and realistically. Searches should use standard tools, such as soils maps, geological maps, and aerial photography. Populations in remnant glades, prairies, oak savannas, or xeric hardpan forests will be especially difficult to locate and will require extensive use of aerial photography or reconnaissance. These populations, however, will offer far superior opportunities for long-term viability.

   Transplantation and reintroduction should be undertaken only after the genetic composition of the individual populations is known. As a general rule, restoration of extirpated populations should maximize genetic variation through the

use of material from several maternal sources and by using a sufficient number of propagules (at least 50 survivors) to prevent genetic drift or inbreeding depression. Populations with the highest genetic diversity should be the primary source. Techniques for propagation and transplantation of this species should be summarized and disseminated to appropriate organizations and individuals. Reintroduction efforts should be conducted in cooperation with knowledgeable personnel at private nurseries, botanical gardens, and the Center for Plant Conservation. Transplant sites must be closely monitored to determine success and to adjust methods of reestablishment.

3. Protect viable populations through a range of protection tools (management agreements, acquisition, registry, cooperative agreements, etc.). The full range of protection tools will likely need to be used for this species. Fee acquisition, tax-free land exchanges, signed management agreements, registry, and interagency memoranda of understanding have already been employed to provide protection of this species. Because of the need for active management of the habitat of Schweinitz's sunflower, permanent means of protection (such as fee simple acquisition or conservation easements), accompanied by a long-term commitment to the provision of active stewardship/management of the site, is needed to assure population viability. Resources of a variety of agencies and private conservation organizations may be available.

4. Monitor existing populations. Annually monitor the size and vigor of known populations. This monitoring should include counts (and, in some cases, mapping) of all individuals in the population and (in some populations) seedling plots. Monitoring of populations will provide information on the efficacy of various management techniques.

5. Conduct research on the biology of the species and on suitable management tools for maintaining the natural ecosystem in which it occurs. A basic understanding of the biology of Schweinitz's sunflower is needed in order to manage populations of the species and to successfully recover it. A partial list of topics that need research includes habitat parameters (soils, geology, sun/shade, competition, etc.), reproductive biology (pollination, seed production, asexual reproduction via rhizomes and tubers, conditions and requirements for seedling establishment, etc.), demographics, and management techniques.

6. Maintain cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation. Maintaining the genotypes of small, isolated populations in cultivation should be of high priority. Vegetative propagules or seed should be collected as soon as possible from all populations that are still healthy enough to tolerate such harvest. The Center for Plant Conservation has expressed interest in helping maintain and expand cultivated sources. A ready source of cultivated material should ease the threat of taking from wild populations.

7. Implement management of protected populations. The exact management techniques to be used will be determined by research conducted in earlier steps. Preliminary information leads us to expect that periodic controlled burning in more natural sites and either controlled burning or occasional bush-hogging in roadside sites will likely be needed.

8. Enforce laws protecting the species and/or its habitat. Schweinitz's sunflower is not currently known to be a significant part of the horticultural trade, although it is offered for sale by a few native plant nurseries. A ready source of cultivated material should ease the threat of taking from wild populations. However, until this source is available, taking of plants from the wild could become a threat. The Endangered Species Act prohibits taking of the species from Federal lands without a permit and regulates trade. However, *H. schweinitzii* does not occur on Federal lands. Section 7 of the Act provides additional protection of the habitat from impacts related to federally funded or authorized projects. In addition, for listed plants, the 1988 amendments to the Act prohibit: (1) their malicious damage or destruction on Federal lands and (2) their removal, cutting, digging, damaging, or destroying in knowing violation of any State law or regulation, including State criminal trespass law.

   Schweinitz's sunflower is listed as endangered in North Carolina, where State law prohibits taking of the species without a permit and the landowner's written permission and regulates trade in the species (North Carolina General Statute 19-B, 202.12-202.19). The State of South Carolina lists the species as threatened and of National Concern. South Carolina, however, offers no legal protection to State-listed plants (Rayner *et al.* 1984).

9. Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of Schweinitz's sunflower could play an important part in encouraging landowner assistance and conservation efforts. This is especially true for the

populations that occur in areas being adversely affected by development associated with expanding urban areas. Information materials should not identify the plant's locations so as not to increase the threat of taking.

9.1 Prepare and distribute news releases and informational brochures. News releases concerning the status and significance of the species and recovery efforts should be prepared and distributed to major newspapers in the range of the species, as well as to smaller newspapers in the vicinity of the species' habitat.

9.2 Prepare articles for popular and scientific publications. The need to protect the species in its native habitat and cooperation among local, State, and Federal organizations and individuals should be stressed. Scientific publications should emphasize additional research that is needed and solicit research assistance from colleges and universities that have conducted studies on this or closely related species.

10. Annually assess success of recovery efforts for the species. Review of new information, evaluation of ongoing actions, and redirection, if necessary, are essential for assuring that full recovery is achieved as quickly and efficiently as possible.

C. Literature Cited

Anashchenko, A. V. 1979. Phylogenetic relationships within *Helianthus* L. Trudy po Prikladnoi Botanike, Genetike i Selektsii 64 (2):146-156. (Only the English summary consulted.)

Cronquist, A. 1980. Vascular flora of the Southeastern United States: Volume I, *Asteraceae*. University of North Carolina Press, Chapel Hill, NC. 261 pp.

Heiser, C. B., Jr., D. M. Smith, S. B. Clevenger, and W. C. Martin, Jr. 1969. The North American sunflowers (*Helianthus*). Mem. Torrey Bot. Club 22 (3):1-218.

Kartesz, D. A. In press (publication expected in 1993). A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. Timber Press, Portland, OR.

Kral, R. 1983. A report on some rare, threatened, or endangered forest-related vascular plants of the South. Forest Service, Southern Region Technical Publication R8-TP 2.

Nelson, J. 1992. The vanishing blackjacks. South Carolina Wildlife 39(2):34-39.

Radford, A. E., H. E. Ahles, and C. R. Bell. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill, NC. 1,183 pp.

Rayner, D., C. Aulbach-Smith, W. Batson, and C. Rodgers. 1984. Rare and endangered plants of South Carolina. South Carolina Heritage Trust, Columbia, SC.

Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina, third approximation. North Carolina Natural Heritage Program, Raleigh, NC. 325 pp.

Small, J. K. 1933. Manual of the Southeastern flora. University of North Carolina Press, Chapel Hill, NC. 1,554 pp.

Sutter, R. D. 1990. List of North Carolina's endangered, threatened, and candidate plant species. Plant Conservation Program, North Carolina Department of Agriculture, Raleigh, NC.

U.S. Fish and Wildlife Service. 1991. Endangered and threatened wildlife and plants; determination of *Helianthus schweinitzii* (Schweinitz's sunflower) to be an endangered species. Federal Register 56(88):21087-21091.

Weakley, A. S. 1991. Natural Heritage Program list of the rare plant species of North Carolina. North Carolina Natural Heritage Program, Raleigh, NC. 69 pp.

PART III

IMPLEMENTATION SCHEDULE

Priorities in column one of the following Implementation Schedule are assigned as follows:

1. Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

2. 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.

3. Priority 3 - All other actions necessary to meet the recovery objective.

Key to Acronyms Used in This Implementation Schedule

CPC - Center for Plant Conservation
TE - Endangered Species Division of the U.S. Fish and Wildlife Service
FWS - U.S. Fish and Wildlife Service
LE - Law Enforcement Division of the U.S. Fish and Wildlife Service
R4 - Region 4 (Southeast Region), U.S. Fish and Wildlife Service
SCA - State Conservation Agencies - State plant conservation agencies of participating States. In North Carolina, these are the Plant Conservation Program (North Carolina Department of Agriculture) and the Natural Heritage Program (North Carolina Department of Environment, Health, and Natural Resources); in South Carolina, the Heritage Trust Program (South Carolina Wildlife and Marine Resources Department).

SCHWEINITZ'S SUNFLOWER IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency FWS	Responsible Agency Other	Cost Estimates ($000's) FY1	FY2	FY3	Comments
1	1	Implement emergency protective management of known remnant populations.	5 years	R4/TE	SCA	15.0	15.0	20.0	
1	3	Protect viable populations through a range of protection tools (management agreements, acquisition, registry, cooperative agreements, etc.).	Unknown	R4/TE	SCA	30.0	30.0	30.0	
1	5	Conduct research on the biology of the species and on suitable management tools for maintaining the natural ecosystem in which it occurs.	5 years	R4/TE	SCA	20.0	10.0	10.0	
1	7	Implement management of protected populations.	Unknown	R4/TE	SCA	15.0	15.0	20.0	
1	8	Enforce laws protecting the species and/or its habitat.	Ongoing	R4/TE and LE	SCA	2.0	2.0	2.0	
2	2	Survey suitable habitat for additional populations and potential reintroduction sites; reestablish populations within the species' historic range.	3 years	R4/TE	SCA, CPC	15.0	20.0	25.0	
2	4	Monitor existing populations.	Ongoing	R4/TE	SCA	20.0	10.0	10.0	
2	6	Maintain cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation.	Ongoing	R4/TE	SCA, CPC	8.0	3.0	3.0	
3	9.1	Prepare and distribute news releases and informational brochures.	Ongoing	R4/TE	SCA	2.0	1.0	1.0	
3	9.2	Prepare articles for popular and scientific publications.	Ongoing	R4/TE	SCA	1.0	0.5	0.5	
3	10	Annually assess success of recovery efforts for the species.	Ongoing	R4/TE	SCA	0.5	0.5	0.5	

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