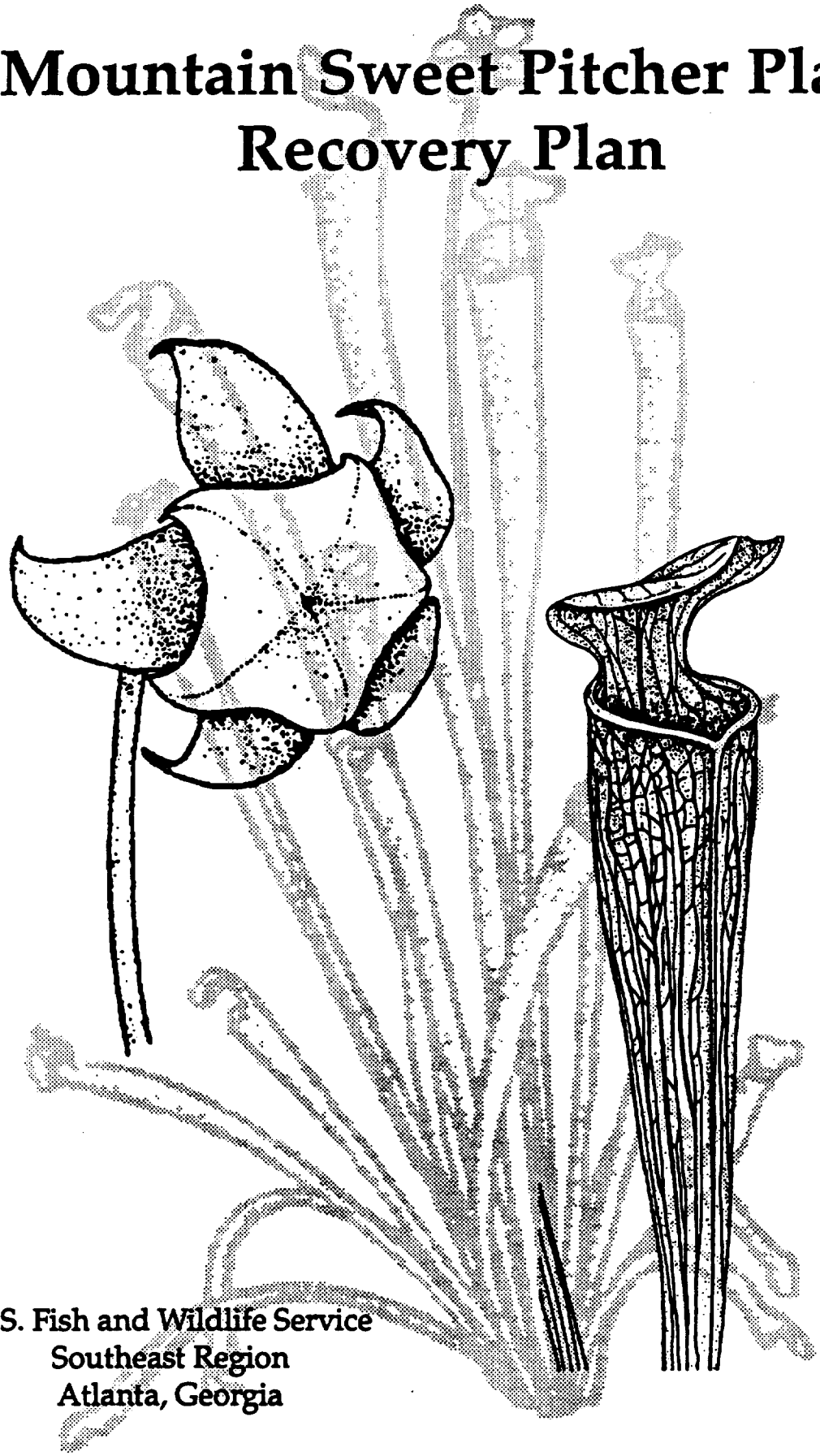
Mountain Sweet Pitcher Plant Recovery Plan



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

RECOVERY PLAN

for

Mountain Sweet Pitcher Plant
(*Sarracenia rubra* ssp. *jonesii* [Wherry] Wherry)

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Approved: _____
Regional Director, U.S. Fish and Wildlife Service

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Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1990. Mountain Sweet Pitcher Plant Recovery Plan. Atlanta, Georgia. 39 pp.

Additional copies of this plan may be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
Phone: 301/492-6403 or
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EXECUTIVE SUMMARY

Current Species Status: Sarracenia rubra ssp. jonesii is listed as endangered. There are 10 populations remaining, all within North Carolina and South Carolina; 16 sites have been destroyed. Most of the surviving populations are small, and many have been adversely altered by flooding or drainage for recreational, industrial, or agricultural development. Three of the South Carolina sites have been acquired by the State; none of the North Carolina populations are permanently protected. Plant succession threatens all populations.

Habitat Requirements and Limiting Factors: This insectivorous species is native to bogs and a few streamsides in the Blue Ridge Mountains of North Carolina and South Carolina. Other (coastal plain) species of this genus are known to benefit from periodic fire, which reduces woody competition; however there is some evidence that this mountain species may actually be harmed by fire. More research on management and biological requirements of the species is needed. Mountain sweet pitcher plant is also seriously threatened by collectors.

Recovery Objective: Delisting

Recovery Criteria: Four self-sustaining populations within each occupied drainage must be permanently protected.

Actions needed:

1. Survey suitable habitat for additional populations.
2. Monitor and protect existing populations.
3. Conduct research on the biology of the species.
4. Establish new populations or rehabilitate marginal populations to the point where they are self-sustaining.
5. Investigate and conduct necessary management activities at all key sites.

Total Estimated Cost of Recovery: Because so little is known about actions needed to recover this species, it is impossible to determine costs beyond estimates for the first few years' work (in 1,000's):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Total
1990	20	4	54	5	3.5	86.5
1991	10	3	38	25	2	78
1992	10	2	18	11	7	48
1993						
1994						
1995						
1996						
1997						
1998						
1999						
2000						

Date of Recovery: Impossible to determine at this time.

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PART I

INTRODUCTION

Mountain sweet pitcher plant (Sarracenia rubra Walter ssp. jonesii [Wherry] Wherry) is a rare insectivorous plant native to bogs in the Blue Ridge Mountains of North Carolina and South Carolina. Due to its rarity and vulnerability to threats, the species was federally listed as endangered on September 30, 1988 (U.S. Fish and Wildlife Service 1988). Sarracenia rubra ssp. jonesii is officially listed (as Sarracenia jonesii) as "endangered - special concern" by the North Carolina Department of Agriculture's Plant Conservation Program (North Carolina Plant Conservation Program, 1990). The species is recognized in South Carolina (as Sarracenia jonesii) as "endangered and of national concern" by the South Carolina Committee on Rare, Threatened, and Endangered plants (Rayner et al. 1984). It is included in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Current and Historical Distribution

Mountain sweet pitcher plant is endemic to a few mountain bogs and streams in southwestern North Carolina and northwestern South Carolina along the Blue Ridge Divide. Only 10 populations are currently known to exist--four are in the French Broad River drainage in Henderson and Transylvania Counties, North Carolina, five are in the Saluda River

drainage in Greenville County, South Carolina, and one is in the Enoree River drainage in Greenville County, South Carolina. The species has also been reported from Buncombe County in North Carolina, but it is not currently known to survive there. Sixteen populations have been extirpated. Because of the extreme rarity of this species and its vulnerability to collectors, locations of extant populations are not specified in this plan.

Description, Ecology, and Life History

Mountain sweet pitcher plant is one of eight species in the genus Sarracenia which occur primarily on the coastal plain of the Southeastern United States (Bell 1949). Only S. r. ssp. jonesii, S. oreophila, and S. purpurea occur outside the coastal plain (McDaniel 1971). S. r. ssp. jonesii is widely disjunct from the other members of the S. rubra complex. S. purpurea is the only sympatric Sarracenia that shares the montane habitat of mountain sweet pitcher plant. The taxonomy of this genus is extremely complex, with extensive natural hybridization documented (Bell 1952, McDaniel 1971). There has been substantial disagreement about the taxonomic classification of Sarracenia rubra ssp. jonesii, with different authors having treated it as a regional variant (McDaniel 1971), a form (Bell 1949), a subspecies (Wherry 1972; Schnell 1977, 1978), and as a distinct species (Wherry 1929, Case and Case 1976, McDaniel 1986). Nomenclature in this plan follows the most recently published determination.

Sarracenia rubra ssp. jonesii was first described by E. T. Wherry (1929) from material collected in North Carolina in 1920. It is an insectivorous, rhizomatous, perennial herb, which grows from 21 to 73 cm (8.3 to 28.7 inches) tall. The numerous erect leaves grow in clusters and are hollow and trumpet-shaped, forming slender, almost tubular pitchers (inspiration for the most frequently used common name) covered by a cordate hood. The pitchers are a waxy dull green, usually reticulate-veined with maroon-purple. The tube of the pitchers is retrorsely hairy within and often partially filled with liquid and decayed insect parts. The uniquely showy and fragrant flowers have recurving sepals, are borne singly on erect scapes, and are usually maroon in color. The species blooms from April to June, with fruits ripening in August (Massey et al. 1983, Wood 1960).

Like many other species in this genus, mountain sweet pitcher plant shows some variation within and between populations, probably due to both genetic and environmental differences. Plants growing in shade tend to be less erect and much less conspicuously color-veined. Variations in color extend to a yellow-flowered form of this species reported by Case and Case (1976). Reproduction is by seeds or by fragmentation of rhizomes (Massey et al. 1983, Wood 1960); individual rhizomes have been reported to live intact for 20 to 35 years (MacFarlane 1908, McDaniel 1971, F. Case, Saginaw, Michigan, pers. comm., 1990).

Sarracenia rubra ssp. jonesii can be distinguished from other subspecies of Sarracenia rubra by its greater pitcher height, scape length equal to

pitcher height, long petiole, abruptly expanded pitcher orifice, cordate and slightly reflexed hood, and petals and capsules which are usually twice as large as other Sarracenia rubra (Massey et al. 1983, Sutter 1987, Case and Case 1976, Wherry 1929).

Other common names of pitcher plants include trumpets, bugle-grass, bog-bugles, dumb-watches, watches, buttercups, Eve's cups, biscuit flowers, frog bonnets, fly bugles, and huntsman's cups (Wood 1960, Radford et al. 1964, Massey et al. 1983). The many common names are illustrative of the fascination engendered by these unique organisms. The evolutionary role of carnivory in such plants is not fully understood, but some evidence indicates that absorption of minerals from insect prey may allow carnivorous species to compete in nutrient-poor habitats (Folkerts 1977). Insects are attracted by nectar secreted from glands near the pitcher orifice, or by the plant's coloration, and fall or crawl into the pitchers. Just inside the mouth of the pitcher tube is a very smooth surface, offering no foothold to most insects; below this, the pitcher is lined with stiff downward-pointing hairs which assist descent and virtually prevent ascent. Those insects which cannot escape are eventually digested by enzymes in the fluid secreted inside the pitchers (Folkerts 1977, McDaniel 1971, Givnish 1988).

The habitat of mountain sweet pitcher plant consists of mountain bogs and streamsides, usually on soils of the Toxaway silt loam or Hatboro loam series. These soils are deep, poorly drained combinations of loam, sand, and silt, with a high organic matter content and medium to highly acidic

pH. Most sites occur in level depressions associated with floodplains; however, a few occur in "cataract bog" or "waterslide" situations, where sphagnum and other typical bog species line the sides of waterfalls on granite rock faces. The hydrology of the sites can be described as intermittently exposed to intermittently flooded (Schafale and Weakley 1985, U.S. Department of Agriculture 1980).

Bogs occupied by this species are typically dominated by herbs and shrubs but may have scattered trees such as red maple (Acer rubrum), hemlock (Tsuga canadensis), pitch pine (Pinus rigida), white pine (Pinus strobus), and, at high elevations, red spruce (Picea rubens). A dense shrub understory often alternates with open patches of sedges, forbs, and sphagnum. Dominant shrub species include poison sumac (Rhus vernix), alder (Alnus serrulata), willow (Salix sericea and S. humilis), chokeberry (Sorbus arbutifolia), rhododendron (R. maximum), azalea (R. viscosum), swamp rose (Rosa palustris), viburnum (V. cassinoides), lambkill (Kalmia angustifolia), mountain laurel (K. latifolia), St. John's-wort (Hypericum densiflorum), male-berry (Lyonia ligustrina), and minnie-bush (Menziesia pilosa). Herbs include sedges (Carex leptalea, C. muricata, C. folliculata, and occasionally C. collinsii), twigrush (Cladium mariscoides), beak rush (Rhynchospora alba), bulrush (Scirpus expansus), golden ragwort (Senecio aureus), marsh fern (Thelypteris palustris), rush (Juncus effusus), Gray's lily (Lilium grayi [a category 2 candidate for Federal listing]), grass-of-Parnassus (Parnassia grandifolia), cotton grass (Eriophorum virginicum), saxifrage (Saxifraga pensylvanica), cowbane (Oxypolis rigidior), coreopsis

(Coreopsis gladiata), skunk cabbage (Symplocarpus foetidus), golden club (Orontium aquaticum), and sphagnum (S. palustre, S. imbricatum, S. bartlettianum, and S. recurvum). Other dominant bryophytes include Polytrichum commune, Mnium appalachianum, Aulacomnium palustre, and Bazzania trilobata (Schafale and Weakley 1985).

These shrub-dominated communities are early successional types and must be maintained at this disclimax in order for mountain sweet pitcher plants to thrive. Historically the bogs probably were kept open by severe droughts, water fluctuation, periodic fires, ice damage, climatic extremes, and other forms of natural disturbance. In the South, other species of the genus Sarracenia are well adapted to moderate fires which remove old growth, reduce competition, and help induce flowering (McDaniel 1971). In recent times widespread fire suppression has resulted in substantial changes to much Sarracenia habitat. More information is needed on the relationship (if any) between mountain sweet pitcher plant and natural fire.

The Sarracenias form the exclusive food for a number of moths including Olethreutes (which feeds upon the flowers and seeds), Papaipema (a rhizome-borer), and three species of Exyra (which eat the leaves). Other insects are known to live in the pitchers, including two harmless species of mosquito, a Sarcophagan fly, a gnat, and a Sciarid fly (Wood 1960, Folkerts 1982). There may be some insect species restricted to S. r. ssp. jonesii, in which case, they also are in danger of extinction (Thomas Gibson, University of Wisconsin, pers. comm., 1990).

Threats and Population Limiting Factors

The most serious threat to mountain sweet pitcher plant is the destruction or degradation of its small wetland habitats, which has already resulted in the elimination of the species from 62 percent of the known originally occupied sites. Sixteen populations have been extirpated due to drainage; impoundment; cultivation and intensive grazing; natural succession; and development for recreational, residential, and industrial facilities. The single most significant threat to this plant is recreational development (particularly golf courses).

The importance of moderate periodic fires to other members of this genus is well documented for coastal plain species (McDaniel 1971, Folkerts 1977, Barker and Williamson 1988); fire is necessary to reduce the encroachment of competing plants and to stimulate the growth of pitcher plants and many other bog inhabitants. Decades of fire suppression have resulted in heavy litter accumulations, which in turn can fuel catastrophic wildfires that damage or kill species normally considered to be fire tolerant. Such fires, coupled with prior drainage, can lead to the complete elimination of these carnivorous species from a site within a decade (Folkerts 1977). The role played by fire in the montane habitat of *S. r.* ssp. *jonesii* is not known; although wildfires may have served historically to create openings for colonization, there is some evidence that direct burning of this subspecies may be detrimental (F. Case, pers. comm., 1990).

Channelization of adjacent streams can result in destruction of hydrological integrity, even if the bog itself is not directly targeted. The deepening and widening of the stream channel often causes a lowering of the local water table, which results in drying of the bog habitat and acceleration of shrub succession. Site conversion to "productive" uses, such as row crops or improved pasture, usually follows. Many historically known populations have been destroyed by this means.

In addition to maintaining open habitat, severe drought is also a potential threat; the effects of the successive drought years of 1986, 1987, and 1988, on this species are presently unknown. However, there have been observations of populations being decimated by severe drought in the late 1970's, then later recovering to former vigor (T. Gibson and F. Case, pers. comm., 1990). It is not known if the plants in such populations survive as rhizomes or if they recolonize the habitat from seedbanks.

Collecting by amateur plant enthusiasts, professional botanists, and commercial horticulturists continues to be a problem for carnivorous plants, even though cultivated sources are available for almost all species. Recently, additional pressure on the Sarracenias (including S. leucophylla, a category 2 candidate for Federal listing [Bruce MacBryde, U.S. Fish and Wildlife Service, pers. comm. 1990]) has come from commercial florists who use the dried "pitchers" in floral arrangements. A counterpoint to this perceived threat is that the commercial demand for pitchers has resulted in some landowners' placing

increased value on their pitcher plant bogs, preserving the habitat and managing it for the benefit of the species (F. Case, pers. comm., 1990). However, for species like mountain sweet pitcher plant, with very few wild populations remaining, indiscriminate collecting could easily result in the extinction of the species.

Many of the remaining mountain sweet pitcher plant sites are in close proximity to agricultural fields, pastures, and orchards. Accidental herbicide drift or runoff from these areas, or from adjacent power line maintenance operations, could result in damage or destruction of these tiny populations. To protect the plants at these sites, it will be important to encourage adjacent landowners to use herbicides with extreme care and at the lowest effective application rates, avoiding aerial applications whenever possible. In addition to threats from herbicides, fertilizer runoff can put unwanted nutrients in the bog, enrich the soil, and cause pitcher plants to rot (T. Gibson, pers. comm., 1990), as well as potentially causing adverse pH alterations.

Conservation Efforts

Eight of the 10 remaining populations of mountain sweet pitcher plant are located on privately owned lands. The U.S. Fish and Wildlife Service, along with the South Carolina Wildlife and Marine Resources Department, the North Carolina Natural Heritage Program, The Nature Conservancy, and the North Carolina Plant Conservation Program, is working with these private landowners to protect and manage the sites. One of the North

Carolina sites is now a Registered State Natural Area, and the owners are managing the land for the benefit of the species. One of the South Carolina sites is owned by the South Carolina Department of Parks, Recreation, and Tourism, which is aware of the presence of the plants and is protecting them. Two additional sites in that State have been acquired by the South Carolina Wildlife and Marine Resources Department, and negotiations are currently underway for acquisition of a third. Conservation agencies in both States, along with the U.S. Fish and Wildlife Service, are actively conducting surveys of potential habitat in hopes of finding and protecting additional populations of S. r. ssp. jonesii or of finding good sites for reintroduction.

PART II

RECOVERY

A. Recovery Objectives

Mountain sweet pitcher plant (Sarracenia rubra ssp. jonesii) will be considered for delisting when there are at least four self-sustaining populations within each occupied drainage (French Broad, Enoree, and Saluda Rivers) that are protected to such a degree that the subspecies no longer qualifies for protection under the Endangered Species Act (see criteria below). A self-sustaining population is a reproducing population that is large enough to maintain sufficient genetic variation to enable it to survive and respond to habitat changes. The number of individuals necessary (determined at least in part through genetic analysis) and the quantity and quality of habitat needed to meet this criterion will be determined as one of the recovery tasks.

This recovery objective is considered an interim goal, because of the lack of specific data on biology and management requirements of the species. The goal may be adjusted up or down at a later date as additional information is acquired that allows for refinement of the estimate of populations required to ensure the continued survival of mountain sweet pitcher plant. This objective will be reassessed at

least annually in light of any new information that becomes available.

The first step toward recovery will be protection and management of all extant populations of mountain sweet pitcher plant to ensure their continued survival. Although biological requirements for some of the other species in this genus have been studied, little is known about S. r. ssp. jonesii. Therefore, before extrapolating management recommendations for other species to this one, it will be necessary to conduct detailed demographic studies and ecological research for the purpose of gaining the understanding needed to develop appropriate protection and management strategies. The ultimate effects of various kinds of habitat disruption must be determined and prevented; active management necessary to ensure continued survival and vigor must be defined and carried out. Therefore, mountain sweet pitcher plant shall be considered for removal from the Federal list when the following criteria are met:

1. It has been documented that at least four populations within each occupied drainage (Enoree, French Broad, and Saluda Rivers) are self-sustaining and that necessary management actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival.

2. All 12 of the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations.

B. Narrative Outline

1. Protect existing populations and essential habitat. Only 10 populations of mountain sweet pitcher plant are currently known to exist, all within the Blue Ridge Mountains of North Carolina and South Carolina. Until more is known about the species' biology and specific habitat requirements, and about the measures necessary to protect the hydrology of occupied sites, all existing populations should be protected. The long-term survival of 12 populations (approximately 40 percent of those historically known) in three watersheds (requiring reestablishment or discovery of additional populations) is believed to be essential to the recovery of the species as a whole.

1.1 Develop interim research and management plans in conjunction with landowners. Except for extrapolation from studies of other species in this genus, little is known about specific management practices necessary to ensure the long-term survival of mountain sweet pitcher plant. Therefore, immediate emphasis will be on protection (e.g., prevention of drainage and other site alterations which are known to be detrimental), in cooperation with the landowners, until appropriate management procedures have been developed through research. Ongoing experiments being conducted in cooperation with one private landowner in North Carolina

involve cutting of competing shrubs followed by prescribed burning. Pre- and post-management demographic studies, as well as maintenance of control plots, should provide important insights into management needs at this and other mountain sweet pitcher plant sites.

For populations in close proximity to areas where pesticides are used, landowners should be encouraged to use only the most target-specific herbicides available, at the lowest effective application rates, and to avoid aerial applications. Monitoring of these populations should include data on the distance from nearest agricultural or right-of-way area, type of pesticide used, and number of applications of each. Site protection plans should take into account topographic features and drainage systems that would facilitate movement of pesticide residues from adjacent treated areas to the low-lying areas inhabited by mountain sweet pitcher plant.

1.2 Search for additional populations. Although several intensive searches for mountain sweet pitcher plant have been conducted within parts of the historic habitat, a thorough systematic effort to locate additional populations is still needed (very small populations, consisting of only a few plants, particularly at overgrown sites, are easily missed in less intensive efforts). The North Carolina

Natural Heritage Program recently funded a survey of mountain bogs in the State, which will include documentation of all rare species found. Searches should be preceded by an examination of soil and topographic maps and aerial photographs to determine potential habitat and to develop a priority list of sites to search.

1.3 Determine habitat protection priorities. Because of the small number of existing populations and the pervasive threats to the habitat, it is essential to protect as many as possible. However, efforts should be concentrated first on the sites in protective ownership, or where current private landowners are cooperative, and where the largest and most vigorous populations occur. This strategy is being followed in acquisition efforts currently underway by the South Carolina Wildlife and Marine Resources Department. An understanding of natural bog formation and destruction processes and longevity is also essential to this effort. In "last resort" situations where a population is imminently threatened and all other methods of protecting the habitat have failed, plans for immediate rescue of the plants should be devised.

1.4 Evaluate habitat protection alternatives. The greatest possible protection should be obtained for those existing populations which are considered critical to the recovery of

mountain sweet pitcher plant. Fee simple acquisition or conservation easements provide the greatest degree of protection. However, it is unknown as yet how much buffer land around each population is necessary to protect the hydrological integrity of occupied sites. Protection through management agreements or short-term leases may provide adequate short-term protection but should only be considered as intermediate steps in the process of ultimately providing for permanent protection. Short-term protection strategies may be necessary if private landowners are not agreeable to, or monies are not available for, acquisition of conservation easements, hydrologic easement, or fee simple title. Conservation agreements with adjacent landowners or owners of rights-of-way (power companies) should be developed to prevent inadvertent adverse alterations of the habitat.

2. Determine and implement management necessary for long-term reproduction, establishment, maintenance, and vigor. Protection of habitat for S. r. ssp. jonesii is the obvious first step in ensuring its long-term survival, but this alone will not be sufficient. Even though initial emphasis will be on protecting existing populations, reintroduction of the species to sites from which it has been extirpated will also be pursued. Although Case and Case (1976) state that members of the Sarracenia rubra complex are somewhat more shade tolerant than other species in

this genus, management of the habitat will undoubtedly be necessary to allow mountain sweet pitcher plant to successfully perpetuate its life cycle over the long term. However, additional information on the population biology and ecology of this rare plant is necessary before effective management guidelines can be formulated and implemented.

2.1 Determine population size and stage-class distribution for all populations. Population size and stage-class distribution data are essential to predicting what factors may be necessary for populations to become self-sustaining (Menges 1987). Data on these characteristics are needed for the existing populations and for any newly discovered populations.

2.2 Study abiotic and biotic features of the species' habitat. An understanding of the hydrology of the habitats occupied by mountain sweet pitcher plant is essential to the long-term survival and recovery of mountain sweet pitcher plant. Monitoring studies should include populations within a wide range of habitats, both altered and undisturbed, since population dynamics may vary within these different habitats. Permanent plots should be selected and established to determine the relationship between abiotic factors (such as soil depth and type, frequency and depth of inundation, and light intensity) and biotic factors (such as

reproduction, germination, and degree of competition and predation). This information is necessary to determine appropriate timing and type of management for ensuring the continued vigor of existing populations and to accurately select good potential sites for reintroduction.

The vectors of seed dispersal must be determined and their effectiveness under different ecological and spatial conditions assessed. At least some seed dispersal is by water; however, little else is known, including how far seeds can be dispersed by this vector and others and what conditions are optimal for dispersal. Major pollinators need to be determined and protected. Bumblebees have been observed to be the major pollinators for some other species in the Sarracenia rubra complex (Case and Case 1976), but the pollinators and pollination mechanisms of S. r. ssp. jonesii remain unidentified. The relative importance of sexual and vegetative reproduction to the long-term survival of mountain sweet pitcher plant is unknown and must be determined for effective management and protection to take place.

Relationships with competing species must be investigated. It is believed that competition from invading species was controlled historically by some periodic natural disturbance such as drought or possibly fire, and by continuous

saturation of the sites occupied by mountain sweet pitcher plant. However, the effects of and exact interactions between mountain sweet pitcher plant and potential competitors are unknown. This information is essential to accurate timing (season and frequency) of management such as hand clearing and thinning. Fire should be used with extreme caution, if at all (and only after sufficient experimentation has proven its suitability for use with this subspecies). Direct burning has been observed to kill cultivated specimens of mountain sweet pitcher plant, while other Sarracenias growing adjacent to it benefitted (F. Case, pers. comm., 1990).

2.3 Conduct long-term demographic studies. Long-term demographic studies should be conducted in permanent plots located within each study site established for habitat analysis. Plots should be visited annually, for at least 5 to 7 consecutive years, after seed set has occurred. For this species, one measure of population vigor is an abundance of seedlings and small plants, accompanied by profuse flowering and large, upright, well-colored leaves (F. Case, pers. comm., 1990). The locations of individual plants of all stage-classes should be mapped; data should be collected for each mapped plant on sizes of pitchers and inflorescences and seed set. Larger plots, surrounding each of the smaller, more intensively measured and mapped plots,

should be monitored for seed germination and seedling establishment. Seedlings should be mapped and measured. Any changes in the habitat within each plot (soil disturbance, increases or decreases in light intensity, hydrology, etc.) should be noted at each visit (see Task 2.2 on study-site selection).

2.4 Determine the effects of past and ongoing habitat disturbance. Establishment and long-term monitoring of permanent plots may be the most effective means of assessing the effects of disturbance. Appropriate methodology for this must be determined but will likely include measurement of many of the parameters specified in Tasks 2.2 and 2.3. Light grazing by cattle has been observed to benefit mountain sweet pitcher plant, when the grazing pressure was just enough to suppress shrub succession without destroying the surface layer of sphagnum. Intensive pasturing, on the other hand, is detrimental, causing soil compaction and erosion, and raising the pH of the bogs (F. Case, pers. comm., 1990).

2.5 Define criteria for self-sustaining populations and develop appropriate habitat management guidelines based upon the data obtained from Tasks 2.2 through 2.4. There is currently insufficient data to determine what mountain sweet pitcher plant requires in order for populations to be

self-sustaining. Research as described under Tasks 2.2 through 2.4 should provide the information needed to protect and manage occupied habitat so that the continued survival of healthy populations is assured.

2.6 Implement appropriate management techniques as they are developed from previous tasks. In general, mountain sweet pitcher plant seems to benefit from the maintenance of open habitat. The best technique for accomplishing this without harming the plants remains to be determined. Once management has been implemented, long-term monitoring will have to be initiated to determine management effects.

2.7 Develop techniques and reestablish populations in suitable habitat within the species' historic range. Techniques for seed collection, germination, propagation, and transplantation of mountain sweet pitcher plant have been developed by several private nurseries and botanical gardens. Reintroduction efforts will have to be conducted in cooperation with knowledgeable personnel at such facilities. Transplant sites in native habitat must be closely monitored to determine success and to adjust methods of reestablishment. Many of the tiny populations of S. r. ssp. jonesii appear to have been genetically isolated for a long time; declines in reproductive vigor observed in these populations may be evidence of inbreeding depression

(F. Case, pers. comm., 1990). Genetic research is needed, and experimental outcrossing may be necessary to produce more vigorous propagules for reestablishment of populations in the wild.

3. Develop a cultivated source of plants and provide for long-term seed storage. There are presently several cultivated sources of mountain sweet pitcher plant, where it is artificially propagated in a closed cycle. Techniques for seed storage, germination, and maintenance of cultivated specimens have already been developed by private nurseries and botanical gardens. At least one of the latter is a cooperator with the Center for Plant Conservation. It is essential to collect and store seed or other live material from all populations to protect the genetic diversity of this species, since it is so vulnerable to extinction in the wild. Extra care must be taken when maintaining live specimens in long-term cultivation, since many Sarracenias hybridize readily if kept in close proximity. A ready source of artificially propagated material might ease the threat of taking from wild populations. However, some believe this may actually increase the existing demand; more information is needed on actual reactions of collectors.

4. Enforce laws protecting the species and/or its habitat. Pitcher plants have been collected and sold as ornamentals and curiosities for over a century (Harper 1918), and the

demand for rare species such as mountain sweet pitcher plant is particularly intense. The Endangered Species Act prohibits taking of Sarracenia rubra ssp. jonesii from Federal lands without a permit and regulates trade. 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.

Under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), export/import permits are generally required before international shipment of this plant may occur. Generally, import or export is not allowed for primarily commercial purposes unless the plants are certified as artificially propagated. In addition, interstate shipment of plants taken in violation of any existing laws (including state and local) becomes a Federal violation under the Lacey Act.

The State of North Carolina 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 offers no legal protection for plants.

The considerable commercial demand for this rare species has resulted in removal of large numbers of wild plants and, in some cases, entire seed crops from populations, in spite of laws prohibiting such practices. Federal and State enforcement agents, whose jurisdiction includes the known range of mountain sweet pitcher plant, should be made aware of this threat and be able to identify specimens.

5. Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of mountain sweet pitcher plant could play an important part in encouraging landowner assistance and conservation efforts. In general, information materials should not identify the plant's locations so as not to increase the threat of taking from wild populations; alternatively, if demand arises, curious readers could be directed to botanical gardens or to one well-known and easily accessed wild population to take the pressure off other sites. Sources of artificially propagated material should be made available to collectors.

5.1 Prepare and distribute news releases and informational brochures. News releases concerning the status and significance of mountain sweet pitcher plant and recovery

efforts should be prepared and distributed to newspapers within its range. Brochures should also be developed and distributed, detailing the plant's significance and the threats to its continued existence.

5.2 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.

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

C. Literature Cited

Barker, N. G. and G. B. Williamson. 1988. Effects of a winter fire on Sarracenia alata and S. psittacina. Amer. J. Bot. 75:138-143.

Bell, C. R. 1949. A cytotaxonomic study of the Sarraceniaceae of North America. Journal of the Elisha Mitchell Scientific Society 65:137-166.

------. 1952. Natural hybrids in the genus Sarracenia. I. History, distribution, and taxonomy. Journal of the Elisha Mitchell Scientific Society 68:55-80.

Case, F. and R. Case. 1976. The Sarracenia rubra complex. Rhodora 78:270-325.

Folkerts, G. 1977. Endangered and threatened carnivorous plants of North America. IN Extinction is forever: status of endangered and threatened plants of the Americas, eds. G. T. Prace and T. S. Elias; New York Botanical Garden, Bronx, NY. Pp. 301-313.

------. 1982. The gulf coast pitcher plant bogs. American Scientist 70:260-267.

Givnish, T. J. 1988. Ecology and evolution of carnivorous plants. In W.B. Abrahamson (ed.), Plant-Animal Interactions. McGraw-Hill, New York. Pp. 243-290.

Harper, R. 1918. The American pitcher-plants. Journal of the Elisha Mitchell Scientific Society 34:110-125.

MacFarlane, J. 1908. Sarraceniaceae. IN A. Engler, Das pflanzenreich 4:110.

Massey, J., D. Otte, T. Atkinson, and R. Whetstone. 1983. An atlas and illustrated guide to the threatened and endangered vascular plants of the mountains of North Carolina and Virginia. General Technical Report SE-20. Asheville, North Carolina: USDA Forest Service, Southeastern Forest Experiment Station. Pp. 156-159.

McDaniel, S. 1971. The genus Sarracenia (Sarraceniaceae). Bulletin of Tall Timbers Research Station 9:36.

------. 1986. Taxonomic studies of Sarracenia subspecies. Contract report for U.S. Fish and Wildlife Service, Atlanta, Georgia. 15 pp.

Menges, E. 1987. Predicting the future of rare plant populations: demographic monitoring and modeling. Natural Areas Journal 6(3):13-25.

North Carolina Plant Conservation Program. 1990. List of North Carolina's Endangered, Threatened and Candidate Plant Species. North Carolina Department of Agriculture, Raleigh, NC. 18 pp.

Radford, A., H. Ahles, and C. Bell. 1964. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill. Pp. 511-512.

Rayner, D., C. Aulbach-Smith, W. Batson, and C. Rodgers. 1984. Native vascular plants--rare, threatened or endangered--in South Carolina. South Carolina Advisory Committee on Rare, Threatened and Endangered Vascular Plants. Columbia, South Carolina. 25 pp.

Schafale, M. and A. Weakley. 1985. Classification of the natural communities of North Carolina, second approximation. North Carolina Natural Heritage Program, Raleigh (unpublished).

Schnell, D. 1977. Infraspecific variation in Sarracenia rubra Walter: some observations. Castanea 42:149-170.

------. 1978. Sarracenia rubra Walter: infraspecific nomenclatural correction. Castanea 43:260-261.

Sutter, R. 1987. Sarracenia jonesii species account. North Carolina Plant Conservation Program. 4 pp.

U.S. Department of Agriculture, Soil Conservation Service. 1980. Soil survey of Henderson County, North Carolina. 89 pp.

U.S. Fish and Wildlife Service. 1988. Endangered and threatened wildlife and plants; determination of endangered status for Sarracenia rubra ssp. jonesii (mountain sweet pitcher plant). Federal Register 53(190):38470-38474.

Wherry, E. 1929. Acidity relations of the Sarracenia. Journal of the Washington Academy of Science 19:379-390.

------. 1972. Notes on Sarracenia subspecies. Castanea 37(2):146-147.

Wood, C. 1960. The genera of Sarraceniaceae and Droseraceae in the Southeastern United States. Journal of the Arnold Arboretum (XLI):152-163.

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

FWE - Fish and Wildlife Enhancement
FWS - U.S. Fish and Wildlife Service
LE - Law Enforcement, FWS
PA - Public Affairs Office, FWS
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).

IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY			COST ESTIMATES ($000'S)			COMMENTS
				FWS						
				Region	Program	Other	FY 1991	FY 1992	FY 1993	
1	1.1	Develop interim research and management plans in conjunction with landowners.	2	4	FWE	SCA	5.0	5.0	---	
3	1.2	Search for additional populations.	3	4	FWE	SCA	20.0	10.0	10.0	
1	1.3	Determine habitat protection priorities.	1	4	FWE	SCA	1.0	---	---	
1	1.4	Evaluate habitat protection priorities.	2	4	FWE	SCA	1.0	1.0	---	
2	2.1	Determine population size and stage-class distribution for all populations.	2	4	FWE	SCA	15.0	15.0	---	
2	2.2	Study abiotic and biotic features of the species' habitat.	5	4	FWE	SCA	10.0	8.0	8.0	

IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY			COST ESTIMATES ($000'S)			COMMENTS
				FWS						
				Region	Program	Other	FY 1991	FY 1992	FY 1993	
2	2.3	Conduct long-term demographic studies.	5	4	FWE	SCA	16.0	6.0	6.0	
2	2.4	Determine the effects of past and ongoing habitat disturbance.	3	4	FWE	SCA	8.0	4.0	4.0	
2	2.5	Define criteria for self-sustaining populations and develop appropriate habitat management guidelines based upon the data obtained from Tasks 2.2 through 2.4.	1	4	FWE	SCA	---	---	5.0	
2	2.6	Implement appropriate management techniques as they are developed from previous tasks.	Unknown	4	FWE	SCA	?	?	?	

IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY			COST ESTIMATES ($000'S)			COMMENTS
				FWS		Other	FY	FY	FY	
				Region	Program					
3	2.7	Develop techniques and reestablish populations in suitable habitat within the species' historic range.	5	4	FWE	SCA	---	20.0	10.0	
3	3	Develop a cultivated source of plants and provide for long-term seed storage.	3-5	4	FWE	SCA	5.0	5.0	1.0	
1	4	Enforce laws protecting the species and/or its habitat.	Ongoing	4	FWE LE	SCA	2.0	2.0	2.0	
3	5.1	Prepare and distribute news releases and informational brochures.	Ongoing	4	FWE	SCA	2.0	1.0	1.0	
3	5.2	Prepare articles for popular and scientific publications.	Ongoing	4	FWE	SCA	1.0	.5	.5	

IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (Years)	RESPONSIBLE PARTY			COST ESTIMATES ($000'S)			COMMENTS
				FWS		Other	FY	FY	FY	
				Region	Program					
3	6	Annually assess success of recovery efforts for the species.	Ongoing	4	FWE PA	SCA	.5	.5	.5	

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