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OUTPLANTING OF THE ENDANGERED PONDBERRY

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Abstract—Pondberry [*Lindera melissifolia* (Walt) Blume, Lauraceae] is an endangered shrub that occurs in seasonally flooded wetlands in the Southeastern United States. We established new pondberry populations as an aid in conserving the species, whose distribution and abundance have been affected by habitat destruction and alteration. We dug equal numbers of young male and female pondberry stems from a natural population, planted them in pots, and translocated them to five protected locations in the field. After 1 year, 69 percent of the plants survived, with male and female plants surviving equally well. More than 90 percent of the surviving plants had stems that increased in height, although the height of the tallest stems decreased. Many of the plants produced new stems, but some older stems died during the year. Most of the present pondberry habitat is surrounded by agricultural fields, which significantly limits dispersal. This study shows that pondberry can be successfully outplanted, in efforts to assure survival of the species.

INTRODUCTION

Pondberry [*Lindera melissifolia* (Walt) Blume, Lauraceae] is a rare woody plant that occurs in seasonally flooded wetlands and on the edges of sinks, ponds, and depressions in the Southeastern United States (Radford and others 1968). The plant is a stoloniferous, clonal shrub that grows to 2 m in height. The species was listed as endangered by the U.S. Fish and Wildlife Service in 1986 (U.S. Fish and Wildlife Service 1986). Pondberry probably has always been rare (Kral 1983, Steyermark 1949), but the distribution and abundance of the species have been affected by habitat destruction and alteration, especially timber cutting, clearing of land, and local drainage or flooding of wetlands. Agricultural land clearing operations have severely reduced pondberry populations in Missouri and Arkansas since the 1940s [Tucker, G.E. 1984. Status report on *Lindera melissifolia* (Walt) Blume. Provided under contract to the U.S. Fish and Wildlife Service, Southeast Region, Atlanta, GA. 41 p. Unpublished manuscript. On file with: U.S. Fish and Wildlife Service, Southeast Region, 1875 Century Blvd., Suite 200, Atlanta, GA 30345]. Many of the existing pondberry colonies are quite small. The species commonly occurs in patches of woods, too wet for crops, surrounded by huge agricultural fields.

Pondberry occurs in Arkansas, Georgia, Mississippi, Missouri, North Carolina, and South Carolina, but has apparently been extirpated from Alabama, Louisiana, and possibly Florida. The 1993 pondberry recovery plan states that there are 36 populations (U.S. Fish and Wildlife Service 1993), but other colonies have been discovered since 1993 in new locations and near known populations. The current number of populations is unknown; some populations previously believed to be far enough apart to preclude interbreeding (as on the Delta National Forest, MS) may have been linked by recently discovered colonies. In addition, some colonies that were present in 1993 no longer exist. All of the plants in a colony near Cleveland, MS, recently died. Another colony on private land in eastern Arkansas was destroyed by the landowner.

Pondberry is dioecious, with small yellow flowers that bloom in spring. The plant usually occurs in clones with numerous stems, but because the species is clonal, colonies with abundant stems may contain few genets (genetic individuals) (Eriksson 1992, Oinonen 1967). Male stems outnumber female stems in most colonies, and some colonies are composed of only male clones (Wright 1989, 1990). Seed production is often sporadic, and few seedlings are observed in and around natural populations (Wright 1990), as in many clonal plant species (Cook 1979, Eriksson 1989, Harper 1977).

The purpose of our study was to investigate whether establishing new pondberry populations aids in conserving and bringing about the recovery of the species over its presumptive former range. In order for a species to survive and spread, plants must colonize unoccupied habitat at least as often as populations die out (Schemske and others 1994). The pondberry recovery plan (U.S. Fish and Wildlife Service 1993) states that the species will be downlisted when 15 protected, self-sustaining populations occur throughout the historic range of the plant. The specific objectives of this study were to examine the following questions: (a) Is it possible to transplant clonal pondberry material successfully? (b) Does percent survivorship differ among male and female plants for this species?

METHODS

During the spring flowering season, we tagged pondberry plants in a population on private land in Mississippi in order to establish gender. We separated young rooted stems from clones and dug them with soil from the area in which they grew. The stems were planted in pots; a synthetic soil mix was used to fill in around the root mass. The plants were maintained in a greenhouse for at least several weeks then translocated to the field. We translocated equal numbers of male and female plants to a total of five sites in protected locations in Mississippi. The planting sites were Leroy Percy State Park near Hollandale, two sites at Yazoo National Wildlife Refuge near Glen Allen, Morgan Brake

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National Wildlife Refuge, and Hillside National Wildlife Refuge near Tchula. Planting sites were chosen in low areas with medium light, but not so much light that competition by other plants would be a problem. We located sites within 200 m of a trail to facilitate our watering of the plants as well as viewing by visitors. We placed the pondberry plants in slight depressions at least 3 m away from medium-to-large trees. In September 2000, plants were translocated to Leroy Percy State Park and to Yazoo National Wildlife Refuge. In November 2000, plants were translocated to Morgan Brake National Wildlife Refuge and to Hillside National Wildlife Refuge. Each pair of male and female plants was surrounded by a cage of chicken wire on wooden supports to prevent damage by animal herbivores and was labeled (fig. 1). Each plant had been previously tagged, and the height of each stem was recorded at planting. We watered the plants weekly during the growing season unless ample rainfall had occurred that week. We monitored the plants monthly for insect pests and applied pesticide and fertilizer as needed. One year after outplanting, we monitored the survival of the plants, recorded new stems, measured the height in cm of surviving and new stems, and noted whether dieback had occurred at the apex of the stem.

Figure 1—A pair of outplanted pondberry (*Lindera melissifolia)* plants surrounded by a cage for protection against animal herbivores.

RESULTS

Most of the potted plants produced new stems within a few weeks in the greenhouse, and new stems occurred on plants at every site except Morgan Brake. At one site on the Yazoo National Wildlife Refuge, animals, probably armadillos (*Dasypus novemcinctus*), tunnelled under the wire enclosures and dug up several of the plants. We replaced the plants promptly, and all survived. Most of the plants (69.2 percent overall) survived and grew (table 1). Survival was lowest at Morgan Brake (35 percent) where the plants were attacked by a scale insect that also attacked the surrounding vegetation. The percentage of surviving plants that increased in height after introduction to the sites ranged from 92.3 to 100. The percentage of plants that experienced some stem dieback ranged from 84.6 to 100. After 1 year, the mean height of the stems of surviving plants was slightly less than the height at time of planting at three of the five planting sites, and the mean number of stems decreased slightly at four of the five sites (table 2). Fisher's exact tests demonstrated no differences in survival of female vs. male plants at the sites (table 3).

DISCUSSION

The pondberry plants we translocated showed good overall survival and health except at Morgan Brake, where the plants were infested with scale. Morgan Brake was the only location where no new stems were produced, but the surviving stems grew taller than stems at the other sites. After the attack by scale insects, regrowth occurred in existing stems instead of in the production of new stems.

Although one or more stems of many of the plants increased in height, the stress of introduction and the effects of dieback apparently resulted in a decrease in mean height of the stems at three sites. New stems were produced, but

Table 1—Survival and growth of pondberry plants introduced to five protected sites in Mississippi, 1 year after translocation. Data for male and female plants are pooled. Overall survival was 69.2 percent

	Surviving plants				
			Plants with		
Site	Plants	Surviving	Height increase	New stems	Dieback
	- - *number* - -		- - - - *percent* - - - -		
Leroy Percy	20	13 (65.0)	92.3	38.5	100.0
Yazoo 1	31	26 (83.9)	92.3	54.8	84.6
Yazoo 2	10	7 (70.0)	100.0	28.6	85.7
Morgan Brake	20	7 (35.0)	100.0	0.0	85.7
Hillside	40	31 (77.5)	96.8	22.5	87.1

Table 2—Height and number of stems of pondberry at planting and 1 year after translocation. Data for male and female stems are pooled.

Location and original number of plants	At planting[a]		1 year later[a]	
	Mean			
	Height	Stems per plant	Height	Stems per plant
	cm	*number*	*cm*	*number*
Leroy Percy (20)	46.3 (29.4)	1.8 (1.2)	45.2 (27.7)	1.2 (0.4)
Yazoo1 (30)	48.2 (32.9)	2.0 (1.3)	39.2 (26.9)	2.2 (1.2)
Yazoo 2 (10)	41.8 (30.5)	1.5 (0.5)	43.9 (24.8)	1.2 (0.8)
Morgan Brake (20)	42.8 (29.6)	2.0 (1.0)	63.8 (19.8)	1.0 (0.0)
Hillside (40)	45.3 (27.7)	1.9 (1.4)	41.2 (24.7)	1.8 (1.3)

[a] Standard deviations in parentheses.

Table 3—Survival of male vs. female pondberry plants introduced to five protected sites in Mississippi, 1 year after translocation

Site	Gender	Alive	Dead	Total	Fisher's exact test (*P*)
Leroy Percy	Female	5	5	10	0.15
	Male	8	2	10	
Yazoo 1	Female	12	3	15	0.34
	Male	13	2	15	
Yazoo 2	Female	4	1	5	0.42
	Male	3	2	5	
Morgan Brake	Female	5	5	10	0.15
	Male	2	8	10	
Hillside	Female	14	6	20	0.16
	Male	17	3	20	

they were not quite equal to the number of stems that died during the year. The turnover period in stems in natural populations is unknown. The stem dieback that was noted in the introduced plants also occurred in all the natural populations that we visited. At present, the cause of dieback is not known. Three fungal species previously reported for *Lindera* were isolated from dead pondberry stems by Devall and others (2001), but the authors did not demonstrate that the fungi caused the dieback. Godt and Hamrick (1996) suggest that stem dieback in pondberry may be an aging phenomenon. Other researchers have noted dieback as well (Richardson and others 1990, Tucker 1984). Morgan (1983) recorded dieback in a pondberry population in Missouri; 20 years later dieback is still occurring at the same site, but there are thousands of stems and the population seems vigorous, indicating that pondberry plants can survive for a long period in the presence of dieback (Devall and others 2001).

Although male stems outnumber female stems in many natural populations of pondberry, and some natural populations are composed of only male stems (Richardson and others 1990, Wright 1994), the male and female plants in our study survived outplanting equally well. J. Lovett Doust and P. Lovett Doust (1988) suggest that in dioecious species, the greater physiological cost of reproduction for females may result in gender ratios biased in favor of males. Almost no flowering (two plants flowered) and no fruit production occurred in the outplanted pondberry, so the cost of reproduction has probably not affected survival in these plants.

In our study, removing individual stems from pondberry clones provided large plants for introduction to new sites within a few weeks without apparent damage to the original clones and without decreasing the genetic diversity of the natural population. One advantage of using clonal material is the decreased time and cost of maintaining plants in the greenhouse, compared with using seedlings. It would take at least 2 years for seedlings to grow to the size of clonal transplants. Larger introduced pondberry plants may also survive better than seedlings. At a site in Florida, Kent and others (2000) found that initial plant size affected survival in Britton's beargrass (*Nolina brittoniana*), scrub plum (*Prunus geniculata*), and probably scrub lupine (*Lupinus aridorum*). Size at time of planting did not affect the survival of papery whitlow-wort (*Paronychia chartacea*), but only the larger plants flowered and set seed.

The Lower Mississippi Alluvial Valley, where most of the present pondberry populations occur, is one of the most endangered ecosystems in the United States (Noss and others 1995). Much of the former forest has been cleared for agriculture, and flood control projects have drastically changed hydrological cycles (Stanturf and others 1998, 2000). Most of the potential pondberry habitat is fragmented and surrounded by agricultural fields, thus the possibility for dispersal is very limited, and populations that die out will usually not be replaced (Devall and others 2001).

Schemske and others (1994) suggest that designing and managing new populations of rare plant species is the most difficult task associated with their conservation. Introductions of rare species into new or former habitat have produced mixed results (Griffith and others 1989). Existing pondberry populations should be protected where possible, and searches for new populations should continue, but this study indicates that introduction of pondberry plants in governmentally or privately protected sites provides additional assurance of the survival of the species.

In summary, after 1 year in the field, clonal material provided successful transplants, with no difference in survivorship between male and female plants. To provide more information for future restoration, the plants in our study should be monitored for several years. Additional studies should also be undertaken to compare the survival of outplanted seedlings to the survival of outplanted stems taken from clones.

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