New England Plant Conservation Program

Rhexia mariana L.
Maryland Meadowbeauty

Conservation and Research Plan
For New England

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SUMMARY

Rhexia mariana L., Maryland meadowbeauty, (Melastomataceae) is a regionally rare, but globally secure, species that is listed S1 (Endangered) in Massachusetts and has never been documented in any other New England state. There are nine extant and four historical occurrences in Massachusetts, all of which are on Cape Cod. Only three of these sites were found to include over 500 stems in the 2001 season; several others had less than 50. The small number of sites for this species, their small populations, and the instability of population numbers from year to year all make *R. mariana* very vulnerable in the region.

This perennial herb of pond shores and wet meadows is common in the southern Atlantic coastal plain from central New Jersey to Florida and on the Gulf coast to Texas. Although *R. mariana* is secure in the heart of its range, preserving the species in New England is important because such peripheral populations often serve as reservoirs of genetic diversity for a species as a whole. The Massachusetts occurrences represent a disjunct population at the northern extreme of the species' range. Here, it is found along with other characteristic coastal plain species on the acidic and nutrient-poor, sandy beaches of freshwater ponds, in full sun. Fluctuating water levels on these ponds may be a key to the persistence of *R. mariana* and several other rare plants. A closely related species, *R. virginica*, is much more common in New England and even farther north, but it is not clear why it survives northern conditions better than *R. mariana*.

Major threats to the persistence of *Rhexia mariana* in the region are: habitat loss due to development; physical destruction of mature plants and propagules from pedestrian and vehicular traffic; alterations in hydroperiod, which can allow open pond shores to become overgrown with woody plants; and eutrophication due to fertilizer use and septic field inputs. All of these threats are growing in proportion to the burgeoning human population and increasing recreational activity on Cape Cod.

Several extant locations are currently protected and managed, but only informally. These need to acquire a stronger legal basis along with formal, long-term management plans. Similar protection and management must be extended to other sites not currently managed in any way. Modest management steps, including augmentation of existing small populations, at a few such sites should make it possible to add two or three current EOs to the list of locations supporting populations of 500 stems or more. A program of introductions (or reintroductions) should be started in order to expand the precariously low number of extant occurrences of this taxon in New England by one or two sites. To inform this project, research is needed on the habitat requirements and reproductive potential of this species. Additional genetic research could determine how many populations actually exist and the amount of gene flow, if any, between the sub-populations found at separate sites. A goal of maintaining at least seven occurrences of 500 stems or more should be set for the next two decades.

PREFACE

This document is an excerpt of a New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. Because they contain sensitive information, full plans are made available to conservation organizations, government agencies and individuals with responsibility for rare plant conservation. This excerpt contains general information on the species biology, ecology, and distribution of rare plant species in New England.

NEPCoP is a voluntary association of private organizations and government agencies in each of the six states of New England, interested in working together to protect from extirpation, and promote the recovery of the endangered flora of the region.

In 1996, NEPCoP published "*Flora Conservanda*: New England," which listed the plants in need of conservation in the region. NEPCoP regional plant Conservation Plans recommend actions that should lead to the conservation of Flora Conservanda species. These recommendations derive from a voluntary collaboration of planning partners, and their implementation is contingent on the commitment of federal, state, local, and private conservation organizations.

NEPCoP Conservation Plans do not necessarily represent the official position or approval of all state task forces or NEPCoP member organizations; they do, however, represent a consensus of NEPCoP's Regional Advisory Council. NEPCoP Conservation Plans are subject to modification as dictated by new findings, changes in species status, and the accomplishment of conservation actions.

Completion of the NEPCoP Conservation and Research Plans was made possible by generous funding from an anonymous source, and data were provided by state Natural Heritage Programs. NEPCoP gratefully acknowledges the permission and cooperation of many private and public landowners who granted access to their land for plant monitoring and data collection. If you require additional information on the distribution of this rare plant species in your town, please contact your state's Natural Heritage Program.

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I. BACKGROUND

INTRODUCTION

Rhexia mariana L. (Melastomataceae), commonly known as Maryland meadowbeauty, pale meadowbeauty, or deergrass, is a perennial herb of wet, sandy, acidic soils. As the common names imply, it has a large attractive flower (pale pink to white in this particular species) and is also frequently browsed by deer. It is reported in 24 states and the District of Columbia, but is concentrated mainly along the Atlantic coastal plain. It is common, even weedy, in the southeastern coastal states, exhibiting some tolerance for a range of soil conditions as well as anthropogenic alterations to the landscape, such as roads, agriculture, and forest clearance. However, at the extremes of its range, such as in New England, Michigan, and in the mountains of West Virginia, it is rare and apparently restricted to unaltered, wet to seasonally flooded sites. Periodic high water, in fact, may be necessary to keep *R. mariana* sites clear of other species that could outcompete it.

Rhexia mariana is distinguished from *R. virginica,* the only other member of the genus found in New England, by its paler flowers, narrower leaves, rounder stems, and non-tuberous roots. *Rhexia mariana* has been subdivided into several varieties by taxonomists. The variety present in New England is the typical one, var. *mariana.* The other two varieties are most common in the deep south and in the interior, far from this region.

The species relies on vegetative spread at least as much as sexual reproduction for maintaining itself year-by-year on any particular site. New shoots grow from stoloniferous rhizomes in the fall, after a mature plant flowers. Pollination is dependent on insects; in fact, pollen is only expelled from the closed anthers when the flower is vibrated by a bumblebee. Both seeds and viable rhizomes are able to persist in the soil for several years until conditions are appropriate for them to sprout. This may be important to the persistence of the population through periods of high water.

The main threats to the presence of this taxon in New England are its already very low numbers and the rapid pace of development and increased human use of Cape Cod. Few pond shores are sufficiently free from human alteration (whether intentional or accidental) to provide habitat for these plants. Much good habitat has been converted to buildings and lawns, while other pond shores are repeatedly assaulted by off-road vehicles. An additional, indirect, alteration of this habitat comes with the increased human use of Cape Cod's underground freshwater resources. The lowering of the water table and the resulting reduction in flood maxima may facilitate the encroachment of more competitive upland species, forcing out *R. mariana* and other pondshore specialists.

Active, though small-scale, management measures have been crucial to the survival and expansion of this rare species at some sites. Extension of such practices to a few others would make *R. mariana* significantly less precarious on Cape Cod. Preserving a population of *Rhexia mariana* at the northern extreme of its range may be important to the species as a whole since genetic diversity is often greatest in peripheral areas (Lesica and Allendorf 1995). Habitat requirements are usually more sharply exposed at the extreme of a species' range, making them easier to study and understand.

DESCRIPTION

Rhexia mariana L. (Melastomataceae) is an erect, often freely branched, perennial herb from 20 to 100 cm tall. It is usually found in moist, open places on the Atlantic coastal plain from Cape Cod to Florida, as well as inland as far west as southern Indiana, Missouri, and Texas (Gleason and Cronquist 1991). Leaves are opposite, lanceolate to lance-oblong, and sessile or short-petioled, with 3 nerves, though in some cases only the central one is conspicuous (Kral and Bostick 1969). The flowers have 4 broad, asymmetric, open petals (12–15 mm long) varying from pale purple or pink to almost white. The flowers are borne in terminal cymes from July through September in Massachusetts (personal observation). Eight long, curved anthers (5–9 mm) are bright yellow at anthesis and turn red afterwards. They release their pollen through a tiny terminal pore, only about 1/3 the diameter of the anther tip (James 1956).

The urn-shaped hypanthium at maturity is 9–11 mm long and glandular-hirsute. Its neck is longer than its body and it bears narrow teeth on the margin, which often curl back (Rickett 1967). Thoreau described the hypanthium of *R. virginica,* which is similar but with a shorter neck, as "perfect little cream pitchers" (DiGregorio and Wallner 1989). The capsule contains numerous seeds, 0.5–0.7 mm long. Each seed is cochleate (shaped like a coiled snail shell) with tiny papillae, usually oriented in longitudinal rows (James 1956). These papillae are visible under a hand lens in the variety found in New England, but only under greater magnification in some other varieties (Gleason 1952). The stem appears sub-terete (almost round in cross section), but actually is slightly quadrangular, with unequal faces—two opposite sides being narrower and flat to concave, while the other pair are wider and convex (Gleason and Cronquist 1991). However, unlike some other members of the genus, the stem has no wings, or ridges, so the overall feel of the stem is round. The base of the stem is sometimes subligneous, with a reddish-brown, slightly exfoliating, thin bark. The shallowly set, elongate, stoloniferous rhizomes give rise to new stems (Kral and Bostick 1969).

The only other member of this genus found in New England is *R. virginica* (Virginia meadowbeauty). It is considerably more common on Cape Cod than is *R. mariana,* and its range continues north as far as Ontario and Nova Scotia. It can be distinguished from *R. mariana* by its broader, usually sessile leaves, its darker purple petals, and the square feel of its stem due to four wings along the length of the stem. In *R. virginica*, the hypanthium neck is shorter than the body, the opposite of their relationship in *R. mariana* (Kral and Bostick 1969). Furthermore, *R. virginica* roots are

tuberous where shoots develop, whereas *R. mariana* has no tuberous roots, producing shoots from slender, horizontal rhizomes. In *R. mariana* stomata are present on both surfaces of the leaf, while the leaves of *R. virginica* have stomata only on the abaxial surface (Holm 1907).

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

This genus and species were both named by Linnaeus in *Species Plantarum* in 1753. The generic name derives from the Greek *rhexis*, a breaking or bursting forth (Wurdack and Kral 1982). Pliny had used the name for a different plant, possibly a species of *Anchusa* or *Echium* (Boraginaceae), which the Romans believed was medically useful for curing ruptures (James 1956). There is no evidence of why Linnaeus chose the name, but it could possibly be a reference to the dehiscence of the stamens (see below).

The Melastomataceae is a large family with 166 genera and 4200 to 4500 species worldwide (Baskin et al. 1999), but it is almost completely restricted to the tropics. The majority of species occur in the neotropics, and no genus is common to both the Old and New Worlds (Wurdack and Kral 1982). *Rhexia* is distinguished from other Melastomataceae by its stamens, which are isomorphic, with unilocular anthers, unlike most other species in the family, which have 2 or 4 pollen sacs in each anther (James 1956).

Rhexia is one of two genera that occur in the United States, and the only non-tropical genus in the family (Renner and Meyer 2001). The other U.S. genus is represented in this country by one species—*Tetrazygia bicolor*—which occurs only in subtropical Florida and was probably introduced from Central America or the Caribbean (James 1956). Because of its unique distribution within the Melastomataceae, and its concentration on the Atlantic coastal plain, which was repeatedly flooded in the Pleistocene, *Rhexia* had been presumed to be a relatively young genus within the family, possibly derived from a West Indian, Mexican, or Central American ancestor (Renner and Meyer 2001). A recent analysis of molecular and fossil evidence suggests, however, that *Rhexia* is actually a basal genus within the tribe Melastomeae. Ancestors of *Rhexia* (and possibly other now extinct members of the tribe) apparently entered North America from northeast Asia in the early Miocene (18 million years ago). From this continent, they colonized and diversified in South America and ultimately spread to Africa and Asia. Today's species of *Rhexia* (or its ancestors) survived the Pleistocene sea level changes in refugia in southeastern North America, while other members of the family were extripated from the continent (Renner and Meyer 2001).

The taxonomy of the genus has been revised several times in the past 50 years. *Rhexia mariana* and *R. virginica,* the two most widespread species, have been the subjects of most of these taxonomic changes. James (1956) recognized 12 species of *Rhexia,* with both *R. mariana* and *R. virginica* including two varieties. Kral and Bostick (1969) also listed 12 species, but added two new ones and subsumed two of James's

species as varieties of *R. mariana* (var. *ventricosa* and var. *interior*). Kartesz (1994) proposed only 11 species. Kartesz (1994) recognized three varieties of *R. mariana: mariana, interior,* and *ventricosa* but only one of *R. virginica* as did Kral and Bostick (1969). The *interior* and *ventricosa* varieties have each been considered separate species by various other authors. Kral and Bostick (1969) point out that both these varieties display characteristics of *R. mariana* var. *mariana* (rhizomes, hypanthium, seed) as well as of *R. virginica* (wider leaves, winged stems), and that both varieties will hybridize with both *R. mariana* and *R. virginica. Rhexia mariana* var. *mariana* has also been called *R. delicatula* Small, *R. filiformis* Small, *R. augustifolia* Nutt., *R. lanceolata* Walt., *R. mariana* var. *exalbida* Michx. and *R. mariana* var. *leiosperma* Fern. & Grisc. Kartesz's system also considers *R. nashii* Small as a species, although others have called it *R. mariana* var. *purpurea* Michx. All *Rhexia mariana* found in New England are var. *mariana*.

SPECIES BIOLOGY

Rhexia mariana is a perennial herb that reproduces both sexually and asexually. Vegetative propagation is by means of shoots that bud from the slender, shallow rhizomes of a mature plant after it flowers in late summer. These new root-shoots have overlapping leaves and very short internodes, and they remain that way through the winter until growth resumes in the spring (James 1956). Nearly 100 years ago, Holm (1907: 32) commented that "Rhexia must be placed with that type of plants in which the production of root-shoots is necessary to the normal development of the individual." This method of propagation enables the species to achieve high densities and spread aggressively in some conditions. In fact, some apparently large populations may include only a few genetically distinct individuals (Kral and Bostick 1969).

Flowers are perfect, and each of the eight anthers consists of a single pollen sac which dehisces through a tiny pore in the tip. Such poricidal anthers occur in only about 6–8% of all flowering plant species but are common in the Melastomataceae (Larson and Barrett 1999a). In the bud, the stigma lies considerably above the stamens, preventing self-fertilization before the flower opens (Leggett 1881). In fact, *R. mariana* and most other *Rhexia* species are obligate outbreeders (Kral and Bostick 1969). When the flower opens, the floral axis is oriented horizontally. The style elongates and droops, while the stigma curves upward, leaving the stigma below the anthers (James 1956). Simultaneously, each filament twists just enough to orient its anther vertically, with the pore at the bottom and facing outward. The eight anthers line up parallel to each other in a single plane, with four on one side and four on the other of the floral axis (James 1956).

The style provides a landing point for an insect, usually a bumblebee. The pores of the anthers all point out toward the bee. Bees land on the stigma first, then crawl up onto the anthers, causing the release of the pollen (James 1956). Pollen is ejected by the bellows-like lower part of the anther only when vibrated (possibly at fairly specific frequencies) by the buzzing of a bee. Some observers report an unusually vigorous buzzing by bumblebees visiting *Rhexia* flowers (Eyde and Teeri 1967). A field study of

R. virginica in Ontario (Larson and Barrett 1999b) concluded that only about 10% of a flower's pollen is released during a single bumblebee visit, and an average of nearly 50% of the pollen is retained at the end of anthesis. Each flower lasts only a single day (Larson and Barrett 1999b). Seed set by these plants in the 13 populations studied was also low, leading the authors to conclude that pollination is a limiting factor for the species in that area. Both *R. virginica* in Ontario and *R. mariana* in Massachusetts are at the northern limit of their range, so a similar situation may apply to New England populations of *R. mariana*, but further research would be needed to determine if this is the case.

Rhexia mariana produces small seeds that may survive well in the natural seed bank. Seeds of *R. mariana* var. *interior* remained viable through 32 months of burial (Baskin et al. 1999). Keddy and Reznicek (1982) found 900 seeds of *R. virginica* germinated per square meter of sediment (5 cm thick) taken from a lake bottom in Ontario. These experiments imply that *R. mariana* also may persist in the seed bank for some time, enabling populations to survive fluctuations in water levels from year to year. The study of *R. marina* var. *interior* germination also demonstrated that cold stratification was necessary to break initial seed dormancy and that sunlight and temperatures of 25:15ºC to 35:20ºC (mean daily maximum : mean daily minimum) were required for optimum germination (Baskin et al. 1999). The viability of seeds in the natural seed bank, along with a perennial life cycle and vegetative propagation all mean that populations of *R. mariana* are not dependent on successful seed production every year. Therefore, even in healthy populations, numbers can fluctuate greatly from year to year, including even a year or two in which no individuals flower.

The base number of chromosomes for the *Rhexia* genus is 11 (Kral and Bostick 1969). Kral and Bostick (1969) report that ploidy is one of the characteristics distinguishing among varieties of *R. mariana.* The typical variety has a chromosome number of 11, while the *interior* and *ventricosa* varieties have 22.

Hybridization between *R. mariana, R. virginica*, and a few other species has been observed in nature and produced experimentally (Wurdack and Kral 1982). These hybrids often display features intermediate between their parents, or a combination of features from both parental species. However, most such hybrids are infertile (Kral and Bostick 1969).

HABITAT/ECOLOGY

Rhexia mariana is found in wet sandy soil that is usually acidic and nutrient-poor. It requires full sun. Within the heart of its range, in Virginia and the Carolinas, it is also common in disturbed areas such as roadside ditches and along the edges of clear cuts (Mike Schafale, North Carolina Natural Heritage Program, and John Townsend, Virginia Division of Natural Heritage, personal communications). In the Florida panhandle, where it is the most common species of the genus, it can be weedy in any moist soil, disturbed or undisturbed (Loran Anderson, Florida State University, personal

communication). In Virginia, *R. mariana* is considered an easy species for wildflower gardeners to grow, and it can naturalize in any low, sunny spot (Hugo 1990). In New England, at the northern edge of its range, it appears almost exclusively on the wet upper margins of relatively undisturbed pond shores, where it may be at least seasonally flooded due to fluctuating pond levels (Massachusetts Natural Heritage and Endangered Species Program 1985).

Rhexia mariana, like many rare coastal plain species, may be dependent on the occasional flooding of these pond shores. Alternating periods of inundation and exposure suppress the growth of more competitive plants—both upland and aquatic species—leaving a band around these ponds that is available for coastal plain species (Keddy and Reznicek 1982). These species, like *R. mariana,* have evolved strategies for surviving in a variable environment, especially persisting in the seed bank during periods that are not conducive to flowering. Of the 13 current and historical occurrences of *R. mariana* in Massachusetts, 11 are on pond shores, one is near a former cranberry bog, and one is a short distance from a pond in a seasonally flooded depression. Of the 11 sites where exposure can be determined, nine are on the north or west sides of a pond or bog, one is under a power line, and only one is on the south shore of a pond. This distribution is an indication of the importance of full sun to this species.

Species associated with *Rhexia mariana* on Cape Cod include many typical coastal plain plants. Among these are *Rhexia virginica*, *Drosera intermedia, Eleocharis melanocarpa, Eupatorium perfoliatum, Euthamia tenuifolia, Hypericum canadense, Juncus biflorus, J. canadensis, J. militaris, Rhynchospora capitellata, Sphagnum* spp., *Spiraea tomentosa,* and *Viola lanceolata.* Several rare species are also found in association with *R. mariana,* including *Coreopsis rosea* (G3, Massachusetts S3, Rhode Island S2) and *Sabatia kennedyana* (G3, Massachusetts S3, Rhode Island S1). The most commonly associated shrubs are *Clethra alnifolia* and *Vaccinium corymbosum.*

THREATS TO TAXON

Habitat requirements for *Rhexia mariana* in New England, at the northern limit of its range, appear to be much more specific than farther south, in the Carolinas. It is now restricted to only one peculiar area within our region—Cape Cod—and one habitat—freshwater pond shores. Since there are a decreasing number of unaltered coastal plain pond shores on Cape Cod, the status of the species is not likely to improve without intervention. Cape Cod is home to disjunct populations of a number of other coastal plain species (Sorrie 1994). Being surrounded by water, the cape has a milder climate than most of the rest of New England. Its sandy glacial outwash soils and its extensive shorelines (both freshwater and salt) provide many habitat options for coastal plain species. Also, until about 50 years ago, human population and activity on Cape Cod was a relatively minor factor compared with other New England coastal areas that have been urbanized for centuries. All these factors help explain why Cape Cod is the only place in New England in which *R. mariana* currently occurs. How long this population has been isolated from the majority of the species is unknown. At this point, the total numbers of

this species are so low and so variable, the number of sites so few, and the geographic distribution of these sites so restricted that it is very vulnerable to stochastic events that can suddenly wipe out a large portion of the occurrences in New England. These include unusual weather events, fire, tree falls, longer-term changes in water levels, and genetic chance events that can cause reproductive failure.

Development

The human population of Cape Cod has grown exponentially. It took 125 years (1825–1950) to double from 25,000 to 50,000 (Stone 2000). Since 1950, it has more than quadrupled to over 222,000 (U.S. Census Bureau 2002). (This counts permanent residents only; the total number of people on Cape Cod, especially in the summer, is far higher.) The suburbanization of the region has meant development pressures on all open spaces. Pond shores are especially desirable as building sites, and where houses, lawns, beaches, and boat ramps go in, species like *R. mariana* cannot survive. At two of the Element Occurrences (EOs) for *R. mariana*, the area inhabited by this species abruptly stops where homeowners have extended lawns or access paths to the water. Another pond had a small population reported in the early 1980s, but not since 1985. Several houses have been built nearby since then.

Off-road Vehicles

Along with development, *per se*, comes increased recreational use of the remaining undeveloped land and waters. Most Cape Cod residents and the millions who visit there expect to find water and beaches for their enjoyment. A particularly destructive form of recreation—off-road vehicles (ORVs)—ironically occurs most frequently in the least developed areas. The open sandy shores exposed when pond levels recede are apparently irresistible to ORV enthusiasts. Traffic by these vehicles damages growing plants and often changes the contours of the beach, increasing erosion and causing alterations in flooding frequency. They compact the soil, accelerate oxidation of organic matter that had accumulated in the pond bottom for years (Sorrie 1994), expose seeds at inappropriate times for their germination, and destroy underground propagules. Residents of more developed pond shores usually keep these vehicles off their beaches, but undeveloped land, which provides the only remaining habitat for rare plants, is vulnerable. Several pond shores in the Hyannis Ponds Wildlife Management Area are continually torn up by ORVs despite repeated efforts to block access (personal observation).

Altered Hydroperiod

Human population growth has also led to increasing use of underground water supplies, lowering the water table and decreasing the frequency and duration of pondshore flooding (McHorney 1998). Fluctuation in pond levels is an important factor

in maintaining the habitat for *R. mariana* and many other pondshore endemics (Schneider 1994). Occasional floods keep woody, upland species off the pond shore, while receeding water levels prevent the domination of aquatic and emergent species. In a more stable environment—either always dry or always wet—these plants would outcompete pondshore herbs like *Rhexia mariana* (Keddy and Reznicek 1982; personal observation). At two EOs still considered extant but where *R. mariana* has not been found for several years, pitch pines *(Pinus rigida)* and other upland species have invaded the area. (At one of these sites, the pines are now dead due to subsequent high-water years.) Pitch pines alter the pondshore environment with shade and pine needle litter, both of which severely inhibit the growth of many herbaceous species typical of this habitat (Craine 2002).

Eutrophication

Increasing the fertility of the soil through runoff of fertilizers from nearby lawns and golf courses or from septic field drainage may harm species like *R. mariana* that are frequently found in nutrient-poor soil. The mechanism is similar to the effect of decreasing flood disturbance. Increasing soil fertility can allow new species, often more competitive ones, to colonize an area that previously supported only species that are less competitive but tolerant of poor soils. Increased fertility and decreased flooding both generally lead to lower diversity in coastal plain pondshore plant communities (Keddy and Wisheu 1989).

DISTRIBUTION AND STATUS

General Status

Rhexia mariana occurs in wet, sandy soils on the coastal plain from eastern Massachusetts to Florida and west to Texas. It is also found at lower elevations inland, farther west, to southern Indiana, Illinois, and Missouri (Gleason and Cronquist 1991). Since it has been extirpated from New York State, where it was last reported in 1923 on Long Island (Zaremba and Lamont 1993), the closest population to that in Massachusetts is in central New Jersey. From there, populations of the species occur virtually continuously down the Atlantic coastal plain and around the Gulf of Mexico. Interior, non–coastal plain populations occur especially in the Ohio/Tennessee basin (Tennessee, Kentucky, southern Indiana and southern Illinois) and in the lower Mississippi Valley (Missouri and Arkansas). The one or two occurrences in West Virginia are on river banks (Barbara Sargent, West Virginia Nongame Wildlife and Natural Heritage Program, personal communication). It has recently been located in southwest Michigan, in an area near Lake Michigan where other coastal plain disjuncts are also found (Mike Penskar, Michigan Natural Features Inventory, personal communication). It is not found in Canada, although *R. virginica* does occur in Ontario and Nova Scotia, where it is considered rare.

Rhexia mariana is globally secure (G5), but regionally rare in New England. It is listed S1 (Endangered) in Massachusetts (Massachusetts Natural Heritage and Endangered Species Program 2002). It is not present now and has never been reported in any other New England state. It is placed in Division 2, Regionally Rare Taxa, by *Flora Conservanda,* New England, the New England Plant Conservation Program (NEPCoP) list of plants in need of conservation (Brumback and Mehrhoff et al. 1996).

The North American distribution of *Rhexia mariana* (by state) is illustrated in Figure 1 on the next page. These data are taken from NatureServe (formerly the Association for Biodiversity Information) (NatureServe Explorer 2001) and the USDA's PLANTS Database (USDA, NRCS 2001) and consider *R. mariana* without regard to variety, although the plants found in New England are all of the variety *mariana*. The New England distribution (by town) is presented in Figures 2 and 3 on pages 13 and 14.

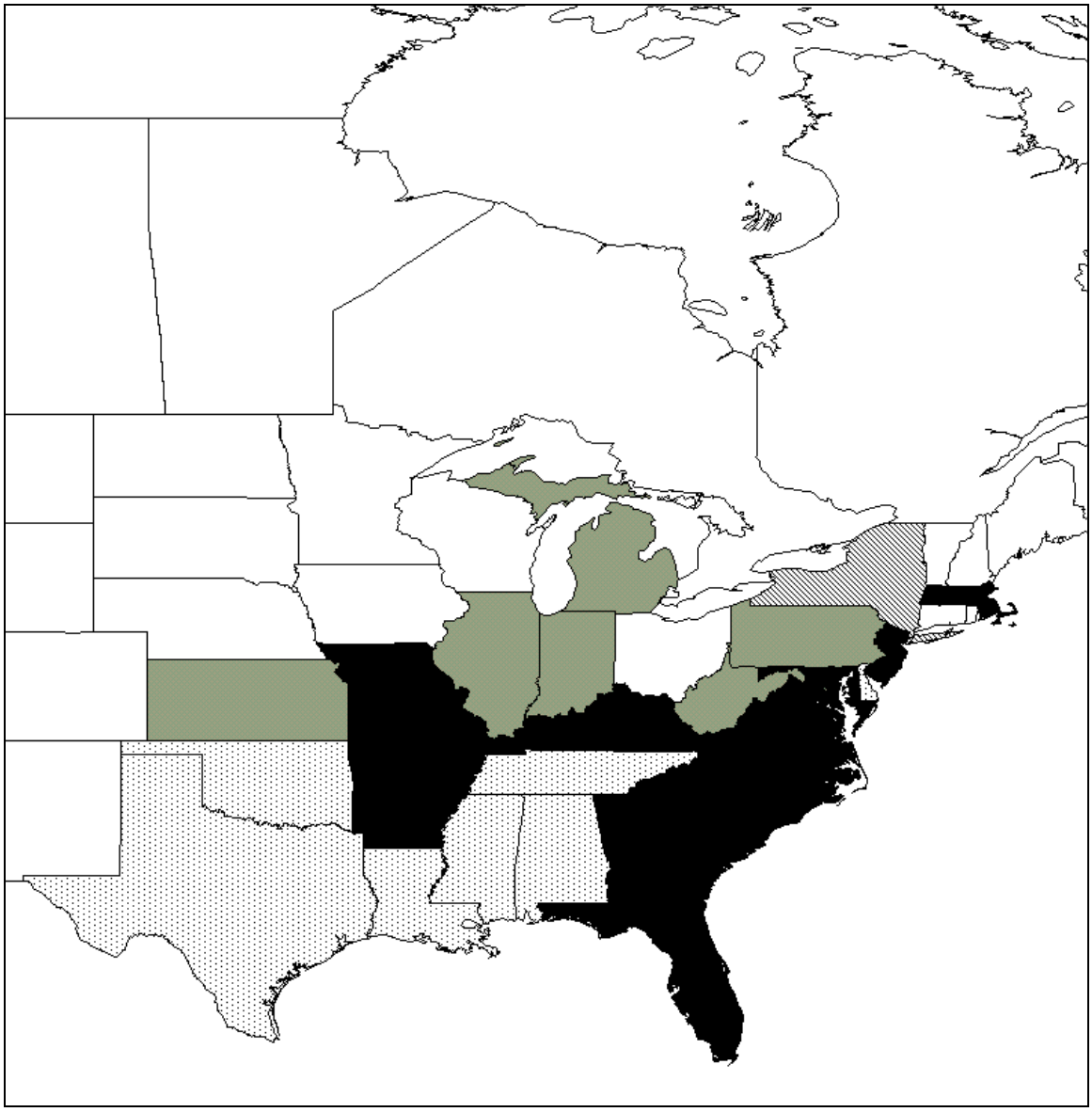

Figure 1. Occurrences of *Rhexia mariana* in North America. States shaded in gray have one to five current occurrences of the taxon. States shaded in black have more than five confirmed occurrences. States with diagonal hatching are designated "historic" or "presumed extirpated," where the taxon no longer occurs. States with stippling are ranked "SR" (status "reported" but not necessarily verified). See Appendix 2 for explanation of state ranks.

Table 1. Occurrence and status of *Rhexia mariana* in the United States and Canada based on information from Natural Heritage Programs.			
OCCURS & LISTED (AS S1, S2, OR T & E)	**OCCURS & NOT LISTED (AS S1, S2, OR T & E)**	**OCCURRENCE REPORTED OR UNVERIFIED**	**HISTORIC (LIKELY EXTIRPATED)**
Kansas (S1): present in 1 county (USDA, NRCS 2001)	District of Columbia (S?)	Alabama (SR)	New York (SX): last seen in 1923 (Zaremba and Lamont 1993)
Massachusetts (S1): 9 extant and 4 historic occurrences	Illinois (S?): present in 5 counties (USDA, NRCS 2001)	Arkansas (SR): present in 49 counties (USDA, NRCS 2001)	
Pennsylvania (S1): several extant occurrences all in one county; other sites known from herbarium records (Ann Rhoads, University of Pennsylvania, personal communication)	Indiana (S?): 2 extant occurrences in 2 counties (Michael Homoya, Indiana Department of Natural Resources, personal communication)	Delaware (SR)	
West Virginia (S1): 1 verified and 1 unverified extant occurrences in 2 counties (B. Sargent, personal communication)	Kentucky (S?): present in 18 counties (USDA, NRCS 2001)	Florida (SR): common on temporary ponds in N. Florida (LaClaire 1995); most common *Rhexia* sp. in Panhandle (L. Anderson, personal communication)	
	Michigan (S?): 5 extant occurrences in 2 counties (M. Penskar, personal communication)	Georgia (SR): present at Arabia Mountain (Houle 1987); present in 55 counties (USDA, NRCS 2001)	
	New Jersey (S?): collected from all coastal counties except 2 (Snyder 1996)	Louisiana (SR)	
	North Carolina (S5): present in 76 counties (Radford et al. 1968)	Maryland (SR): common in wet meadows in Patuxent Research Refuge (Hotchkiss and Stewart 1947)	
	Virginia (S5): present in 35–40 counties (J. Townsend, personal communication)	Mississippi (SR)	
		Missouri (SR): present in 13 counties (USDA, NRCS 2001)	
		Oklahoma (SR)	

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OCCURS & LISTED (AS S1, S2, OR T & E)	**OCCURS & NOT LISTED (AS S1, S2, OR T & E)**	**OCCURRENCE REPORTED OR UNVERIFIED**	**HISTORIC (LIKELY EXTIRPATED)**
		South Carolina (SR): present in 36 counties (Radford et al. 1968)	
		Tennessee (SR)	
		Texas (SR)	

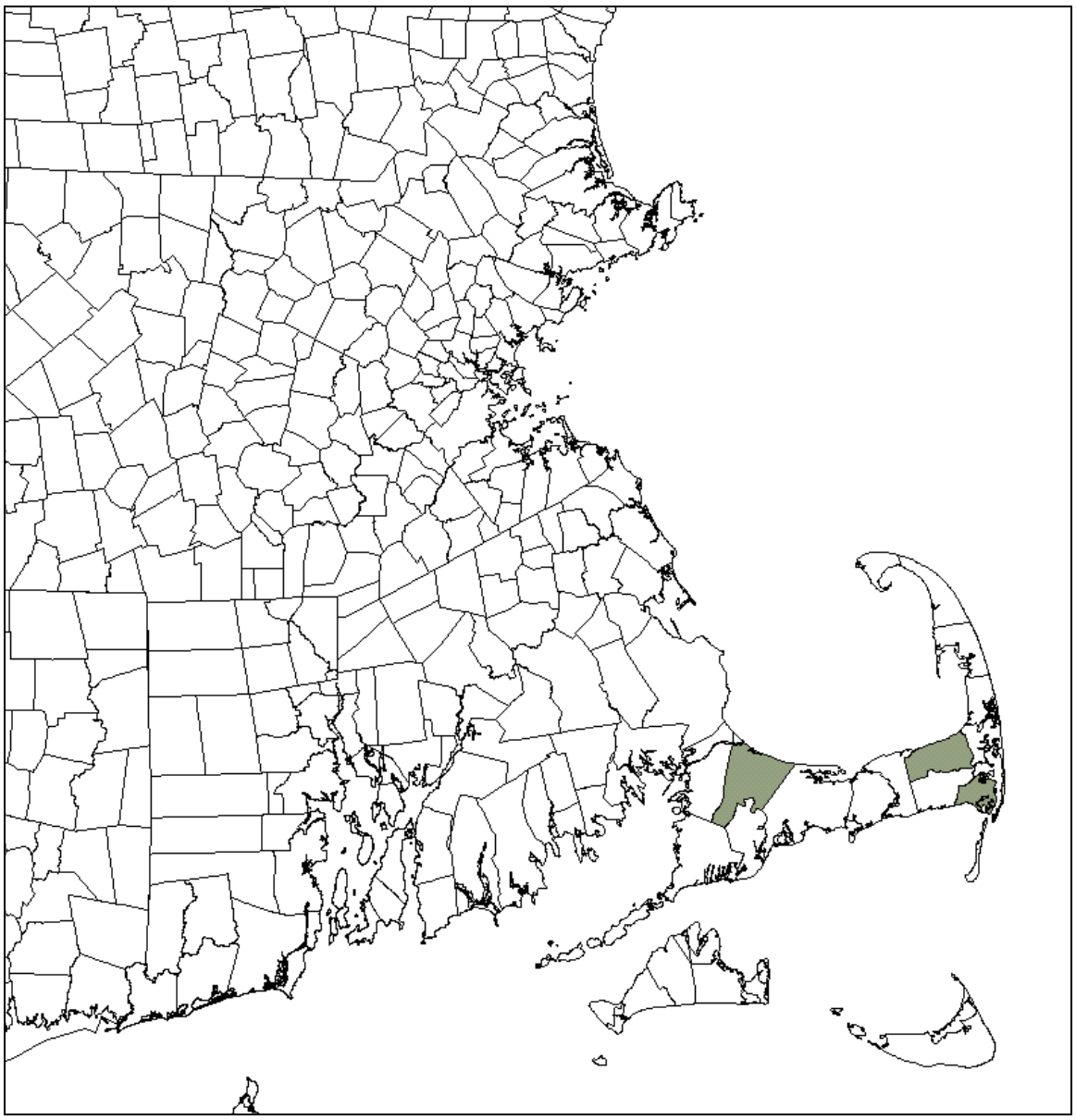

Figure 2. Extant occurrences of *Rhexia mariana* in New England. Town boundaries for southeastern New England are shown. Towns shaded in gray have one to five confirmed, extant occurrences of the taxon.

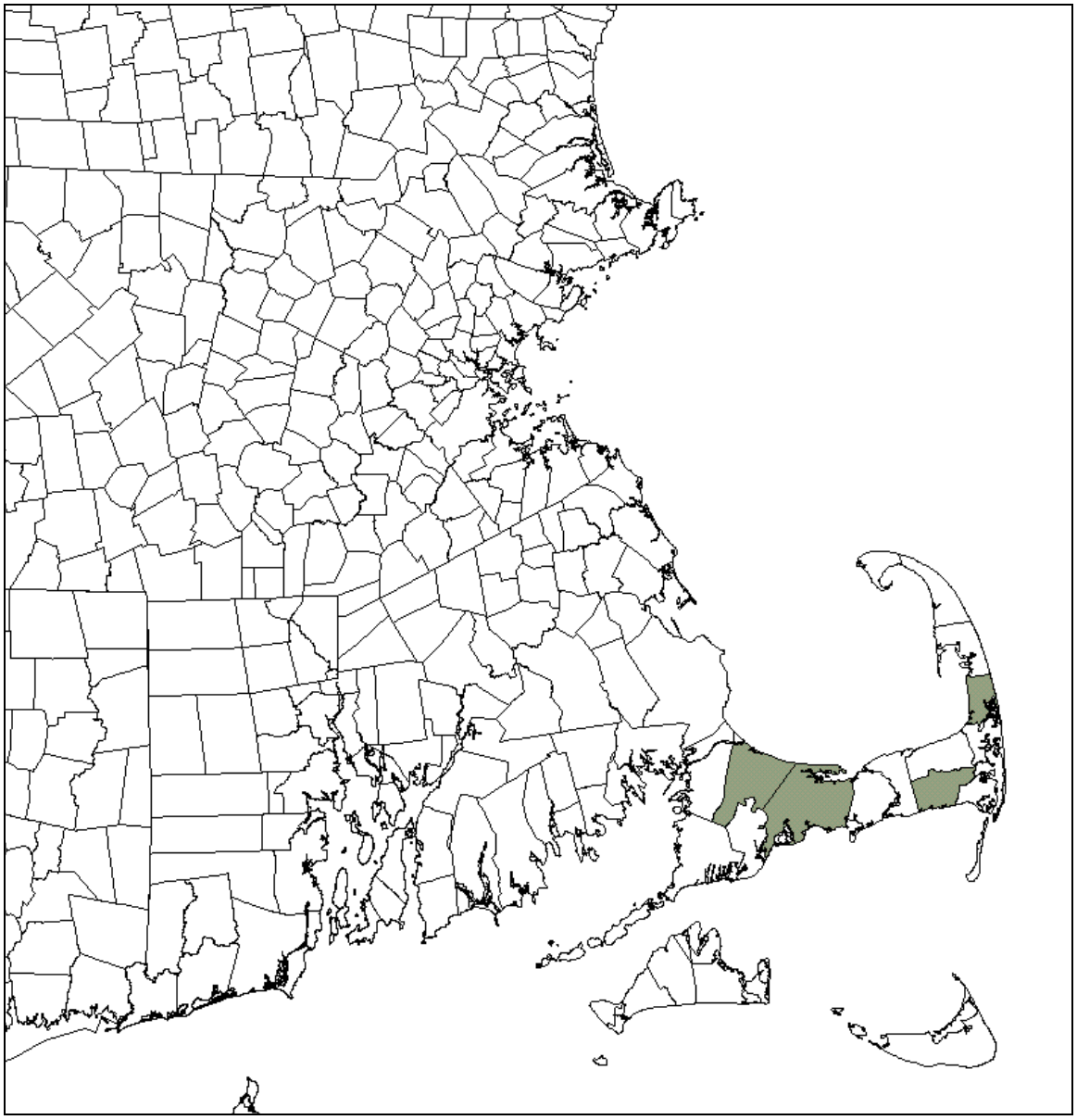

Figure 3. Historical occurrences of *Rhexia mariana* in New England. Towns shaded in gray have one to five historical records of the taxon.

Status of All New England Occurrences—Current and Historical

There are 13 known occurrences (nine extant and four historical) of *Rhexia mariana* in New England. All are located on Cape Cod (Barnstable County), Massachusetts. Table 2 (pages 19 and 20 below) summarizes available information on these sites, including: EO number, town, ownership, year of first and last observation, site description, EO rank, population size at various dates of observation, potential threats, and general comments. This information is taken from files of the Massachusetts Natural Heritage and Endangered Species Program (NHESP) and site visits made by the author in 2001. EO rankings in the table are those recognized by the Massachusetts Natural Heritage and Endangered Species Program. Rank specifications for this species are listed in Appendix 1.

Table 2. New England Occurrence Records for *Rhexia mariana.* Shaded occurrences are considered extant.

State	EO #	County	Town
MA	**.001**	**Barnstable**	**Brewster**
MA	**.002**	**Barnstable**	**Chatham**
MA	**.003**	**Barnstable**	**Sandwich**
MA	**.004**	**Barnstable**	**Sandwich**
MA	.005	Barnstable	Sandwich
MA	**.006**	**Barnstable**	**Brewster**
MA	.007	Barnstable	Eastham
MA	.008	Barnstable	Harwich
MA	.009	Barnstable	Barnstable
MA	**.010**	**Barnstable**	**Brewster**
MA	**.012**	**Barnstable**	**Brewster**
MA	**.013**	**Barnstable**	**Brewster**
MA	**.014**	**Barnstable**	**Sandwich**

Note: There is no EO .011.

CURRENT CONSERVATION MEASURES IN NEW ENGLAND

Four of the nine extant occurrences of *Rhexia mariana* in New England have had some active management in recent years. Measures taken to protect this taxon (and other rare species that may be present at some sites) include restricting human traffic, removal or trimming of woody plants, and refraining from mowing until after seed has been set in the fall. At one site, one-time shrub clearance in the late 1980s may have been insufficient to prevent succession of a former bog to a pitch pine/blueberry thicket. Changes in hydrology since the draining of the bog also worked against the preservation of *R. mariana* there. One managed site, within a state park, is designated as an "environmentally sensitive area" to discourage human use. Another is separated from a

golf course fairway by a fence, with signs warning golfers to stay off the pond shore to protect rare plants. At one site, the cooperation of a homeowner has been indispensable to the protection of the population, which otherwise could be mown down along with the surrounding meadow or cut by the power company when it clears its power line right of way. Other reported occurrences that are prospering as of 2001 are doing so simply through benign neglect. How well this will serve them in the long run is unknown.

The species is listed as Endangered (S1) in Massachusetts, and as such is theoretically afforded protection by the state's Endangered Species Act.

An *ex situ* seed bank is maintained by the New England Wild Flower Society in Framingham, Massachusetts. It contains approximately 6,000 seeds, all of which were collected at one site (MA .013 [Brewster]) in 1992. Germination tests on these seeds yielded germination rates of about 4 percent after cold, moist stratification. Similar results were obtained after three years of cold storage (Christopher Mattrick, New England Wild Flower Society, personal communication).

II. CONSERVATION

CONSERVATION OBJECTIVES FOR TAXON IN NEW ENGLAND

The small number of New England sites in which *Rhexia mariana* is currently found—and the even smaller number of sites with substantial, sustainable populations—means this species is at risk in the region. It will remain at risk until both of these numbers can be increased. Numbers in even the most well established populations of this species fluctuate widely, especially as pond levels rise and fall from year to year, and even fairly large populations can seem to disappear for a time. Therefore no one year can be used to measure the health of a population. Generally, numbers seem to be highest when a period of low pond levels follows a year or two of high water.

The first objective for the conservation of *R. mariana* must be to protect and maintain the existing populations, especially the three that had over 1,000 stems at last count. One of these three sites is not managed or protected in any way at present. Secondly, some of the smaller sites need to be improved through protection from human traffic and removal of overhanging shrubs so the species there has a chance to spread and approach a sustainable population size of at least several hundred flowering stems. Hand pollination and/or introduction of seed or vegetative propagules from other Cape Cod *R. mariana* populations could augment these smaller populations. It is realistic to expect that two or three such sites could be enhanced in this way after several years of active management. None of these management actions is complex, but some conservation entity has to take responsibility to pursue their implementation, or it is probable that nothing will be done.

Even if populations at all the extant sites (officially nine, but possibly only seven) could be increased substantially, this is still too few populations on which to depend in the long run. Every *R. mariana* population is essentially ephemeral. For instance, only three of our extant EOs were first observed before 1980. This increases their vulnerability to demographic, genetic, and environmental stochastic events. Therefore, a conservation priority must be to expand the number of Element Occurrences through introductions of the species to new sites (or sites that were occupied in the past). This will require research on the habitat requirements, reproductive potential, and genetic diversity of the species in this region. Sites for possible introduction will have to be carefully studied to make sure they are both appropriate for the species and defensible from various threats. When possible, new populations should be introduced near enough to existing ones to make possible the development of metapopulations. Once introduction is begun it will require continued monitoring for many years. But the process should be started soon or it could be too late.

The overall goal for the next 20 years should be to achieve seven EOs that reach 500 or more stems (or an "A" ranking) in those years that water levels permit, with some of these at least occasionally supporting 1,000 or more stems. This would assume that

the three largest populations can be protected and maintained, that two or three of the smaller populations can expand to the 500 stem range with proper management, and that introduced populations can be successfully established in one or two locations within the next 20 years.

Some specific goals for the next five years should be set so progress toward the general goals can be assessed.

1. Populations at the three EOs with over 500 stems should be maintained at that level, and in peak years exceed 500. Management must be put in place at the site that is currently unprotected and protection at the other locations formalized and improved.

2. At least two of the remaining four extant sites should be able to expand to the 500-stem range through protection and augmentation and have an active management plan in place.

3. The *ex situ* seed bank of *R. mariana* at NEWFS should be expanded with more diverse sources for seeds from other Massachusetts sources.

4. Research should be carried out to determine the conditions necessary for the species to thrive on Cape Cod and to better understand the genetic structure of the Cape Cod population.

5. At least one introduction (or reintroduction) should be initiated.

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IV. APPENDICES

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1. State of Massachusetts Element Occurrence Ranking Specifications for *Rhexia mariana*

2. An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe

2. State of Massachusetts Element Occurrence Ranking Specifications for *Rhexia mariana*

A-Rank Specifications: *Condition:* dense colonies, flowering and fruiting
Size: >500 stems
Landscape: sandy margin of peaty coastal plain pond shore with naturally fluctuating water levels

B-Rank Specifications: *Condition:*
Size: 300-500
Landscape:

C-Rank Specifications *Condition:*
Size: 25-300
Landscape:

D-Rank Specifications: *Condition:*
Size: <25
Landscape:

Justification:

A-Rank Threshold: Appearance of large numbers depends on hydrologic conditions, thus occurrence may seem sporadic. Largest size recorded in MA is 3000+, but few reach more than 300.

C-D Threshold: [none]

General Comments: In SE Mass. a coastal plain pondshore perennial herb with shallowly set, slender elongate rhizomes with 4 light pink, lop-sided petals; recurved stamens; hirsute stems; blooms Aug-Sept. Ranges on coastal plain from TX and FL to NJ, disjunct in MA. 9 current occurrences, no others in NY or NE. Secure in VA and NC. Boggy habitats on acid, usually sandy substrates often with south to SW aspect; weedy response to disturbance. Thought to hybridize with R. virginica. Threats are development and/or recreational use of pondshore, stormwater and septic inputs.

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Natural Heritage & Endangered Species Program
Massachusetts Division of Fisheries & Wildlife

2. An explanation of conservation ranks used by The Nature Conservancy and NatureServe

The conservation rank of an element known or assumed to exist within a jurisdiction is designated by a whole number from 1 to 5, preceded by a G (Global), N (National), or S (Subnational) as appropriate. The numbers have the following meaning:

1 = critically imperiled
2 = imperiled
3 = vulnerable to extirpation or extinction
4 = apparently secure
5 = demonstrably widespread, abundant, and secure.

G1, for example, indicates critical imperilment on a range-wide basis — that is, a great risk of extinction. S1 indicates critical imperilment within a particular state, province, or other subnational jurisdiction — i.e., a great risk of extirpation of the element from that subnation, regardless of its status elsewhere. Species known in an area only from historical records are ranked as either H (possibly extirpated/possibly extinct) or X (presumed extirpated/presumed extinct). Certain other codes, rank variants, and qualifiers are also allowed in order to add information about the element or indicate uncertainty.

Elements that are imperiled or vulnerable everywhere they occur will have a global rank of G1, G2, or G3 and equally high or higher national and subnational ranks (the lower the number, the "higher" the rank, and therefore the conservation priority). On the other hand, it is possible for an element to be rarer or more vulnerable in a given nation or subnation than it is range-wide. In that case, it might be ranked N1, N2, or N3, or S1, S2, or S3 even though its global rank is G4 or G5. The three levels of the ranking system give a more complete picture of the conservation status of a species or community than either a range-wide or local rank by itself. They also make it easier to set appropriate conservation priorities in different places and at different geographic levels. In an effort to balance global and local conservation concerns, global as well as national and subnational (provincial or state) ranks are used to select the elements that should receive priority for research and conservation in a jurisdiction.

Use of standard ranking criteria and definitions makes Natural Heritage ranks comparable across element groups; thus, G1 has the same basic meaning whether applied to a salamander, a moss, or a forest community. Standardization also makes ranks comparable across jurisdictions, which in turn allows scientists to use the national and subnational ranks assigned by local data centers to determine and refine or reaffirm global ranks.

Ranking is a qualitative process: it takes into account several factors, including total number, range, and condition of element occurrences, population size, range extent and area of occupancy, short- and long-term trends in the foregoing factors, threats, environmental specificity, and fragility. These factors function as guidelines rather than arithmetic rules, and the relative weight given to the factors may differ among taxa. In some states, the taxon may receive a rank of SR (where the element is reported but has not yet been reviewed locally) or SRF (where a false, erroneous report exists and persists in the literature). A rank of S? denotes an uncertain or inexact numeric rank for the taxon at the state level.

Within states, individual occurrences of a taxon are sometimes assigned element occurrence ranks. Element occurrence (EO) ranks, which are an average of four separate evaluations of quality (size and productivity), condition, viability, and defensibility, are included in site descriptions to provide a general indication of site quality. Ranks range from: A (excellent) to D (poor); a rank of E is provided for element occurrences that are extant, but for which information is inadequate to provide a qualitative score. An EO rank of H is provided for sites for which no observations have made for more than 20 years. An X rank is utilized for sites that known to be extirpated. Not all EO's have received such ranks in all states, and ranks are not necessarily consistent among states as yet.