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CANBY'S DROPWORT

Recovery Plan

RECOVERY PLAN

for

Canby's Dropwort (*Oxypolis canbyi* [Coulter & Rose] Fernald)

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

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Recovery plans delineate reasonable actions that are believed to be required to recover and/or protect the 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. Canby's Dropwort Recovery Plan. Atlanta, Georgia. 25 pp.

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Cover Illustration by: Robert Kral, 1981. Notes on Some "Quill" -Leaved Umbellifers; Sida 9(2):124-134.

EXECUTIVE SUMMARY

Current Species Status: *Oxypolis canbyi* is listed as endangered. There are 25 populations remaining; 9 have been destroyed. Of the 25 extant populations, most were severely affected by the droughts of the late 1980s. Only three plants now survive north of the Carolinas. Four sites have been acquired for preservation; however, even these are not completely protected from the broad-scale alterations of groundwater hydrology and habitat that threaten all remaining populations.

Habitat Requirements and Limiting Factors: This species is native to the coastal plain of Delaware, Maryland, North Carolina, South Carolina, and Georgia, where it occupies pond cypress savannas, the shallows and edges of cypress/pond-pine sloughs, and wet pine savannas. Maintenance of these shallowly flooded, open habitats depends upon a stable groundwater regime and protection from adverse alterations such as ditches, dams, etc. Reproductive requirements of the species are not fully understood.

Recovery Objective: Delisting

Recovery Criteria: Fourteen of the extant populations must be protected from habitat destruction (particularly hydrological alterations), and five additional populations must be found, reestablished, or (in the case of populations that are now marginal) augmented to the point where they can be self-sustaining. All 19 populations needed for recovery must be determined to be self-sustaining and 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 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	7	61	5	8.5	101.5
1991	10	3.5	61	25	4.5	104
1992	10	3.5	21	11	9.5	55
1993						
1994						
1995						
1996						
1997						
1998						
1999						
2000						

Date of Recovery: Impossible to determine at this time.

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PART I

INTRODUCTION

Canby's dropwort (Oxypolis canbyi) is a rare plant native to the coastal plain of Delaware, Maryland, North Carolina, South Carolina, and Georgia, where it occupies pond cypress savannas, the shallows and edges of cypress/pond-pine ponds, sloughs, and wet pine savannas. Due to its rarity and vulnerability to threats, the species was federally listed as endangered on February 25, 1986 (U.S. Fish and Wildlife Service 1986). Oxypolis canbyi is officially listed as endangered by the States of Maryland and North Carolina, as threatened by the State of Georgia, and as threatened and of national concern by the State of South Carolina.

Current and Historical Distribution

Only 25 populations of Canby's dropwort are currently known to exist. Nine populations are known to have been extirpated. The distribution by State and County of extirpated and extant populations is as follows:

STATE	COUNTY	EXTIRPATED POPULATIONS	EXTANT POPULATIONS
DE	Sussex	1	0
MD	Queen Anne's	0	1
NC	Scotland	0	1
SC	Allendale	0	1
	Bamberg	0	1
	Barnwell	0	2
	Berkeley	1	1
	Clarendon	0	4
	Colleton	0	1
	Hampton	1	1
	Lee	0	1
	Orangeburg	0	1
	Richland	0	1
	Williamsburg	0	1
GA	Burke	2	0
	Dooly	0	4
	Lee	3	4
	Sumter	1	0
	Total:	9	25

Description, Ecology, and Life History

Canby's dropwort is one of five Southeastern species in the exclusively American genus Oxypolis. It is a perennial herb which grows 0.8 to 1.2 meters (2.6 to 3.9 feet) tall. The stems are erect or ascending, terete, slender but stiffish, and arise from scaly buds at the tips of the previous year's rhizomes, as well as from the first, second, or third nodes. Perennation from the nodes occurs most often in wetter habitats or following damage to the stem. Stems usually branch only well above mid-stem, with the branches arching-ascending and forking or ternately rebranching. The "quill-like" leaves are slender, terete, hollow, and septate (Kral 1981, Boyer 1988). The compound umbels of small five-parted flowers appear from mid-August to October with white petals and pale green sepals, some of which are tinged with red or pink. The five sepals are triangular-subulate, mostly about 0.5 mm (0.02 inch) long, rarely persisting on ripe fruit. The five petals are each about 1.2 to 1.3 mm (0.04 to 0.05 inch) long and short-clawed (Kral 1983, Radford et al. 1964, Gleason 1952). The fruit is a schizocarp about 4 to 6 mm (0.16 to 0.24 inch) long, broadly obovoid or ellipsoidal, and strongly compressed dorsoventrally. The medial surface over the seed cavity is often sparsely but evidently muricate (Tucker et al. 1983). The lateral margins of the fruit are expanded into thick, corky wings (one of the best distinguishing features of this species [Tucker, et al. 1983]). The rootstock of Canby's dropwort is very distinctive and, along with the mature fruit, is one of the features that distinguishes this species from similar ones such as Oxypolis filiformis (Walt.) Britt. Kral (1981) describes the rhizome and the vegetative reproductive capability of the plant as follows:

> "The rootstock of O. canbyi is a fairly slender, ascending rhizome that develops as a branch bud from [the] rather deep-set, slender, forking horizontal rhizome. This ascending rhizome expands distally into an erect, purplish or pinkish, short-internoded, fistulose stem base which is usually submersed or imbedded in peat-muck and which produces from its close-set nodes whorls both of roots and lax, elongate, pale, stoloniferous rhizomes, some several decimeters in length and which root at their distant nodes to produce new plants. In short, this is a strongly cloning species which can in some cases become an aspect dominant."

Oxypolis canbyi was originally described as a variety of the more common O. filiformis (Coulter and Rose 1900). Fernald (1939) later elevated the taxon to a full species based on differences in leaf and fruit characters. Kral (1981) and Tucker et al. (1983) agree with Fernald's taxonomic judgement.

Oxypolis canbyi can be confused with two other taxa in the family Apiaceae--Ptilimnium nodosum and O. filiformis. Ptilimnium nodosum can be distinguished from O. canbyi by its much smaller terete and wingless

fruits and by the difference in flowers. In Ptilimnium, the petals are incurved at the tips only; in Oxypolis the entire petal blade is strongly incurved.

The following table was developed by Aulbach-Smith (1985) from information in Kral (1983) and Tucker et al. (1983) for distinguishing O. canbyi from O. filiformis:

Character	O. canbyi	O. filiformis
Perennating organs:	stoloniferous rhizomes	crown buds
Lower internodes:	suffused with pink or purple	usually green
Primary rays of the umbel:	5 to 9, rarely more	10 to 20
Fruits:	dorsally flattened with dilated margins (i.e., thickest at the edges)	dorsally flattened with wings thinnest at the edges

(The differences in rhizomes and fruits are considered the most reliable distinguishing characters [Franz and Boyer 1987].)

Oxypolis canbyi has been found in a variety of coastal plain habitats, including natural ponds dominated by pond cypress, grass-sedge dominated Carolina bays, wet pine savannas, shallow pineland ponds, and cypress-pine swamps or sloughs. Bowling (1986) found that in Georgia, habitats occupied by this species were usually at the heads of small drainages leading off broad flat "ridges" of higher ground between larger drainages. The largest and most vigorous populations have been found to occur in open bays or ponds that are wet throughout most of the year but which have little or no canopy cover. Soils are sandy loams or acidic peat-mucks underlain by clay layers which, along with the slight gradient of the areas, result in the retention of water. Soil types known to support Canby's dropwort include Rembert loam, Portsmouth loam, McColl loam, Grady loam, Coxville fine sandy loam, and Rains sandy loam. All of these soil types are characterized by medium to high organic content and high water table; they are also deep, poorly drained, and acidic (Aulbach-Smith 1985). Most observers agree that an important key to the ecology of the species and the determination of management requirements is an understanding of the species' relationship with depth and duration of the water table over time. Bowling (1986) stated that natural drainage in areas supporting O. canbyi is often accomplished only through underground channels or by evaporation, and he found evidence of infrequent and shallow (5 to 30 cm [2 to 12 inches]) inundations at sites occupied by the species. The plant's water requirements are narrow;

either too much or too little water present on the site can be detrimental (Rayner et al. 1987). As might be expected, sites with what appears to be optimum habitat (water levels, soil types, topographic position, and canopy characteristics as described above) are less affected by severe droughts than sites supporting less than optimum habitat for this species. For instance, two populations of Canby's dropwort in South Carolina were being monitored during the severe drought of 1986. One of these was an apparently optimum site in Bamberg County; the other was a marginal site in Colleton County. The water level in the Bamberg County site dropped to only 13 inches below the surface during this time, while the water table at the Colleton County site dropped 70 inches below the surface. The Colleton County population went from over 500 plants in 1982 to fewer than 5 in 1986, presumably as a result of the effects of the drought. The Bamberg County site, on the other hand, showed only an insignificant decrease in plant numbers during this time (Rayner 1988). Boyer (1988) observed similar negative effects of this drought on the single extant North Carolina population of O. canbyi, where the number of stems declined by 80 percent from 1986 to 1987. Fruit production in the remaining plants was also drastically affected. The single remaining Maryland population was similarly affected, declining from 200 plants in the mid-1980s to only 7 plants during the severe drought of 1988. The drought was followed by an extremely wet year in 1989, and the population declined again to only three plants. Although there has been no fruit set in Maryland O. canbyi in recent years, soil cores have been taken to search for banked seed.

At most of the extant sites, common associates of Canby's dropwort include the following species; Taxodium ascendens (usually composing an open canopy), Ilex cassine var. myrtifolia, Myrica cerifera, Clethra alnifolia, Nyssa biflora, Pinus serotina, Rhynchospora spp., Rhexia aristosa, Carex walteriana, Polygala cymosa, Pluchea rosea, Hypericum denticulatum, Woodwardia virginica, Erianthus strictus, E. giganteus, Sarracenia flava, Iris spp., Andropogon sp., Panicum hemitomon, Centella asiatica, Lachnanthes caroliniana, Pontederia lancifolia, Nymphaea odorata, Aristida affinis, Agalinis linifolia, Manisuris rugosa, and Stillingia aquatica. Boone et al. (1984) rediscovered O. canbyi on the Delmarva Peninsula in 1982, where the species had been considered extirpated since Canby's last collection in 1894. At this northernmost locality, the habitat is dominated by Carex walteriana, Cladium mariscoides, and Panicum hemitomon. Other associated species at the Maryland site include Sagittaria engelmanniana, Panicum verrucosum, P. longifolium, Erianthus giganteus, Eleocharis microcarpa, E. melanocarpa, Juncus canadensis, Hypericum adpressum, H. virginicum, Ludwigia sphaerocarpa, Proserpinaca pectinata, Utricularia geminisarpa, Cephalanthus occidentalis, Acer rubrum, Liquidambar styraciflua, and Diospyros virginiana. In addition, Canby's dropwort sometimes occurs with other rare species, some of which are federally listed or are candidates for Federal listing, including Lobelia boykinii, Rhexia aristosa, and, less commonly, Ptilimnium nodosum (listed as endangered) and Ilex amelanchier.

Very little specific information is available on the life history and population biology of Canby's dropwort. Boyer (North Carolina Plant Conservation Program, personal communication, 1988) has successfully grown plants from rhizomes in continuously inundated beds, but she has not been successful in germinating seeds (however, only a small number of seeds were available for the project). The rhizomes do not survive well in intermittently dry beds. As mentioned earlier, under the right conditions this stoloniferous perennial can vegetatively become an aspect dominant. The flowers can be either unisexual or bisexual, with the inner flowers of some umbels being male and the outer flowers female. Bisexual flowers may facilitate some self-pollination; however, the flowers are protandrous, which is indicative of some degree of outcrossing. Aulbach-Smith (1985) states:

> "Outcrossing results in increased recombination and heterozygosity, thereby insuring increased evolutionary potential. Sexual reproduction theoretically should act as a sort of evolutionary buffer enabling species to survive environmental changes. This may not be the case in Q. canbyi due to a possible high selfing rate and/or the isolation of small populations."

Boyer (personal communication, 1988) found that selfing in this species is possible, but the rate is low because of the protandry. Boyer commented further that the clonal habit may indicate that each population is just one or a few genetic individuals with very little genetic variation available, even if the apparent outcrossing rate is high. Other observers have questioned this; research is needed to determine genetic variability within and between populations through such techniques as isozyme analysis.

The pollinators of this species are unknown. However, since Canby's dropwort, like many umbellifers, is a favored food plant for the larvae of the black swallowtail butterfly (Papilio polyxenes asterius Stoll), the metamorphosed adults may visit the flowers and act as pollinators. Ironically, predation by the black swallowtail may be a factor in reducing the sexual reproductive potential of Q. canbyi since this caterpillar chews through the stems just below the inflorescences. Permanent plots being monitored in South Carolina populations have shown predation rates of as high as 17 percent (plant tips eaten); scale insects and grasshoppers, in addition to swallowtail larvae, have been observed to damage plants of this species (Rayner, unpublished data). Deer have also been observed to browse upon Q. canbyi (Tom Patrick, Georgia Natural Heritage Program, personal communication, 1989). It is unknown to what extent such predation affects the vigor or long-term survival of Canby's dropwort since even the relative importance to the species of vegetative versus sexual reproduction is unknown.

Threats and Population Limiting Factors

The most serious threat to Canby's dropwort is the loss or degradation of the wetland habitats in which it occurs. Ditching and

draining of wetlands has altered the groundwater table and changed the vegetative composition in many areas of the mid-Atlantic coastal plain where the species historically occurred (Godfrey and Wooten 1979, Ormes et al. 1985, U.S. Fish and Wildlife Service 1986). Much of this habitat destruction has been for agricultural and silvicultural purposes, including conversion of land to row crops, lowland pasture, and pine plantations. Shallow ponds and depressions have also been dredged and deepened to create small reservoirs for watering livestock. The lowering of the water table, in addition to its direct deleterious effects on Canby's dropwort, enables competitive species to become established, thus modifying the natural scheme of vegetative succession on these sites. This usually results in the sites' becoming unsuitable for the growth and reproduction of Canby's dropwort.

Highway construction and maintenance/improvements are believed to have adversely affected populations of the species at several sites in South Carolina and threaten most of the known sites in Georgia. The only known population in Maryland is within the area that would be affected by the Soil Conservation Service's channelization project for the Upper Chester River watershed, should the project be reactivated.

Because of the proximity of many of the extant O. canbyi populations to power line and highway rights-of-way, agricultural fields, and pine plantations, there is a possibility for damage of plants from off-target herbicide drift. No instances of this have yet been documented, but the potential cannot be ignored, particularly where aerial application is involved.

Altered sites, such as the one in Colleton County, South Carolina, which has been planted in slash pine, are more threatened by severe drought than populations in optimum habitat. These sites may require some form of active management, such as canopy thinning or removal and prescribed burning (Rayner et al. 1987, Rayner 1988).

Predation by various insects, as previously described, may be having adverse effects on the sexual reproduction and long-term viability in at least some populations. Ineffective seed dispersal may also be limiting population expansion and colonization. Increasing demands on groundwater supplies caused by expanding suburban and industrial development could also threaten the species' continued survival if water tables are seriously altered.

An important aspect of threats to this species is that many, if not all, populations are severely threatened by stochastic events alone. Small, isolated populations, such as the one in Maryland, are at high risk of extirpation, even without any additional adverse anthropogenic impacts. Such populations are in imminent peril due solely to natural population fluctuations (which can be drastic in this species) and relatively minor natural catastrophes. As stated by Rodney Bartgis of the Maryland Natural Heritage Program, "In a sense, the successful management of such a site probably will depend upon successfully identifying and anticipating such events" (personal communication, 1989).

Although this species is not showy, and therefore, not generally of interest to horticulturalists, some of the populations are so small that over-collection for research or educational purposes could seriously threaten the survival of the plants at those sites.

Conservation Efforts

The U.S. Fish and Wildlife Service and the United States Department of Agriculture Soil Conservation Service signed an interagency agreement on January 13, 1983, in an effort to resolve potential conflicts between this species and the Upper Chester River watershed project. Although plans for this project have since been canceled, the Soil Conservation Service is undertaking a 5-year groundwater monitoring study adjacent to existing ditches on the Delaware side of the Upper Chester River drainage. When available, the results from this study should provide valuable information on the impacts of ditching on this species' wetland habitat.

In 1988, the Maryland Natural Heritage Program, with U.S. Fish and Wildlife Service Section 6 funding, began monitoring the existing population and assessing the feasibility of reestablishing additional populations in Maryland. By 1989, Maryland's only remaining population had declined to only three plants; the Maryland Natural Heritage Program, in cooperation with The Nature Conservancy and the Center for Plant Conservation, then brought two of the surviving plants into cultivation at the North Carolina Botanical Garden in the hope of preserving and propagating this genotype for eventual reintroduction to suitable sites in the Delmarva area (Bartgis, personal communication, 1989).

The North Carolina Department of Agriculture's Plant Conservation Program has set up permanent plots to monitor that State's only population, and has collected seed, stems, and rhizomes for cultivation and long-term storage. Thus far, stems with rhizomes attached have proven to be the most productive for artificial propagation (Boyer, personal communication, 1989). Seedbank investigations are ongoing. The Program is also planning to begin monitoring groundwater levels in the vicinity of the population.

The South Carolina Wildlife and Marine Resources Department's Heritage Trust Program manages the two protected sites in South Carolina for the benefit of the species and is engaged in monitoring and biological research at these and other sites.

State agencies charged with protecting rare plants in the States of Maryland, North Carolina, South Carolina, and Georgia are pursuing protection of additional sites by agreements with landowners or outright acquisition. Conservation agencies in these States, as well as in Delaware (where no known populations remain), are also actively conducting surveys of potential habitat in hopes of finding and protecting additional populations of the species.

The Nature Conservancy has significantly contributed to conservation efforts for this species by acquiring the habitat of four of the known populations in North Carolina, South Carolina and Maryland. The Conservancy is continuing to work with State agencies and the Fish and Wildlife Service to protect other sites.

PART II

RECOVERY

A. Recovery Objectives

Canby's dropwort (Oxypolis canbyi) will be considered for delisting when there are at least 19 self-sustaining populations in existence that are protected to such a degree that the species 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 natural habitat changes. The number of individuals necessary and the quantity and quality of habitat needed to meet this criterion will be determined as one of the recovery tasks. The populations should be distributed throughout the species' historic range. This recovery objective is considered an interim goal because of the lack of data on biology and management requirements of the species. As new information is acquired, the estimate of self-sustaining populations required for the species' survival may be readjusted. The recovery objective for O. canbyi will be reassessed at least annually in light of any new information that becomes available.

Rapid declines can occur even in seemingly stable O. canbyi populations. In South Carolina, the stronghold for this species, a recent 100-year drought event unexpectedly decimated all but 2 of the 15 extant populations. The survival of these severely reduced populations is now in question. Drastic fluctuations such as this indicate that it may be necessary to protect more than 19 populations to ensure long-term survival of the species. This also confirms that future research will be necessary to accurately determine what actually constitutes recovery.

In order to accomplish the goal of removing Canby's dropwort from the list of endangered and threatened species, it is necessary to protect all existing populations and to manage the habitat to ensure their continued survival until it can be determined which of these has the best potential for long-term viability. Because so little is known about this species, it is also necessary, for the full protection of the plants, to conduct 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 disturbance on O. canbyi populations must be determined and prevented. Therefore, Canby's dropwort shall be considered for removal from the Federal list when the following criteria are met:

1. It has been documented that at least 14 of the currently extant populations are self-sustaining and that necessary management

actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival.

2. Through reintroduction, rehabilitation, and/or discovery of new populations, five additional self-sustaining populations exist within the species' historical range.

3. All 19 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 25 populations of Canby's dropwort are currently known to exist, all within the States of Maryland, North Carolina, South Carolina, and Georgia. 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 19 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. Very little is known about specific management practices necessary to ensure the long-term survival of this species. Therefore, immediate emphasis will be on protection (i.e., little or no management, prevention of drainage and other site alterations that are known to be detrimental), in cooperation with the landowners, until appropriate management procedures have been developed through research. Ongoing studies in South Carolina incorporate plans for controlled canopy thinning at one site where the natural habitat of the species has been altered by introduction of slash pine. Pre- and post-management demographic studies should provide important insights into management needs at this and other O. ~~canbyi~~ sites.

1.2 Search for additional populations. Although several intensive searches for the species 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). 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. Also, searches should only be conducted in optimal years, as determined by site visits to at least one-third of the extant populations in the State or geographic area to be searched.

1.3 Determine habitat protection priorities. Because of the small number of existing populations and the pervasive and imperfectly understood 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.

1.4 Evaluate habitat protection alternatives. The greatest possible protection should be obtained for those existing populations that are considered critical to the recovery of the species. 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 regime 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 easements, or fee simple title. Conservation agreements with adjacent landowners or owners of rights-of-way (power companies and highway departments) should be developed to prevent inadvertent adverse alterations of the habitat. This has been accomplished for several of the South Carolina sites.

2. Determine and implement management necessary for long-term reproduction, establishment, maintenance, and vigor. Although protection of the species' habitat is the obvious first step in ensuring its long-term survival, this alone may not be sufficient. Management of the habitat may be necessary to allow the species to successfully perpetuate its life cycle over the long term. However, since very little is known about this species, information on its population biology and ecology is necessary before 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; Menges, in preparation). Such data are needed for the existing populations and for any new populations discovered in the course of additional surveys.

2.2 Study abiotic and biotic features of the species' habitat. An understanding of the hydrology of the habitats occupied by the species is essential to the long-term survival and

recovery of Canby's dropwort. Ongoing monitoring programs should be continued and expanded. Such studies should include populations within a wide range of habitats, both altered and undisturbed. 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 what type of active management, if any, is necessary to ensure continued vigor of existing populations and to accurately select good potential sites for reintroduction.

Experimentation with plants under controlled (e.g., greenhouse) conditions is also essential to understanding recovery prerequisites. Exposure of cultivated plants to controlled stress such as drought, while studying the physiological response of the plants, would provide insight into why some seemingly stable populations respond so drastically to temporary environmental changes.

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 wind; 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. Although various insects have been observed visiting the flowers, the pollinators and pollination mechanisms of the species remain unidentified.

The relative importance of sexual (selfing and outcrossing) and vegetative reproduction to the long-term survival of the species is unknown and must be determined for effective management and protection to take place. Genetic variability within and between populations must be determined through isozyme analysis, electrophoresis, or other appropriate research.

Relationships with competing species must be investigated. It is believed that competition from invading species is controlled by periodic inundation of the sites occupied by Q. canbyi. Some other form of periodic disturbance, perhaps naturally occurring fire, may also play a part in defining these relationships. However, the effects of and exact interactions between this species and potential competitors are unknown.

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. For at least 4 consecutive years, plots should be visited annually at the peak of flowering and after seed set has occurred. The locations of individual plants of all stage-classes should be mapped; data should be collected for each mapped plant, as applicable, on height, stem diameter at base, number of nodes, inflorescence size, fruit size and number, 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. One of the most likely candidates for this type of study is the Colleton County, South Carolina, site, which has been disturbed by road construction, power line right-of-way construction, and introduction of a slash pine overstory. 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. Such techniques as soil coring and examination of historical and current aerial photography should yield information on fire history and successional closure of the bays where Q. canbyi occurs.

2.5 Define prerequisites for self-sustaining populations and develop appropriate habitat management guidelines based upon the data obtained from Tasks 2.2 through 2.4. There are currently insufficient data to determine what this species 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.

2.7 Develop techniques and reestablish populations in suitable habitat within the species' historic range. Techniques for seed or rhizome/stem collection, germination, propagation, and transplantation are unknown for this species. This information will need to be developed in conjunction with knowledgeable individuals in greenhouse or nursery facilities. Transplant sites in native habitat must be closely monitored to determine success and to adjust methods of reestablishment. Also, information on seedbanks in wild

populations must be obtained to determine whether, and under what conditions, decimated colonies can recover naturally (research on this topic is currently being conducted by the North Carolina Department of Agriculture's Plant Conservation Program).

3. Develop a cultivated source of plants and provide for long-term seed storage. There are at present no known cultivated sources of this species. Techniques for seed storage, germination, and maintenance of cultivated specimens must be developed in cooperation with botanical gardens, nurseries, and other appropriate facilities. Maintaining the "genotypes" of small, isolated populations (such as the Delmarva population) in cultivation should be of high priority; preservation of the Delmarva genetic material may be particularly important since it represents the only known remnant of species populations north of the Carolinas and is very close to extinction in the wild. Given the recent precipitous declines at most sites, seed or vegetative propagules should be collected as soon as possible from all populations that are still healthy enough to tolerate such harvest. (Work toward this end has been initiated with the Center for Plant Conservation and with cooperating botanical gardens.) A ready source of cultivated material should ease the threat of taking from wild populations.

4. Enforce laws protecting the species and/or its habitat. The Endangered Species Act (Act) prohibits taking of Q. canbyi 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. 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 Maryland prohibits taking of the species from private property without the landowner's written permission and from State property without a permit and regulates trade in the species (Code of Maryland Regulations 08.03.08). The State of Georgia prohibits digging, removal, or sale of State-listed plants from public lands without the approval of the State management authority (Georgia Department of Natural Resources; Georgia Wild Flower Preservation Act of 1973). Federal and State enforcement agents whose jurisdiction includes the known range of Q. canbyi should be made aware of the threat to the species 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 Canby's dropwort could play an important part in encouraging landowner assistance and conservation efforts. Informational materials should not identify the plant's locations so as not to increase the threat of taking.

   5.1 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. Publicity should not specify locations of plants.

   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 may have conducted studies on 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.

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PART III
IMPLEMENTATION SCHEDULE

KEY TO IMPLEMENTATION SCHEDULE COLUMNS 1 & 4

General Category (Column 1):

Information Gathering - I or Research - R

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

Acquisition - A

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

Other - O

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

Management - M

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

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

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

Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

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

IMPLEMENTATION SCHEDULE

#1 GENERAL CATEGORY	PLAN TASK	TASK NUMBER	PRIORITY	TASK DURATION	RESPONSIBLE AGENCIES #2 FWS REGION	FWS DIVISION	OTHERS #3	ESTIMATED FISCAL YEAR COSTS #4 FY 1	FY 2	FY 3	COMMENTS/NOTES
A3, I4, and M3	Develop interim research and management plans in conjunction with landowners.	1.1	1	2 years	4, 5	FWE	SCA	5	5	---	
I1 and I2	Search for additional populations.	1.2	2	3 years	4, 5	FWE	SCA	20	10	10	
I2 and M7	Determine habitat protection priorities.	1.3	1	1 year	4, 5	FWE	SCA	1	---	---	
M7	Evaluate habitat protection alternatives.	1.4	1	2 years	4, 5	FWE	SCA	1	1	---	
I/R6	Determine population size and stage-class distribution for all populations.	2.1	2	2 years	4, 5	FWE	SCA	15	15	---	
I/R2, 3, and 10	Study abiotic and biotic features of the species' habitat.	2.2	2	5 years	4, 5	FWE	SCA	25	15	15	
I/R6	Conduct long-term demographic studies.	2.3	2	5 years	4, 5	FWE	SCA	16	6	6	
I/R14	Determine the effects of past and ongoing habitat disturbance.	2.4	2	3 years	4, 5	FWE	SCA	8	4	4	

IMPLEMENTATION SCHEDULE

*1 GENERAL CATEGORY	PLAN TASK	TASK NUMBER	PRIORITY	TASK DURATION	RESPONSIBLE AGENCIES *2			ESTIMATED FISCAL YEAR COSTS *4			COMMENTS/NOTES
					FWS						
					REGION	DIVISION	OTHERS *3	FY 1	FY 2	FY 3	
I4	Define prerequisites for self-sustaining populations and develop appropriate habitat management guidelines based upon the data obtained from Tasks 2.2 through 2.4.	2.5	2	1 year	4, 5	FWE	SCA	---	---	5	
M3	Implement appropriate management techniques as they are developed from previous tasks.	2.6	2	Unknown	4, 5	FWE	SCA	?	?	?	
R7 and M2	Develop techniques and reestablish populations in suitable habitat within the species' historic range.	2.7	3	5 years	4, 5	FWE	SCA	---	20	10	
M1 and R7	Develop a cultivated source of plants and provide for long-term seed storage.	3	2	3-5 years	4, 5	FWE	SCA	5	5	1	
O2	Enforce laws protecting the species and/or its habitat.	4	1	Ongoing	4, 5	FWE	SCA	2	2	2	
O1	Prepare and distribute news releases and informational brochures.	5.1	3	Ongoing	4, 5	FWE	SCA	2	1	1	

IMPLEMENTAT. CHEDULE

*1 GENERAL CATEGORY	PLAN TASK	TASK NUMBER	PRIORITY	TASK DURATION	RESPONSIBLE AGENCIES *2 FWS REGION	FWS DIVISION	OTHERS *3	ESTIMATED FISCAL YEAR COSTS *4 FY 1	FY 2	FY 3	COMMENTS/NOTES
01	Prepare articles for popular and scientific publications.	5.2	3	Ongoing	4, 5	FWE	SCA	1	.5	.5	
04	Annually assess success of recovery efforts for the species.	6	3	Ongoing	4, 5	FWE	SCA	.5	.5	.5	

*1 - See page preceding this Implementation Schedule entitled "Key to Implementation Schedule Columns 1 & 4."

*2 - FWS - U.S. Fish and Wildlife Service
FWE - Fish and Wildlife Enhancement
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 Natural Resources and Community Development]; in South Carolina, the Heritage Trust Program [South Carolina Wildlife and Marine Resources Department]; in Georgia, the Natural Heritage Inventory [Georgia Department of Natural Resources]; in Maryland, the Natural Heritage Program [Maryland Department of Natural Resources]; and in Delaware, the Office of Nature Preserves [Delaware Department of Natural Resources and Environmental Control]).

*3 - Other agencies' responsibility would be of a cooperative nature or projects funded under a contract or grant program. In some cases contracts could be let to universities or private enterprises.

*4 - All estimates are for FWS funds only (in thousands).

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