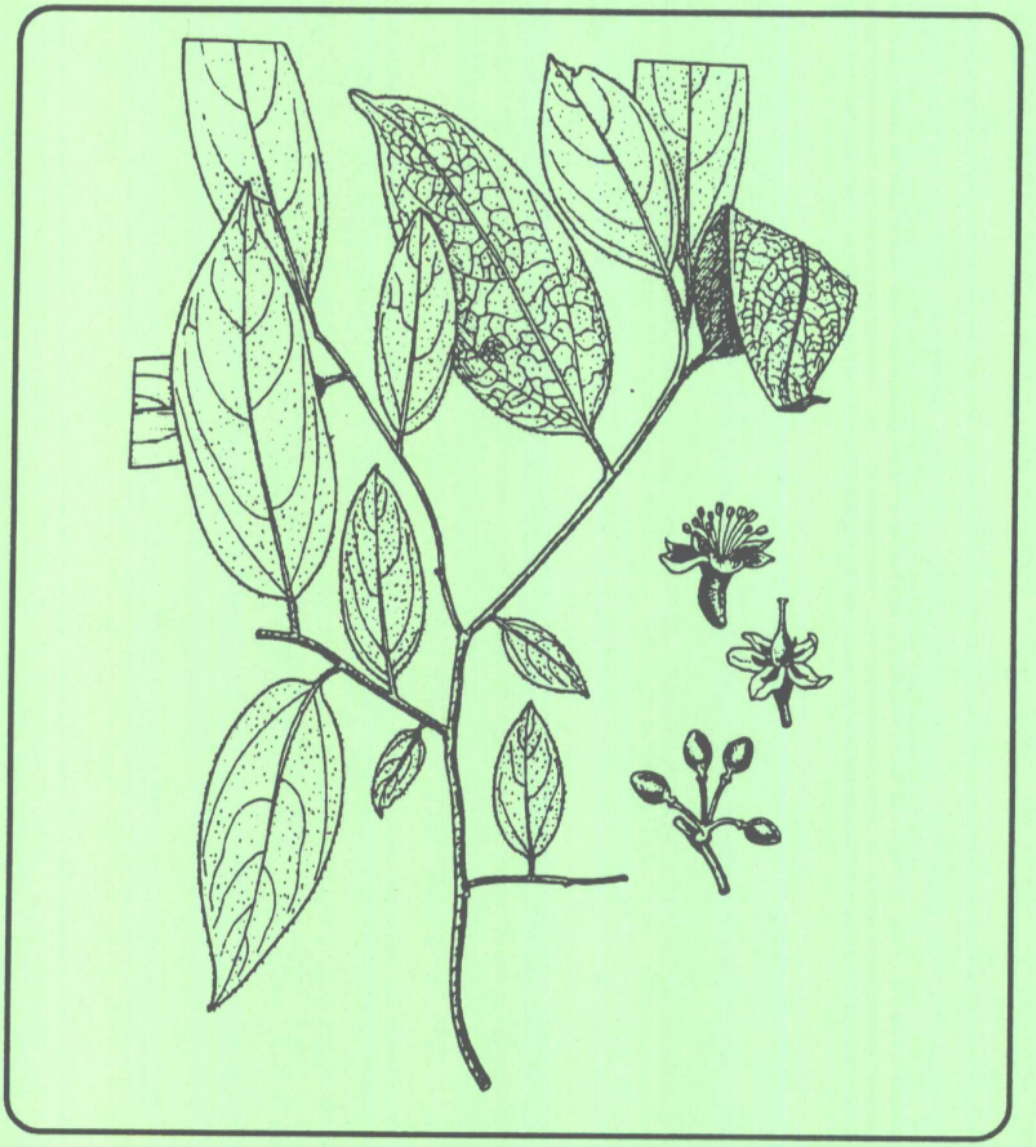
Recovery Plan

Pondberry

(*Lindera melissifolia*)



U.S. Fish and Wildlife Service

RECOVERY PLAN

for

Pondberry (*Lindera melissifolia* [Walt.] Blume)

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Literature citations should read as follows:

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The U.S. Fish and Wildlife Service wishes to express its appreciation to the authors and to the University of Missouri for their efforts in developing this recovery plan for *Lindera melissifolia*. Fish and Wildlife Service funds for the development of endangered species recovery plans are limited. Without the dedication and commitment of the authors and the University, a plan for the recovery of this rare species would not have been developed for several years. Cooperative efforts such as this, between the Federal government and the private sector, are essential if we are to be successful in meeting the goals of the Endangered Species Act and in preventing the extinction of our native flora and fauna.

EXECUTIVE SUMMARY

Current Status: Pondberry is listed as an endangered species. A total of 36 naturally occurring populations are extant. The species is currently known from Arkansas (10 populations), Georgia (4 populations), Mississippi (13 populations), Missouri (1 population), North Carolina (3 populations), and South Carolina (5 populations). The species may have been extirpated from Florida, Louisiana, and Alabama.

Habitat Requirements and Limiting Factors: Pondberry is closely associated with seasonally flooded wetlands. The species has been adversely affected by wetland drainage, timber-harvesting, road construction, and conversion of its habitat to agricultural use.

Recovery Objective: To delist the species.

Recovery Criteria: The species may be downlisted when 15 self-sustaining populations have been protected. The criterion for delisting is the permanent protection of 25 self-sustaining populations. What constitutes a self-sustaining population and what geographical distribution of populations is required to ensure the long-term survival of the species will be determined as recovery tasks.

Actions Needed:

1. Search for new populations and protect and monitor existing populations.
2. Study the species and its habitat.
3. Determine the management requirements of the species and implement actions essential for recovery and protection.
4. Place selected material into cultivation and place seeds from all populations into seed banks.
5. Conduct a public education program.

Recovery Costs ($000s):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Total
1994	62.0	130.0	52.0	21.0	5.0	270.0
1995	57.0	97.0	20.0	0.0	5.0	179.0
1996	42.0	87.0	20.0	0.0	5.0	154.0
1997	22.0	5.0	17.0	0.0	5.0	49.0
1998	22.0	5.0	7.0	0.0	5.0	39.0
1999	22.0	5.0	7.0	0.0	5.0	39.0
2000	22.0	5.0	7.0	0.0	5.0	39.0
2001	22.0	5.0	7.0	0.0	5.0	39.0
2002	22.0	5.0	7.0	0.0	5.0	39.0
2003	22.0	5.0	7.0	0.0	5.0	39.0
TOTAL	315.0	349.0	151.0	21.0	50.0	886.0

Total Estimated Cost of Recovery: The estimated total is $886K, but this figure does not include all potential costs.

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PART I

INTRODUCTION

On July 31, 1986, *Lindera melissifolia* (Walt.) Blume, commonly known as pondberry, was officially listed as endangered under the Endangered Species Act of 1973, as amended (Federal Register 51:27495-27499). The species is known to occur in 36 scattered populations across the Southeastern United States. It is believed that it may have been extirpated from three States within its historic range.

Species Description

Lindera melissifolia (Walt.) Blume, commonly called pondberry or southern spicebush, is a deciduous, aromatic shrub, 0.5 to 2 meters (m) tall (Figure 1). Plants are stoloniferous and generally grow in clones of numerous, usually unbranched, stems. The species is dioecious, and the flowers of both sexes are small and pale yellow. Pistillate flowers are less conspicuous than staminate flowers. Fruits are about 1 centimeter (cm) long at maturity and are bright red. Flowers appear in the spring, prior to leaf development (usually in February or March), and the fruit matures by late summer or fall (Tucker 1984, McCartney in litt.). Steyermark (1949) provided a thorough technical description of pondberry.

Local Field Characters

Lindera melissifolia may be confused with two other species in the Lauraceae family. The first is a variety of spicebush, *Lindera benzoin* var. *pubescens*. Differences in size, leaf shape, leaf venation, and habitat serve to distinguish the two. Spicebush (1.6 to 4.5 m tall) is larger in size than pondberry (0.6 to 2.0 m tall). The foliage of spicebush is erect-ascending or spreading, contrasted to the drooping foliage of pondberry. In spicebush, the base of the leaf surface and the lateral nerves are mostly all parallel, forming an angle with the mid-rib of 35 to 40 degrees. In pondberry, the base of the leaf is obtuse or rounded, venation on the lower leaf surface is conspicuous, and the two lowest pairs of lateral nerves are not parallel to the ones above. McCartney et al. (1989) noted that spicebush and pondberry can be differentiated on the basis of smell. Pondberry leaves have a distinctive sassafras odor when crushed, while spicebush leaves have a spicy aroma. Finally, while these two species may occur in close proximity, they do not occur in the same habitat. Pondberry is found in the wet edges of sinks, ponds, and depressions while spicebush is usually restricted to higher, drier habitats.

The second possible look-alike is *Sassafras albidum*. *Lindera melissifolia* is a low-growing colonial shrub, whereas *Sassafras* is a small to medium-sized tree. Confusion may occur when sassafras is a young tree the height of pondberry. If both species are in leaf, they can be distinguished by their leaf shapes; sassafras leaves are

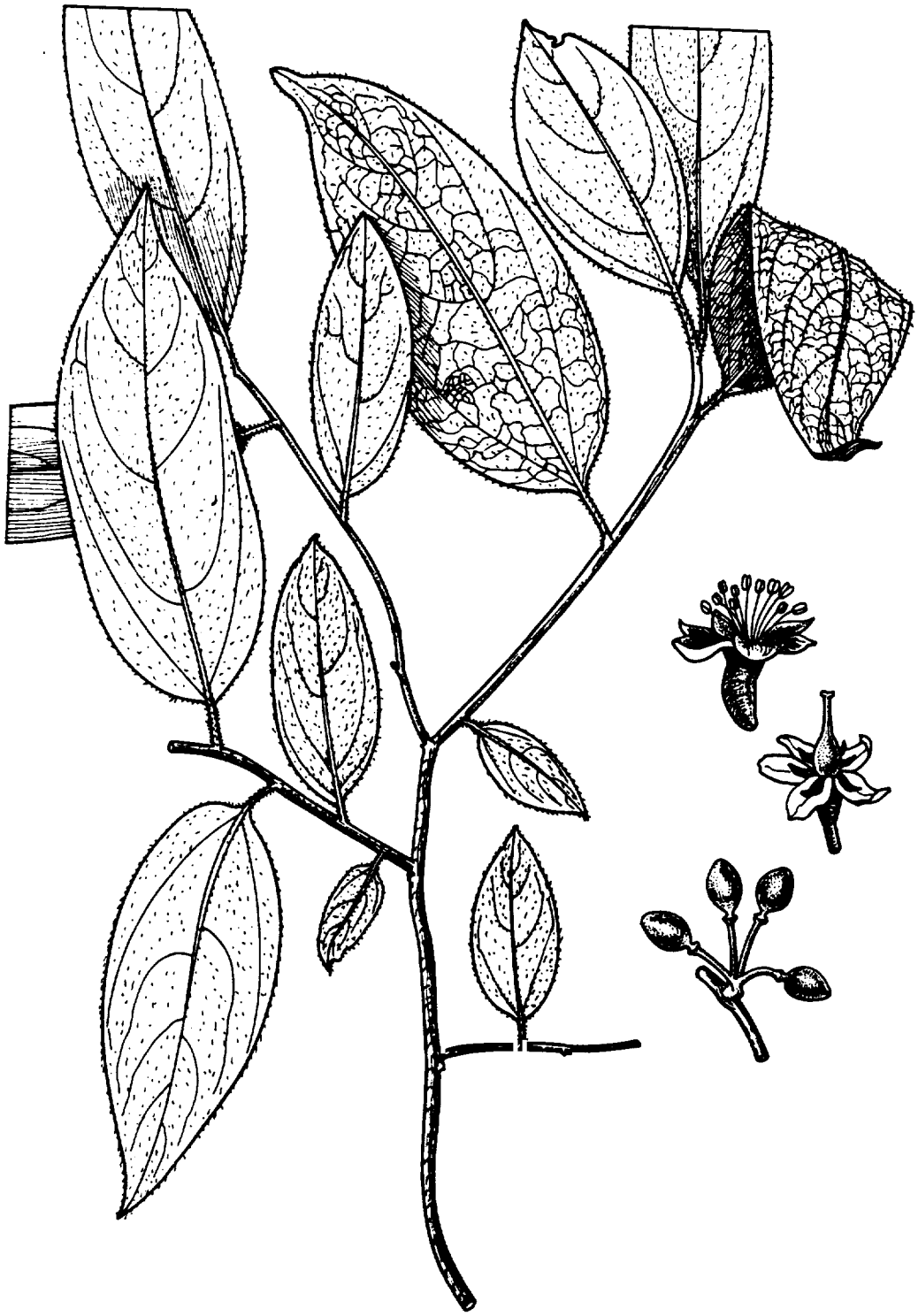

Figure 1. *Lindera melissifolia* from Tucker (1984).

polymorphic, whereas the leaves of pondberry are all of the same shape. During early spring, when neither plant has leaves, *Lindera* will be in flower, while the *Sassafras* will be too immature to flower.

Range and Status

Lindera melissifolia has historically been considered a rare species. Steyermark (1963) described it as one of the rarest shrubs in the nation. There are currently 36 populations of *L. melissifolia* distributed in Arkansas, Georgia, Mississippi, Missouri, North Carolina, and South Carolina (Figure 2, Table 1). This species is assumed to be extirpated from Alabama, Florida, and Louisiana. The following is a summary of the current status in each State.

ALABAMA

Lindera melissifolia has not been observed or collected since the 1839 and 1840 collections from Wilcox County. The species is assumed to be extirpated from the State (Tucker 1984).

ARKANSAS

A total of 10 populations have been found in Arkansas. Clay county contains four populations. These sites cover approximately 0.4 to 0.8 hectare (ha) over approximately 6 ha of habitat (Morgan 1983). Several colonies are comprised of hundreds of stems. The first site is adjacent to the Missouri/Arkansas border and is considered to have historically been part of a larger population that extended into Missouri. Due to habitat destruction and alteration, that population now consists of two subunits. The Arkansas subunit was discovered in 1973. Most of the populations in Arkansas have been adversely affected by timber, land-clearing, and drainage practices (U.S. Fish and Wildlife Service [Service] 1986). A population discovered in 1977, consisting of several colonies with hundreds of stems, was damaged by timber-harvesting. Another population discovered in 1977 persists in an area grazed by cattle, and there is concern that the site will eventually be dominated by more aggressive weeds. The fourth site, also discovered in 1977, was clear-cut and now supports only a few plants.

Additional populations were found in 1985 and later. Woodruff County supports a small population containing several hundred stems. This population occurs in a wooded depression surrounded by farm fields. Another population that was discovered in Lawrence County has since been lost (Wright in litt. Degradation of the hydrology of the site by flooding from surrounding rice fields and drainage modifications caused or contributed to the loss of this population. Four more sites were found in Jackson County. The first site contains several scattered colonies that have been affected by cattle-grazing, timbering, and trash-dumping. The second site is in a bottomland hardwood stand that contains several colonies occupying

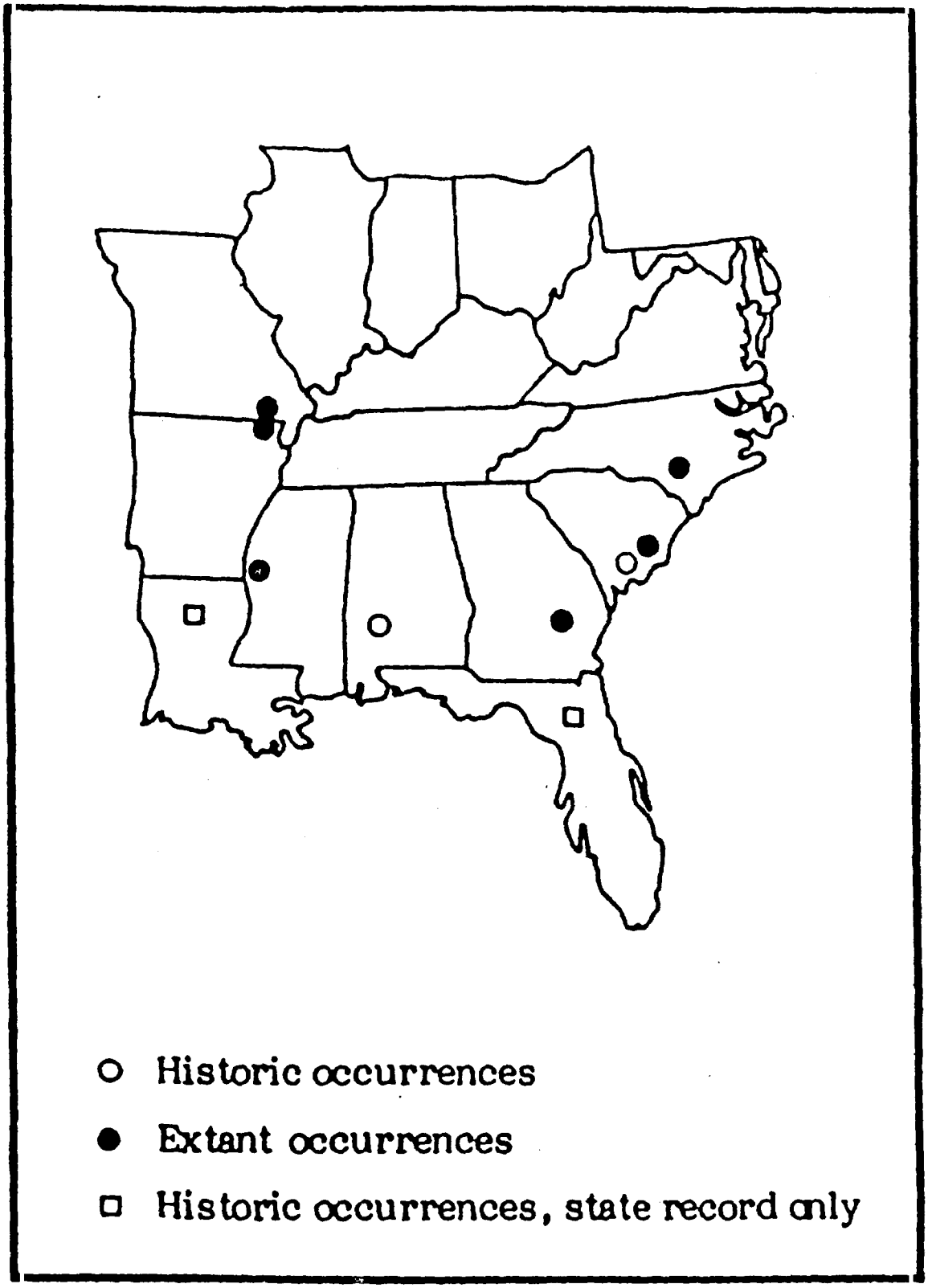

Figure 2. Map of the Southeastern United States showing the distribution of Lindera melissifolia. (Adapted from Morgan, 1983).

Table 1. Distribution and ownership of extant naturally occurring *Lindera melissifolia* populations.

LOCATION	NUMBER OF POPULATIONS	CURRENT OWNERS
ARKANSAS	**10**	
Clay County	4	Private
Woodruff County	1	Private
Lawrence County	1	Private
Jackson County	4	Private
GEORGIA	**5**	
Wheeler County	3	Private
Wheeler County	1	Little Ocmulgee State Park (transplant)
Baker County	1	Private
MISSISSIPPI	**13**	
Sharkey County	10	U.S. Forest Service, Delta National Forest
Bolivar County	1	Private
Sunflower County	2	Private
MISSOURI	**1**	
Ripley County	1	Missouri Department of Conservation, The Nature Conservancy, and Private
Butler County	1	Experimental population established on Missouri Department of Conservation property
NORTH CAROLINA	**3**	
Bladen County	1	Private
Sampson County	2	Private
SOUTH CAROLINA	**5**	
Berkeley County	4	U.S. Forest Service, Francis Marion National Forest
Beaufort County	1	Department of the Navy, Marine Corps Air Station, Beaufort
TOTAL POPULATIONS	**37**	

from 6 m^2 to 0.25 ha (Wright in litt.). The third site is a depression within a lightly disturbed bottomland hardwood forest surrounded by farm fields. The fourth site is described as large and dense, covering a 10- by 15-m area.

The Arkansas sites occur on private, unprotected lands that are threatened by habitat alteration. No protection has been afforded any of the Arkansas sites. Given the opportunity and funds, land acquisition is high on the State's priority list (Bert Pittman, Arkansas Natural Heritage Program, personal communication, 1989 [currently with South Carolina Wildlife and Marine Resources Department]).

FLORIDA

Pondberry has not been recently observed or collected in Florida. The validity of reports that the species occurred in the State has been questioned by some authors. Kenneth Wurdack's discovery in northern herbaria of pondberry specimens collected in Florida by A. W. Chapman confirmed that, at least historically, the species was a part of the Florida flora. These specimens were collected in the mid-1880s from either Gadsden or Jackson Counties (McCartney et al. 1989).

GEORGIA

Three privately owned populations of pondberry occur in Wheeler County. One of these populations was severely damaged by domestic hogs, so three small colonies of that population were transplanted to sites on Little Ocmulgee State Park. Currently, only one colony lives and reproduces vegetatively. The colony is protected by a fence. The other populations are located on lightly disturbed land; however, due to their unprotected state, they are still threatened by development. A forth population was discovered in Baker County by A. Gholson (Wurdack 1989). McCartney (in litt.) reported that historically the species was also known from Chatham and Effingham Counties.

LOUISIANA

Pondberry has not been recently observed or collected in this State and is assumed extirpated (Tucker 1984, Mercer in litt.). Wurdack (1988) provides an interesting review of his efforts to better understand the history of pondberry reports from Louisiana.

MISSISSIPPI

Lindera melissifolia is known from 13 populations in Mississippi. Ten populations are in Sharkey County, on the Delta National Forest. Part of one of these populations is found on a 16-ha area officially designated as a Research Natural Area (Carter in litt.). Two populations occur on private lands in Sunflower County, and one

occurs on private land in Bolivar County (Cary Norquist, Service, personal communication, 1990).

MISSOURI

One dense population stand found on 24 to 32 ha occurs in Ripley County (Morgan 1983). Several colonies consist of 50 to 200 stems, and some colonies consist of several thousand stems. One section covers as much as 2 ha (Eleanor Gaines, Missouri Natural Heritage Program, personal communication, 1989). This population subunit was at one time part of a large Arkansas/Missouri population.

Quantitative sampling in 1983 revealed that 92 percent of the 52 stems sampled fruited, with a range of 1 to 132 fruits per stem. In permanent plots, 56 percent of the flowering stems died back during the growing season (Morgan 1983). An April 1984 survey reported that the majority of stems had died back to the water line (Gaines, personal communication, 1989).

Most of the population is on Missouri Department of Conservation (Sand Ponds Natural History Area) and The Nature Conservancy lands. Small groups of plants occur on adjacent private land. A portion of the population on The Nature Conservancy land was damaged in 1985 due to unauthorized timber-harvesting (Chaplin in litt.).

NORTH CAROLINA

There are three known populations of pondberry in North Carolina. One population exists on private land in Bladen County. There were 50 to 100 stems in 20 m^2 in 1983, and the total habitat was estimated to be 200 m^2. The area has been impacted by timber-harvesting, drainage, and land-clearing for agriculture and pine monoculture. An adjacent population, discovered in 1979, was destroyed by lumbering and land-clearing (Tucker 1984). In late 1991 or early 1992, Steve Leonard (North Carolina Division of Soil and Water Conservation) found two healthy populations in Sampson County.

SOUTH CAROLINA

Four populations of pondberry occur on the Francis Marion National Forest (Porcher 1980). Morgan (1983) reported that several colonies were scattered within 8 kilometers (km) of each other, for a total of seven sites. Morgan (1983) reported Berkeley County pineland wet depressions supporting pondberry over 1,800 m^2 and limestone sink complexes containing pondberry comprising approximately 6 ha.

The species' occurrence in Colleton County was investigated by Doug Rayner through an herbaria and field search in 1984. The search failed to document the species' occurrence in that county (Service 1986).

Since 1985, the South Carolina Heritage Program and the South Carolina Nature Conservancy have campaigned for the Honey Hill limestone sink area to be designated a Research Natural Area of the U.S. Forest Service, Francis Marion District. The proposed site would include 99 ha of Forest Service land and 70 ha of private land. The limestone sink area contains the largest concentration of pondberry in the world. The area contains 64 of the 73 known colonies and 8,000 of the estimated 12,600 stems of pondberry in South Carolina. Due to the rhizomatous nature of this species, this probably represents only 800 genetically distinct individuals (Rayner and Ferral 1988).

More than two-thirds of the 64 colonies consist of fewer than 100 stems. Most colonies occupy small, relatively discrete areas of the sink margins. Most sinks in the area, however, contain large amounts of apparently suitable habitat that is uninhabited by pondberry. Colony vigor is relatively poor. Almost half of the colonies are believed to be weak because the stems are less than 44 cm tall and nonreproducing. Only 10 percent of the colonies are vigorous, containing stems that are 0.9 to 1.8 m tall, nondiseased, and reproducing. Only 22 percent of the colonies produce fruit, and in each of those colonies, fruit averages only 22 fruits per colony (Rayner and Ferral 1988).

In the fall of 1989, Hurricane Hugo caused extensive damage in the Francis Marion National Forest. Pondberry apparently did not receive much physical damage from the hurricane (Porcher 1990). In 1991, Dr. Porcher discovered a population consisting of two colonies on the Marine Corps Air Station at Beaufort. The managers of the site are aware of the presence of the species and are committed to protecting it (Tom Burst, Naval Facilities Engineering Command, personal communication, 1990).

Life History/Reproductive Ecology

Stems of *Lindera melissifolia* flower in the second to fourth year of growth. The stems continue to grow in subsequent years but usually die by the sixth or seventh year. Young stems replace the dead stems at the base. Clones expand vegetatively, eventually consisting of many well-rooted stems. Thus, a mature colony usually consists of numerous dead stems along with younger leafy ones. Many populations consist predominantly of male plants. Evidence of seedling production or seedling establishment has rarely been observed in the wild (Tucker 1984; Robert Wright, University of Central Arkansas, personal communication, 1989). Plants often occur in standing water in early spring, although these ponds are generally dry by April or May. Dormancy breaks with leaf expansion, which generally occurs in April, rather than at time of flowering (Wright, personal communication, 1989).

Although breeding system details are not known, the similarity of pondberry flowers to the flowers of *Lindera benzoin* suggests that it

also may be insect-pollinated. No specific pollinators are known, although flies, wasps, and small bees have been observed on the flowers in Arkansas and Missouri.

The seed dispersal mechanism is a little-understood mechanism in pondberry. Presumably, the fruits are either picked from the plant by some type of animal or they fall from the plant. Seeds have been observed under mature plants (Tucker 1984). McCartney (*in litt.*) reported that *Lindera subcoreacea* fruits are readily eaten by birds, and he believes that birds also eat pondberry fruits.

There is substantial yearly variation in seed production. One seed per fruit is produced, with an individual stem having as many as 150 fruits. An individual clone may have fewer than 10 fruits or as many as 100,000. Because most populations are either all-male or male-dominated, there are few seeds produced in relation to the number of stems. Fruit production varies with the size of the population and the uncertainties of the season. Flowers appear in February or March and remain open for about 1 week. The flowers are often subject to late frost and freezing temperatures, resulting in a reduction in fruit set.

Wright (1990) stated that pondberry seeds exhibited a high percentage of viability. Several attempts by Gary Tucker to germinate seeds through various treatments proved unsuccessful. Wright (personal communication, 1989) reported 16 percent seed germination the first season if the seeds were pushed into the soil and 10 percent germination for undisturbed seeds the second season. Pondberry has been grown successfully from seed in the northern Illinois wildflower garden of J. A. Steyermark as well as in nursery settings. McCartney (in litt.) reported that cleaned seed which has been stratified readily germinates in his commercial South Carolina facility.

No hybridizations, either natural or artificially induced, have been known to occur in pondberry.

Habitat

Lindera melissifolia occurs in seasonally flooded wetlands, sandy sinks, pond margins (Radford et al. 1968) and swampy depressions (Steyermark 1949).

In the southern floodplain forest (Bailey 1976) or in the Mississippi alluvial plains (Fenneman 1938) of Missouri, Arkansas, and Mississippi, pondberry is found on sites with perched water tables and with vegetation similar to that found in bottomland hardwood habitats. In the coastal sites of North and South Carolina, pondberry is associated with the margins of sinks, ponds, and depressions in the pinelands. Pondberry is shade-tolerant. Although growth is vigorous when shade is reduced or eliminated, McCartney (in litt.) indicated that the species' competitors would probably respond more vigorously than it does to the increased light.

The populations in Arkansas and Missouri occupy depressions associated with forested swales in dune fields. Pondberry grows on level ground in these depressions or on the depression banks and is not found on the higher adjacent dunes. These dunes can be 0.6 to 3.0 m higher than the depressions. The depressions form natural swamps and ponds that hold up to 50 cm of water in the spring but are usually dry by October. The depressions are hydrologically connected by the movement of shallow groundwater (Wright in litt.) These ancient aeolian dunes were formed by glacial outwash carried by braided streams during the late Wisconsin glaciation (Saucier 1978). These dune fields vary in size from 2 km^2 to 75 km^2. Each field contains hundreds of individual dunes ranging from 0.5 to 5 ha in area covered and from 4 to 6 m in height.

Soils in these depressions are generally loams and silty loams that usually have a high calcium ion exchange capacity in the subsurface zone. Interdune depressions are most frequently exposed sediments of predune soils rather than materials carried from adjacent areas (Saucier 1978). Pondberry sites are of the Boskett-Tuckerman series (Allgood and Persinger 1978), with Ordovician dolomites as the primary underlying geologic substrate. Soils are fairly acidic, as indicated by the occurrence of several mosses (such as *Climacium* sp., *Polytrichum* sp., and *Leucobryum* sp. [Klomps 1980]), are poorly drained, and have a high water table (Tucker 1984).

Pondberry grows in depressions; *Lindera benzoin* grows on the higher nonflooding ground in the immediate area. Predominant overstory trees at pondberry sites include pin oak (*Quercus palustris*), overcup oak (*Q. lyrata*), willow oak (*Quercus phellos*), swamp red maple (*Acer rubrum* var. *drummondii*), and sweetgum (*Liquidambar styraciflua*). In Missouri, Klomps (1980) reported that other plants do not grow in association or within clumps of pondberry, but she did observe *Smilax glauca* and *Saururus cernuus* growing adjacent to the species (Klomps 1980). However, Wright (in litt.) observed *Smilax glauca* growing in pondberry. One depression included *Itea virginica* and *Boehmeria cylindrica*; another included understory layers of *Impatiens* sp., *Geum* spp., *Carex* spp., *Galium* sp., *Cardamine bulbosa*, *Prunus* sp., and *Carpinus caroliniana*. In some of the Missouri and Arkansas populations pondberry occasionally grows in close proximity to the rare corkwood (*Leitneria floridana*) (Tucker 1984).

The Mississippi site is located on Sharkey-Alligator-Dowling soil associations that are poorly drained, have a high water table, have distinctly gleyed B and C horizons, and have high concentrations of calcium and magnesium (Tucker 1984). Dominant overstory trees include sweetgum (*Liquidambar styraciflua*), sugarberry (*Celtis laevigata*), American elm (*Ulmus americana*), and green ash (*Fraxinus pennsylvanica*).

Pondberry populations in the coastal plain of North and South Carolina occur in distinctly different habitats. The North Carolina population occurs in soil with sandy sediments and high peat content

in the subsurface (Tucker 1984). The water table is high. Charred wood fragments on the surface indicate frequent or intense fires in the past. Such fires were probably important in creating and maintaining the present shrub layer of fetterbush (*Lyonia lucida*) and high bush blueberry (*Vaccinium corymbosum*) (Tucker 1984). In addition to pond pine (*Pinus serotina*) and long-leaf pine (*Pinus palustris*) (Morgan 1983), the following may occur: *Persea borbonia*, *Magnolia virginiana*, *Nyssa sylvatica* var. *biflora*, *Taxodium ascendens*, *Acer rubrum*, *Cyrilla racemiflora*, *Myrica* spp., *Smilax* spp., *Vaccinium* spp., and *Lyonia* spp. (Tucker 1984).

Populations in South Carolina occur at the margins of limestone sinks and undrained shallow depressions. Limestone sinks are formed by the roof collapse of underground caverns. Of the 246 limestone sinks surveyed, 51 contained pondberry (Rayner and Ferral 1988). Radford et al. (1968) stated that the soil at the Honey Hill site was very acidic (pH 4.5), though underlain with limestone. The limestone is deep, resulting in very few basic ions being exchanged. Limestone sinks generally hold water throughout the year, and pondberry is found at the sink margins at water level. Populations also occur in pinelands and in open and burned areas (Porcher 1980). Associated dominants in sinks include *Taxodium ascendens* and *Nyssa sylvatica* var. *biflora*; dominants along the sink margin include *Quercus* spp. and *Pinus taeda*. Pondberry is closely associated with the rare species *Litsea aestivalis* (pondspice).

Sinkholes vary in depth and degree of slope. Some are fed by artesian water and others by rainwater. The water levels fluctuate in the rainwater-supplied sinks. In the Honey Hill area, pondberry occurs in about one-half of the available sinks. Pondberry is typically found on the lower and mid-slopes of gentle sink margins and thus appears to occupy habitats that are not too wet or too dry. Only 14 percent of the colonies occupy flat areas between sinks, and 6 percent occupy habitats with a slope greater than 10 degrees. Most colonies occur in light shade conditions (Rayner and Ferral 1988). However, at some locations the species thrives and is quite vigorous in unshaded conditions (McCartney in litt.).

Limestone sinks are scattered throughout the Atlantic and Gulf Coastal Plains. They are most abundant in Georgia and Florida. South Carolina's limestone sinks exhibit a wide range of geomorphic, floral, and faunal diversity. The Honey Hill area is a very important limestone sink complex in South Carolina and should be protected.

Reasons for Decline

The major threat to the continued existence of *Lindera melissifolia* is alteration or destruction of its habitat through land-clearing, drainage modification, or timber-harvesting.

Land-clearing operations for agricultural and residential development have been responsible for the drastic loss of bottomland forests in Arkansas, Mississippi, and Missouri. The Service (1979) reported a 24 percent reduction of bottomland forests in Clay County, Arkansas, from 1957 to 1977. Korte and Fredrickson (1977) reported a 95 percent loss of Missouri lowland forests since settlement. Similar accounts of habitat destruction, including land-clearing for pine plantations, have been reported in North Carolina (Service 1986).

Drainage from ditch-building and field-leveling alters the wetland habitat of *L. melissifolia* and affects the water levels in the area. Changing water levels reduce the plant's vigor and may eliminate it from a site. One population in Arkansas has suffered because of flooding from the surrounding rice fields (Service 1986). In the Delta National Forest in Mississippi, greentree reservoirs are being developed to provide waterfowl habitat in areas occupied by *L. melissifolia* (Banker and Goetz 1989). The impact of seasonal flooding associated with the operation of these reservoirs is unknown. Other *L. melissifolia* population sites have either been drained or are adjacent to lands with ongoing drainage modifications.

Three populations on private land in Arkansas were severely damaged by timber-harvesting, leaving only a few plants in each site (Service 1986). This problem is also of concern at most of the other known sites. Machinery used in timber-harvesting activities may crush *L. melissifolia* or cause the uprooting of surrounding trees, which would destroy the plants. *Lindera melissifolia* apparently thrives best under a closed canopy (Tucker 1984), and tree removal may be detrimental to the species. Timber-clearing and road construction may also affect the hydrology of the area.

An apparent lack of seedling establishment could be another reason for the decline and/or lack of expansion of *L. melissifolia* colonies. Most colonies are clonal and consist primarily of male plants. Consequently, most of the stems within a colony will not produce seeds. Tucker (1984) reported that flowers are often subject to late frost and freezing temperatures that result in reduced fruit set. In colonies where mature fruits are produced regularly, few seedlings have been observed (Tucker 1984, Wright 1990). Seedlings can be readily produced in a nursery (Robert McCartney, Woodlanders, personal communication, 1989), and Wright (personal communication, 1989) reported that seeds will germinate if pushed below the soil surface or if given time. Although viable seeds are present, germination does not appear to be vigorous in the wild. This lack of sexual reproduction limits genetic variation to that exhibited by the established clones and impairs the establishment of new colonies.

Some pondberry populations have been adversely affected by domestic animals, such as hogs, and by wildlife. These populations and others may decline in numbers because of animal interference. One site in Arkansas is grazed by cattle, which has encouraged the invasion of

the site by aggressive weedy species. Plants at one Georgia site were being trampled by domestic hogs, so the few remaining plants were transplanted adjacent to State lands (Service 1986). Grazing by white-tailed deer (*Odocoileus virginianus*) in South Carolina's Francis Marion National Forest may have adversely affected pondberry (Rayner and Ferral 1988).

Additional reasons for decline include changes in climatic conditions and the presence of a fungus and a weevil. *L. melissifolia* requires moisture to thrive and survive. Recent droughts may have had an adverse effect on growth and germination. Chaplin (in litt.) reports that the Missouri and northern Arkansas populations suffer from severe winter stress that causes the dieback of above-ground stems. McCartney (in litt.) reported that dieback is, in some cases, caused by the fungus *Phomopsis*. Steve Leonard (in litt.) reported the discovery of a weevil (*Heilipus squammosus* [LeConte]) associated with the dying twigs of pondberry. This species belongs to a typically tropical or subtropical genus, and it is not known if it is native or introduced to the area. The significance of drought, the weevil, and the fungus to the long-term survival of the species is not currently known.

PART II

RECOVERY

A. Objective

Lindera melissifolia will be reclassified from endangered to threatened status when there are 15 protected, self-sustaining populations distributed throughout the species' historic range. The species will be considered for delisting when there are 25 protected, self-sustaining populations distributed throughout the species' historic range. A population is defined to be one or more colonies that are in close enough proximity to regularly interbreed and separated from other populations by a sufficient distance to preclude interbreeding on a regular basis. What constitutes a self-sustaining population and the specific geographical distribution required will be determined as recovery tasks.

To reach these recovery objectives, the following is recommended:

1. Continue searches for new populations;

2. Protect and maintain the known populations and their habitat;

3. Protect areas where *L. melissifolia* has not been located but provide suitable habitat; and,

4. Establish new populations or reestablish extirpated populations at suitable sites if necessary to meet recovery objectives.

In order to better understand the species and its habitat requirements, demographic studies and ecological research should be conducted. This information will be useful in developing appropriate protection and management strategies.

These recovery objectives will be reviewed annually in light of new information that may arise.

B. Narrative Outline

1. Conduct searches for additional populations and protect all known sites. Systematically searching for new populations and protecting the known populations of *Lindera melissifolia* presents the best opportunity for assuring survival of this species. Protection should include buffer zones surrounding the existing sites supporting the species. Such zones will assist in protecting the hydrology of existing sites and will provide for the environmental conditions (appropriate shade, etc.) required for the maintenance of healthy populations. It is not currently known what size buffer zone will be needed to adequately protect pondberry's habitat.

   1.1 Search for new populations. Several new populations have been discovered since pondberry was listed as an endangered species. Efforts should be undertaken to carefully search potential habitat throughout the species' historic range for currently unknown populations.

   1.2 Obtain long-term protection of privately owned populations. There are a variety of methods by which the pondberry populations can be protected. These include: (1) registry as a Registered State Natural Area, (2) cooperative management agreements, (3) conservation easements, (4) the Conservation Reserve Program, (5) the Water Bank Program, and (6) land acquisition. The most effective tool that will provide the required long-term protection should be used. A cooperative management agreement will probably be less expensive than purchasing a conservation easement or purchasing the land outright, provided that landowners agree to all the necessary restrictions imposed in such an agreement. In most cases the only feasible method of obtaining long-term protection will be land acquisition or purchase of a conservation easement. Many of the known populations of pondberry are on private lands. Private agencies, like The Nature Conservancy, and public agencies, like the Missouri Department of Conservation, should cooperatively acquire lands as part of their overall endangered species protection strategies.

   1.3 Upgrade the protection status of publicly owned populations through Section 7 consultation. Several populations of *L. melissifolia* occur within the boundaries of national forests in South Carolina and Mississippi. Informal consultation has established guidelines for protecting the species on Mississippi's Delta National Forest. A portion of one of these populations is further protected by its designation as a

Research Natural Area. Four populations in South Carolina occur on the Francis Marion National Forest, and one occurs on lands managed by the Department of the Navy. Site-specific management plans should be developed for these populations to ensure their continued protection. Designation of the South Carolina populations as Research Natural Areas would further protect these sites. Research Natural Areas are designed to ensure protection not only of endangered species but also entire ecosystems (Franklin et al. 1972). The Forest Service, in cooperation with The Nature Conservancy and South Carolina Heritage Trust, is pursuing protection of the Honey Hill populations as a Research Natural Area (Eng in litt.).

1.4 Prevent further loss of *L. melissifolia* habitat. Loss of habitat is the single largest threat to the survival of this species. The Swampbuster provisions of the Food Security Act may offer some protection to pondberry. This legislation excludes farmers who drain wetlands for crop production from all benefits of the Act. Unfortunately, the bill does not cover conversion to other uses, like housing, nor will it affect farmers not participating in Federal farm programs. The current national policy is "no net loss" of the nation's wetlands. Such a pledge "lends focus and intensity to a program of wetland conservation that has been active for many years under the Federal Aid in Fish and Wildlife Restoration Programs" (Fish and Wildlife Reference Service 1989). There is a need to identify habitats capable of supporting *Lindera melissifolia*. This can readily be incorporated into the searches for new populations identified in Task 1.1. Acquisition and management strategies to protect such sites should be developed, if needed, to accomplish the recovery of pondberry.

2. Study the reproductive biology, seed biology, and seedling ecology. Little is known about the population biology of this species and the environmental conditions necessary for the species' long-term viability. Permanent plots should be established to determine relationships between abiotic factors, such as light intensity and soil moisture, and biotic factors, such as germination, competition, and predation.

2.1 Determine the reproductive biology and pollination mechanisms. Insect pollinators (flies and bees) have been seen on pondberry flowers. There is a need to monitor pollinator abundance and effectiveness and the percent of seed set. This is especially important, because the majority of a colony can be male or female.

Studies are needed with regard to the relative importance of selfing or outcrossing and whether the majority of pollen comes from the same colony or from different colonies. These studies may be helpful in defining populations and discovering the effects of isolation.

2.2 Conduct seedling survivorship and establishment studies. There are no known seedlings in the wild. It is typical in clonally reproducing species to have infrequent seed propagation (Harper 1977). However, for a species to maintain genetic variation and to establish new (genetically different) colonies, sexual reproduction must occur.

2.2.1 Determine dispersal mechanisms. Because pondberry fruits are red, the dispersal agent is assumed to be either avian or mammalian. Seed dispersers should be identified to determine their effectiveness and role in the long-term maintenance of the species.

2.2.2 Determine germination mechanisms and dormancy. In preliminary studies in Arkansas (Wright, personal communication, 1989), germination has been observed only after the fruits were pressed into the soil. Seeds also have been successfully germinated in greenhouses. Controlled experiments are needed to determine the seed biology of the species. After germination requirements are thoroughly understood, field studies should be initiated to determine what management actions should be initiated to enhance sexual reproduction in natural populations. Seed dormancy requirements and the longevity of seeds under natural conditions should be used to determine the size of the species' soil seed bank.

2.2.3 Determine the role of predation on seeds and seedlings. This may include field plots of seeds and seedlings with and without scat analysis and examination of seeds for evidence of insect predation.

2.2.4 Determine the environmental requirements of seedlings. Experimental plots of transplanted seedlings should be established to study the effects of light regimes, hydrological conditions, habitat alterations, proximity to established colonies, and plant competitors. To ascertain the species' transplant potential,

seedlings should be transplanted to areas that seem to meet pondberry habitat requirements but contain no plants. South Carolina's Francis Marion National Forest was damaged by Hurricane Hugo in the fall of 1989. Colonies in the area should be monitored for long-term impacts of the hurricane on vegetative and sexual reproduction as well as their response to successional habitat changes and potential plant competition.

3. Determine the colony size and distribution within populations and the vigor of stem size classes. Surveys are needed to determine the exact status of pondberry's reproductive health (sexual and clonal) and the size and distribution of colonies within all populations.

   3.1 Standardize the methodology for defining individuals. To the extent possible identify genetic individuals (genets) consisting of daughter ramets (clones). Success in this task may be limited in light of the need to reduce disturbance to the plants. Because pondberry is strongly rhizomatous, the actual number of genetically different individuals is much fewer than the number of stems present. Numbers of clonal groups within populations should be determined. Surveys should include the number of stems per colony and colony area.

   3.2 Determine the stem replacement rate by asexual reproduction. Inventory colonies to measure expansion or contraction by determining stem dieback and regeneration.

   3.3 Identify the sexually reproducing colonies, sex ratio of flowering plants, and proportion of seed set. Not all plants or colonies produce fruit, because populations often consist entirely or predominantly of male plants. Size classes of stems need to be measured to determine potential age requirements for reproduction.

   3.4 Identify the genetic variability of colonies through electrophoretic studies. Information on the genetic variation within and between colonies of pondberry will enable concerned agencies and organizations to better evaluate the number of individuals, colonies, and populations needed to recover the species.

   3.5 Define a self-sustaining population and determine the distribution of protected populations required for recovery. To meet recovery objectives, it must be determined what constitutes a self-sustaining population and what geographical distribution of protected populations is needed. This task should be completed

after information on the ecological and genetic requirements of pondberry have been obtained.

4. Determine the biological and ecological requirements of the species and provide needed management actions. Protection of existing populations and their habitat is the first step toward recovery. However, the autecology requirements of pondberry must be determined if its long-term survival is to be ensured.

   4.1 Conduct hydrological studies. An understanding of the hydrology of the species' habitat is necessary for pondberry's short- and long-term survival. Studies of the hydrological requirements of pondberry are currently being conducted in Arkansas (Wright, personal communication, 1989), and such studies should be extended to other States to include the range of habitat types supporting pondberry. Plots should be established in undisturbed and disturbed areas so that the impact of hydrological alterations on pondberry can be monitored and better understood.

   4.2 Conduct long-term demographic studies. Permanent plots should be established within each habitat type (hardwood bottomland, pine flatland, limestone sinks). Plots should be visited seasonally to evaluate vegetative growth or dieback, peak of flowering, seed set, percent of fruit removal, and seedling establishment. Reproducing stems should be marked and monitored. Plant data should include height, stem diameter, number of nodes, number of inflorescences, age at first flowering, seed set, and annual growth. Habitat parameters should be recorded at each visit. Data concerning tree cover, shrub cover, light conditions, associated species within and adjacent to the species' habitat, habitat aspect, degree of slope, topographical position, and moisture should be obtained and evaluated.

   4.3 Conduct management technique experiments. While simultaneously executing research on the population biology and seedling establishment of pondberry, experiments should be conducted to identify management techniques that may be used to enhance colony vigor.

      4.3.1 Develop substrate disturbance techniques. Preliminary germination data (Wright, personal communication, 1989) indicate that leaf litter on the forest floor may prevent seeds from coming into contact with the soil. Perhaps a natural action, such as fire that removes litter or a disperser's disturbance of litter, is needed but is absent. Studies examining the effects of

fire, manual leaf removal, and manual seed-planting should be evaluated as management tools.

4.3.2 Develop management techniques to increase colony vigor. Develop and test a series of experiments to determine if mechanical or other means of altering the vegetation associated with pondberry would result in increased colony vigor. A specific item that should be addressed is the relationship between vigor and light exposure.

4.4 Prepare and implement site-management plans. No single management technique may work for all habitats. Information obtained from demographic studies and management technique experiments from each habitat should be used to prepare site-specific management plans.

4.4.1 Establish buffer zones around colonies in management areas. Buffer zones should be established around each population and colony. The size of the buffer zones may vary depending on topography, vegetation, and soil type.

4.4.1.1 Protect *L. melissifolia* from forestry and agricultural management actions. A biological evaluation prepared for the Delta National Forest in Mississippi (Banker and Goetz 1989) concluded that a 30-m buffer around a colony would maintain crown closure as well as keep hydrological influences intact. Management concerns in the national forests are construction, clear-cutting, timber-thinning, and reconstruction and maintenance of roads and trails, as well as associated ditching to prevent road flooding. Roads, trails, and ditches should be relocated, if necessary, to protect individual populations of pondberry. All populations on Federal lands should be protected by site-specific management plans developed through Section 7 consultation between the Service and the Federal land management agency.

The impact of the construction and operation of greentree waterfowl reservoirs needs to be determined. Currently, Mississippi's Delta National

Forest has 2,607 ha in the greentree reservoirs that are completed or are in various stages of completion. Two colonies of pondberry occur in the area, and there are plans to survey and monitor reservoirs for others. Future developments should be carefully planned in order to avoid impacts to the species. Past levee maintenance has included mowing and herbicide spraying. Herbicide use near pondberry plants should be discontinued until its impact is assessed. The cumulative effects of forestry activities or hydrological alterations should be considered for populations as a whole. Care should be taken to prevent the creation of isolated pondberry islands. Individual colonies within populations should, if possible, be contiguous to ensure that natural dispersal takes place.

Agricultural runoff and herbicide/ pesticide use will also need to be assessed. The water level impacts of management practices on adjacent lands need to be evaluated.

4.4.1.2 Protect *L. melissifolia* from herbivore damage. Agreements need to be made with private landowners concerning the establishment of protected buffer zones. Pondberry should be protected from grazing and browsing animals. Domestic stock grazing on pondberry areas on State and Federal lands should be prohibited. If necessary, fences should be constructed to protect privately owned populations. Insect damage should be monitored. The weevil recently discovered on pondberry in North Carolina should be studied to determine its role in the pondberry stem dieback, which was previously assumed to be caused by a fungus.

4.4.2 Monitor areas immediately around colony buffer zones to determine their environmental impact. Impacts on areas surrounding buffer zones should be monitored to determine activities that could negatively affect pondberry. The hydrology and evapotranspiration rates of an area could be

altered by large-scale clear-cutting, draining or flooding from agricultural practices, or reservoir construction. Impacts of agricultural contaminants should be assessed.

4.4.3 Monitor the populations annually. The size and health of all populations should be determined annually to ensure that current management practices provide for the long-term health of the species.

5. Reestablish colonies in recorded and unrecorded sites within the historic range. *Lindera melissifolia* may no longer be found in Florida, Louisiana, and Alabama. Some remaining populations are threatened by the alteration or destruction of habitat. In order to reach recovery objectives and to ensure the survival of pondberry, additional populations may need to be established. If undertaken, efforts toward reestablishing the species should be monitored regularly. The Missouri Department of Conservation recently transplanted pondberry to currently unoccupied habitat near the known Missouri population. Information gained from this trial relocation will be useful throughout the species' range.

5.1 Identify sites and rank their importance. Past destruction or alteration of pondberry's habitat makes reintroduction into some previously occupied sites impossible. In sites providing suitable habitat, as determined by the results of Task 2.3.4, reestablishment is possible. Preference should be given to manageable extirpated historic sites and sites on public, more easily protected, lands. The long-term protection of all reintroduction sites should be obtained when feasible.

5.2 Prepare sites, acquire seed stock for plantings, and plant seedlings. Although understory competition should be reduced by removing small woody and herbaceous growth, the overstory should be left intact. Because pondberry may need standing water for part of its life history, it may be important to reintroduce the species to sites near the water line of sinks and ponds.

Seeds from the existing populations of *L. melissifolia*, as well as established seed banks (see Task 5.1), should be used to provide the stock for future plantings. Although few seedlings have been observed in the wild, not all seeds should be collected. The seeds have been shown to be easily germinated in a nursery setting. Growers who have a demonstrated knowledge and capability to produce seedlings should be selected. Isolation from other natural and cultivated populations of *Lindera*

melissifolia, as well as other *Lindera* species, should be ensured. When seeds are collected, the collection sites should be documented by herbarium vouchers deposited in a public herbarium.

Plants should be received from the grower in a semi-dormant condition at the end of the growing season. Seedlings should be planted in marked rows or blocks to facilitate the future monitoring of survival and growth. Records and maps should be kept on restockings. To determine the effectiveness of spring planting, some seedlings should be overwintered in the nursery before transplanting. Selection of the genetic stock used in transplants should be made on the basis of the geographic location and the habitat into which the seedlings will be placed.

5.3 Manage reestablished sites. See Task 4.4 above.

5.4 Monitor reestablished sites. See Task 4.4.3 above. Reestablished colonies should be monitored annually until the populations are reproducing either sexually or asexually; thereafter, they should be monitored every 3 years.

6. Protect the genetic resources of *L. melissifolia*. Protection of the *L. melissifolia* gene pool can be accomplished through the establishment of a seed bank and through cultivation. This material can also be used for research and propagation studies. In cooperation with the Center for Plant Conservation, long-term seed storage facilities, botanical gardens, and commercial nurseries should be chosen to provide for the protection of pondberry's genetic material. Seeds should be collected at the appropriate time of the year, as determined by baseline studies; cataloged as to location, time of collection, and genetic content; and preserved. The viability of the seeds should be tested every 2 years.

7. Implement public education programs and establish a part-time recovery coordinator.

7.1 Educate the public about *L. melissifolia* and its habitat. Public awareness and support are important for the conservation of the species. Many methods can be used to increase the public's knowledge of *L. melissifolia* and its habitat. The public should be made aware of the importance of *L. melissifolia* as a wetland species. Articles should be published in local newspapers and newsletters, and educational displays should be established at local botanical gardens. Workshops can be established for local teachers at the elementary, junior high, high school, and university

levels. These workshops should provide the teachers with lesson plans that educate students about *L. melissifolia* and its habitat.

All public education attempts should keep the precise locations confidential, carry a strong conservation message, and provide the name of a person to contact if additional populations are discovered or if more information is desired. Educational efforts should be concentrated in areas known to support the species and should be directed to those individuals having a vested interest in its habitat.

7.2 Designate a lead field office and part-time recovery coordinator. It is recommended that a part-time recovery coordinator for *L. melissifolia* be established at one of the field stations in the Southeast Region of the Service. This coordinator should collect information on research, management activities, land acquisitions, status of populations, and the seed bank and should distribute this information to interested parties. The coordinator should keep abreast of all activities involving pondberry recovery and receive all information on management activities and land acquisitions of *L. melissifolia* sites. The coordinator will then distribute this information to government agencies, conservation organizations, researchers, and private landowners who are taking part in the recovery effort. The coordinator should work closely with the Center for Plant Conservation's participating botanical gardens and interested commercial nurseries to ensure that the species is cultivated in numbers adequate to provide the material needed for reintroduction efforts and that it is available to private gardeners interested in cultivating rare plants.

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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

FWS - U.S. Fish and Wildlife Service
TE - Endangered Species Division of the U.S. Fish and Wildlife Service
PA - Public Affairs Office of the U.S. Fish and Wildlife Service
CPC - Center for Plant Conservation
DOD - Department of Defense
FS - U.S. Forest Service
SCA - State Conservation Agencies, including the following: Alabama Natural Heritage Program, Arkansas Natural Heritage Commission, Florida Department of Agriculture, Florida Natural Areas Inventory, Georgia Natural Heritage Inventory, Louisiana Natural Heritage Program, Mississippi Heritage Program, Missouri Department of Conservation, North Carolina Natural Heritage Program, North Carolina Plant Conservation Program, South Carolina Wildlife and Marine Resources Department
SCS - Soil Conservation Service
TNC - The Nature Conservancy

PONDBERRY IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency FWS	Responsible Agency Other	Cost Estimates ($000's) FY1	FY2	FY3	Comments
1	1.1	Search for new populations.	3 years	R3, 4/TE	SCA	20.0	20.0	20.0	
1	1.2	Protect private populations.	Ongoing	R3, 4/TE	SCA, TNC	10.0	5.0	5.0	
1	1.3	Protect public populations.	Ongoing	R3, 4/TE	DOD, FS, SCA	20.0	20.0	5.0	
1	1.4	Prevent loss of habitat.	Ongoing	R3, 4/TE	DOD, FS, SCA, SCS	???	???	???	
1	2.1	Study reproductive biology.	1 year	R3, 4/TE	SCA		8.0	8.0	
1	2.2.2	Study germination.	3 years	R3, 4/TE	SCA	8.0	8.0	8.0	
1	2.2.4	Study seedling ecology.	3 years	R3, 4/TE	SCA	8.0	4.0	4.0	Should be combined with Tasks 2.2.1, 2.2.3, and 2.2.4.
1	3.3	Identify sexually reproducing colonies.	3 years	R3, 4/TE	DOD, FS, SCA	5.0	5.0	5.0	
1	3.4	Determine genetic variability.	2 years	R3, 4/TE	DOD, FS, SCA	15.0	15.0		
1	3.5	Define self-sustaining population and determine required population distribution.	1 year	R3, 4/TE	SCA				No readily identifiable costs.
1	4.1	Conduct hydrological studies.	3 years	R3, 4/TE	DOD, FS, SCA	30.0	20.0	20.0	
1	4.2	Conduct demographic studies.	5 years	R3, 4/TE	DOD, FS, SCA	20.0	15.0	15.0	
1	4.3.2	Increase colony vigor.	5 years	R3, 4/TE	DOD, FS, SCA	15.0	5.0	5.0	

PONDBERRY IMPLEMENTATION SCHEDULE (continued)

Priority	Task Number	Task Description	Task Duration	Responsible Agency FWS	Responsible Agency Other	Cost Estimates ($000's) FY1	FY2	FY3	Comments
1	4.4.1	Establish buffer zones.	1 year	R3, 4/TE	DOD, FS, SCA				No readily identifiable costs.
1	4.4.1.1	Protect colonies from inappropriate activities.	Ongoing	R3, 4/TE	DOD, FS, SCA				No readily identifiable costs.
1	4.4.1.2	Protect from herbivores.	Ongoing	R3, 4/TE	DOD, FS, SCA	30.0	5.0	5.0	
1	6	Protect genetic resources.	Ongoing	R3, 4/TE	CPC, DOD, FS, SCA	21.0			Should be coordinated through CPC.
2	2.2.1	Study dispersal mechanisms.	2 years	R3, 4/TE	SCA	10.0	5.0	5.0	
2	2.2.3	Study seed predation.	3 years	R3, 4/TE	DOD, FS, SCA	7.0	7.0	7.0	
2	3.1	Define individuals.	1 year	R3, 4/TE	SCA			5.0	
2	3.2	Study asexual reproduction.	Ongoing	R3, 4/TE	DOD, FS, SCA	12.0	5.0	5.0	
2	4.3.1	Develop substrate disturbance techniques.	3 years	R3, 4/TE	SCA	10.0	3.0	3.0	
2	4.4.2	Monitor colony buffer zones.	Ongoing	R3, 4/TE	DOD, FS, SCA				No readily identifiable costs.
2	4.4.3	Monitor populations.	Ongoing	R3, 4/TE	DOD, FS, SCA	12.0	12.0	12.0	

PONDBERRY IMPLEMENTATION SCHEDULE (continued)

Priority	Task Number	Task Description	Task Duration	Responsible Agency FWS	Responsible Agency Other	Cost Estimates ($000's) FY1	FY2	FY3	Comments
3	5.1	Identify and rank reintroduction sites.	1 year	R3, 4/TE	DOD, FS, SCA				Tasks 5.1 through 5.4 will be undertaken only if reintroduction is found to be essential for the successful recovery of the species; in which case, the task priority will increase to 1.
3	5.2	Reintroduce the species.	5 years	R3, 4/TE	DOD, FS, SCA				
3	5.3	Manage reestablished sites.	5 years	R3, 4/TE	DOD, FS, SCA				
3	5.4	Monitor reestablished sites.	5 years	R3, 4/TE	DOD, FS, SCA				
3	7.1	Implement public education program.	Ongoing	R3, 4/TE and PA	SCA	5.0	5.0	5.0	
3	7.2	Designate lead office and part-time coordinator.	Ongoing	R3, 4/TE					

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