New England Plant Conservation Program
Conservation and Research Plan

Ludwigia sphaerocarpa Ell.
Globe-fruited False-loosestrife

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SUMMARY

Globe-fruited False-loosestrife, *Ludwigia sphaerocarpa* Ell. (Onagraceae), is ranked as a Division 2 species under the New England Plant Conservation Program (NEPCoP) *Flora Conservanda*. The species is secure in the southern part of its North American range, and it is ranked as G5 overall. New England occurrences are more limited. Six extant and six historic populations are known from Connecticut, Massachusetts, and Rhode Island, and it is tracked as a rare species in these three states. Population estimates for *L. sphaerocarpa* are marginal to poor at most stations; however, the species does not appear to be at immediate risk of extirpation in New England. *Ludwigia sphaerocarpa* has clearly declined at stations on riparian systems, with all but one (CT .002, Killingworth) being historic or presumed extirpated. The remaining extant stations support widespread, vigorous populations, and short-term threats are limited. The limiting factor in *L. sphaerocarpa's* abundance and distribution in New England appears to be a lack of suitable habitat across the landscape. In light of its habitat specialization and decline in New England, it deserves recognition as an important conservation target and potential indicator species for habitat-based conservation efforts.

In New England, *Ludwigia sphaerocarpa* occurs on shores of large sandy ponds, on an impounded stream reach, and along a smaller confined pond. It is absent from the locally common kettle hole ponds typical of southeastern New England. It appears to be limited to ponds associated with large wetland systems (remnant glacial lakes). Several historic populations are documented from riparian wetlands. The general conservation objectives for the taxon are to:

C Maintain stable populations at all six extant sites in New England.

C Ensure the occurrence of populations in a natural range of micro-habitat types, including exposed shores, sheltered nutrient rich areas, and riparian habitats (which should be restored if possible).

C Manage the respective habitat (pond or river system) from adverse impacts from hydrologic stress, nutrient enrichment, and invasive plants.

The primary strategy for *L. sphaerocarpa* conservation in New England is a habitat-based approach. Conservation of this and associated rare pond-shore taxa hinges on: an understanding of the specific habitat patterns and processes, threats to habitat and species; and on formal recognition within a plan endorsed by relevant partners that may include landowners, pond associations, land trusts, state-wide conservation organizations, municipal governments, and state agencies. This plan will be considered successful when:

1. Thorough mapping and population estimates are completed for each station.
2. Habitat conservation planning or its equivalent is completed for all extant populations.
3. Periodic monitoring over 20 years demonstrates that populations are stable.
4. Life history and ecological requirements of *L. sphaerocarpa* are sufficiently understood for effective long-term monitoring and management.

PREFACE

This document is an excerpt of a New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. Full plans with complete and sensitive information 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.

This document should be cited as follows:

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I. BACKGROUND

INTRODUCTION

Globe-fruited False-loosestrife *(Ludwigia sphaerocarpa* Ell.) is ranked as a Division 2 species under the New England Plant Conservation Program (NEPCoP) *Flora Conservanda*. The species is secure in the southern part of its North American range (G5), but New England occurrences are more limited. Six extant and six historic populations are known from Connecticut, Massachusetts, and Rhode Island, and it is tracked as a rare species in these three states. *Ludwigia sphaerocarpa* has clearly declined at stations on riparian systems, with all but one (CT .002, Killingworth) being historic or presumed extirpated. The remaining extant stations support widespread, vigorous populations, and short-term threats are limited. The limiting factor in *L. sphaerocarpa's* abundance and distribution in New England appears to be a lack of suitable habitat across the landscape.

In New England, *Ludwigia sphaerocarpa* occurs on shores of large sandy ponds, on an impounded stream reach, and along a smaller confined pond. It appears to be limited to ponds associated with large wetland systems (remnant glacial lakes), while several historic populations are documented from riparian wetlands.

The intent of this conservation plan is to provide information and recommendations leading to the protection and recovery of *Ludwigia sphaerocarpa* in New England. The plan consists of two sections: a synthesis of information on the status and biology of the taxon, and a conservation strategy for the taxon in New England. Species status and biology information are compiled from Natural Heritage program data, the scientific literature, persons knowledgeable about the species, and field visits to several New England occurrences. The conservation strategy utilizes data on the status and species biology of *L. sphaerocarpa* to review potential conservation actions for the taxon and to develop conservation objectives for the taxon in New England during the next 20 years, conservation actions for the taxon in general, and conservation actions for each New England occurrence. The general conservation objectives for the taxon are to maintain stable populations at all six extant sites in New England, occurring in a range of micro-habitat types. These respective habitats (pond or river system) should be protected from adverse impacts from hydrologic stress, nutrient enrichment, and invasive plants. Thorough mapping and population estimates should be completed for each station. Habitat conservation planning or its equivalent should be completed for all extant populations. Periodic monitoring over 20 years must demonstrate that populations are stable for this plan to be considered successful. Finally, life history and ecological requirements of *L. sphaerocarpa* should be better understood for effective long-term monitoring and management.

DESCRIPTION

This description follows from Munz (1965), except as noted. *Ludwigia sphaerocarpa* is an erect perennial, from 0.3 to 1 meter tall (Fernald 1950). Stems are 2-4 mm thick, although underwater parts are often swollen or spongy when inundated. The leaves are 2-10 (-12) cm long, and 3-8 (-10) mm wide. The leaves are opposite, lanceolate to lanceolate oblong, with apex acute to attenuate, and acute at the base. Leaves range from sessile to petiolate (up to 7 mm), and range from glabrous to pubescent. Sessile flowers lacking petals are produced in the upper axils. The calyx is subglobose and minutely pilose (Fernald 1950), the triangular ovate sepals 2.5-3 mm long. The fruit is spherical or sub-spherical, pilose to glabrous, from 2.5-4.6 mm long (Fernald 1950). The calyx lobes are deltoid, about equaling fruit (Fernald 1950). The seeds are globose or broadly obovoid (Fernald 1950), from 0.5 to 0.6 mm long. Seeds in *L. sphaerocarpa* are distinguished from other species in the section by the surface cell pattern. While seeds of most *Microcarpium* have very regular cell patterns, cells of *L. sphaerocarpa* are less regularly oriented, and are both transversely elongate and parallel to the length of the seed (Peng 1988). Fernald (1950) described it as a polymorphic species, and Peng (1988) observed variability in pubescence, leaf and fruit shape/size, and fruit density. Earlier references to var. *macrocarpa* typically described longer fruit (3.5 mm long, 2.8-4 mm broad) and clustered flowers/fruit. Var. *typica* was described as having flowers mostly remote on elongate branches and very acute, glabrous, and 2" long leaves (Fernald and Griscom 1935, Munz 1944).

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

The Genus *Ludwigia*, in the Evening Primrose family (Onagraceae), is considered to be one of the earliest surviving offshoots within the family (Peng 1988). *Ludwigia* is primarily a tropical and subtropical genus, and most North American species are restricted to the southeast Atlantic coastal plain and Gulf coastal plain (Peng 1988). The genus *Ludwigia* is distinguished by the absence of a floral tube, and has a base chromosome number of x = 8 (Hoch 1993). *Ludwigia* is divided into 23 sections. *Ludwigia sphaerocarpa* is included in the section *Microcarpium*, a polyploid complex of 14 species, distinguished by regular fruit dehiscence (Zardini and Raven 1992). *Ludwigia polycarpa* is the only other species within this section that occurs in New England. Section *Microcarpium* is further divided into five groups. Both *L. sphaerocarpa* and *L. polycarpa* are included in Group Four, and share the following features: (1) 16 chromosomes, (2) spongy fruit mesocarp, and (3) thin seed endotesta (Tobe *et al.* 1988).

Within *L. sphaerocarpa*, Fernald (1950) recognized four varieties, two of which occur in our range. Var. *typica* was described as occurring from Louisiana to North Carolina, rarely to Rhode Island. Var. *macrocarpa* was described from New Jersey, southern New York, and eastern Massachusetts (type station: Lakeville, Massachusetts). Sorrie (1987) noted an overlap in characters, and Peng (1988) observed that these varieties "do not hold" when additional material, not available to Fernald and Griscom (1935), is considered. Kartesz (1994) combined all of these varieties. Polymorphism might have accounted for Fernald's splitting, the possible result of having collected material from distinct micro-habitat types. For example, the most likely collecting locality for var. *macrocarpa* at its type station (Lakeville, Massachusetts) is at the pond's most accessible area along Route 105. This area is a sheltered, silty location on the southwestern side of the pond, where *L. sphaerocarpa* occurs in very robust exclusive stands (B. Reid, *personal observation*). Similarly, the most likely historic collecting station for the RI .001 (South Kingstown) site, where var. *typica* was observed, is along Wordens Pond Road. *Ludwigia sphaerocarpa* occurs in sparse mixed stands on the wave-exposed southern shore of the pond. It is less vigorous here, and conforms to characters of var. *typica* (B. Reid, *personal observation*).

Natural hybridization is often observed within the section *Microcarpium.* The distinct irregular cell pattern of *L. sphaerocarpa* seeds may indicate the hybrid origin of this species (Peng 1988). In the southeast coastal plain, *L. sphaerocarpa* naturally hybridizes with *Ludwigia pilosa* and possibly *Ludwigia ravenii*. Some hybrid populations in central and southern Florida are extralimital to the range of either of the parent species. Hybridization between *L. sphaerocarpa* and *Ludwigia polycarpa* has also been observed where the two species occur together (Peng 1988). Hybridization between these species has not been documented at New England stations, where the species are not known to be sympatric.

SPECIES BIOLOGY

Ludwigia sphaerocarpa propagates asexually by creeping and rooting at the nodes, producing leafy stolons in the winter (often referred to as "ramets," or clonally reproduced modules). The stem aerenchymatous tissue, a swollen corky stem base, appears to be well developed only in certain stands and is adaptive for prolonged inundation.

The flowers are apetalous. However, this does not imply autogamy, as the flowers have nectary discs on the ovaries, and the sepals are cream colored and resemble petals (Peng 1988). Peng describes the section as facultatively autogamous: after the flowers open in the morning, the stigma becomes receptive, and the anthers initially spread away from the stigma. In most species, the anthers then arch over and attach to the stigma a few hours later, effecting self-pollination. Cross-pollination is also a likely strategy. Raven (*personal observation* in Peng 1988) observed numerous wasps attracted to *L. sphaerocarpa. Ludwigia* have flowers adapted to pollination by generalized insects (Eyde 1981). Bumble bees, honeybees, and ants have also been observed visiting populations of other species in the section. Natural hybridization also strongly indicates the work of insect vectors (Peng 1988).

Seed dispersal is probably waterborne. Although not observed in the wild, both seeds and fruit capsules float (B. Reid, *personal observation*). The fruits of *L. sphaerocarpa* have a spongy mesocarp (Tobe 1988), which may be adaptive both for floating fruit and defense against insect herbivory (Eyde 1978). Seeds have a uniformly thin endotesta (Tobe *et al.* 1988) and may be neutrally buoyant: they appear to remain afloat largely due to surface tension (B. Reid, *personal observation*). Fruiting is reported to occur from August to September. Fruit dehiscence is not reported, but probably occurs in the following spring and summer (intact fruit observed at RI.001 in January 2000, B. Reid, *personal observation*).

Limited information is available on population demographics for this species. Analysis of demographics is further confounded by poor population estimates for New England stations of *L. sphaerocarpa*. This is probably due to the fact that most populations are widespread and unevenly distributed within relatively large habitat patches. Two stations, Rhode Island .001 (South Kingstown) and MA .005 (Lakeville/Rochester) in Massachusetts, are the largest natural freshwater bodies in their respective states.

Although quantitative data are lacking, two general population patterns are evident for *L. sphaerocarpa*: 1) dense exclusive stands of very robust individuals; and 2) mixed stands of less vigorous plants, more sparsely associated with other stand-forming emergents such as *Cladium mariscoides*, *Juncus militaris*, or *Scirpus pungens* (B. Reid, *personal observation*). Harper (1977, in Dolan 1984) suggested four factors influencing size hierarchies within plant populations: 1) time of germination; 2) starting capital; 3) relative growth rates of genotypes; 4) environmental restrictions. Of these, environmental restrictions on growth appear to be the most likely influence on *L. sphaerocarpa*. Limited observations of Massachusetts and Rhode Island sites indicate that the dense stands of vigorous asexual propagules occur in sheltered, rich, silty micro-habitats, whereas the sparse sub-populations of less vigorous individuals occur on wave exposed pond-shores (B. Reid, *personal observation*).

Population demographics of the vigorous exclusive stands are expected to be relatively stable from year to year, typical of clonal growth forms. Population demographics of the less vigorous sparse populations occurring in mixed stands may be more variable. In his studies of pond-shore vegetation, Keddy (1984) recognized two approaches to understanding plant coexistence: 1) resource specialization; and 2) disturbance and temporary coexistence. Keddy ruled out resource specialization as a significant factor on exposed pond shores, in favor of fluctuating water levels (Keddy and Reznicek 1982) and exposure/wave action (Keddy 1985). It would follow that *L. sphaerocarpa* numbers would fluctuate more widely within mixed stands on exposed shores, in response to disturbance levels and differential response by co-occurring plant species.

Size differences, if truly significant within *L. sphaerocarpa* populations, may result in differences in seed production and survivorship, a phenomenon that has been demonstrated in a variety of taxa including *L. leptocarpa* (Dolan and Sharitz 1984). Individual size is generally an important indicator of reproductive output, with a few individuals contributing to most of the future offspring (Harper and White 1974, in Dolan 1984). If this is true for *L. sphaerocarpa*, then the dense stands of robust stems might have a weighted conservation importance. Additional observations of the reproductive output of individuals within respective stands are needed.

Although little is known about seed release in *L. sphaerocarpa*, prolonged dispersal is a likely strategy, potentially "bet-hedging" against water level fluctuations by releasing fruit late, and well into the next growing season. The author observed most capsules of *L. sphaerocarpa* intact at RI .001 (South Kingstown) in January 2000. If seeds are water dispersed, holding seeds until the following spring, when water levels are typically higher, would be an adaptive strategy for greater dispersal distance.

Little is known about seed survivorship. However, in *L. leptocarpa* the seed bank retains few viable seeds from year to year (Dolan and Sharitz 1984). Although there has been no investigation of seed banking on local pond shores, *L. sphaerocarpa* might also be expected to have limited seed banking capacity, in contrast to the importance of seed banking for typical coastal plain pond taxa (Keddy and Wisheu 1989). High seed production in *L. sphaerocarpa* may be a strategy to offset limited seed banking capability.

There are no documented observations of *L. sphaerocarpa* recruitment. The mixed stands on exposed shores may potentially represent opportunities for recruitment. *Ludwigia sphaerocarpa* seeds may find conditions favorable for germination on otherwise inhospitable exposed shores, where other clonal species have already become established. Absence of isolated *L. sphaerocarpa* individuals on exposed pond shores would indicate a weak colonizing ability relative to species such as *Juncus militaris* and *Cladium mariscoides;* however, more investigation of *L. sphaerocarpa* distribution within habitats is required. Keddy and Wisheu (1989) observed that on wave exposed shores, vegetation cover is a cyclical process, with peat accumulation increasing in large stands of *Cladium mariscoides*, followed by decline caused by erosion. How *L. sphaerocarpa* responds to this cycle, if it is true for local pond-shore habitats, would need to be determined.

Clonal reproduction in *L. sphaerocarpa* provides a potential competitive advantage over other annual and biennial pond-shore species. Unlike coastal plain pond affiliates such as the globally rare biennial Plymouth Gentian *(Sabatia kennedyana), L. sphaerocarpa* may produce more stable populations on a year-to-year basis, without wide population fluctuations as water levels vary. Lundgren (*unpublished data*) noted that the *L. sphaerocarpa* population at MA .001 (Bridgewater) supported a large population in 1997, consistent with previous surveys, while water levels were generally higher than average (Lundgren, *unpublished data* and B. Reid, *personal observation*). At the same time, *S. kennedyana* appeared to have poor establishment, with only a handful of scattered rosettes (Lundgren, *unpublished data*). The author also casually observed similar trends relative to the co-occurring *S. kennedyana* at MA .005 (Lakeville/Rochester) in 1997 and MA new (Middleborough) in 1999.

An understanding of population demographics along river systems is limited by the lack of extant populations. However, one might speculate that since all of the voucher specimens for river systems relate to the former var. *macrocarpa* (Fernald and Griscom 1935), river populations of *L. sphaerocarpa* typically occurred as more robust, dense, clonal stands.

HABITAT/ECOLOGY

New England occurrences of *L. sphaerocarpa* are typically known from sandy/silty acidic ponds on the coastal plain. The closest formally recognized natural community is the coastal plain pond-shore community (Reschke 1990, Kearsley 1999). However, *L. sphaerocarpa* is entirely absent from all of the more typical coastal plain pond habitats within its New England range, including over 60 ponds on Cape Cod and in Plymouth, Massachusetts. It appears to be limited to ponds associated with large wetland complexes (remnant glacial lakes), where acidity is higher, and the water is clearly tannic (B. Reid, *personal observation*). An aquatic community classification system might address the finer distinctions between pond-shore types; however, such a system is lacking for the region. In comparison to classification efforts in the Great Lakes region (Higgins *et al.* 1998), the hydrologic type for *L. sphaerocarpa* stations is best described as a "catchment dominated" system. This system is isolated and relatively unaffected by stream systems, and has a slow turnover rate. The water is primarily from associated wetlands, and groundwater comes from adjacent areas of sand and gravel. The hydrologic regime of these ponds is expected to be buffered by associated swamp wetlands, which are sometimes extensive, resulting in less drastic water level fluctuations than on kettle ponds occurring in glacial outwash (Rich McHorney, The Nature Conservancy, *personal communication*). Despite the dampening of water levels, these fluctuations are probably an important factor in maintaining open pond-shore habitat (Keddy and Wisheu 1989) by preventing shrubs from colonizing the exposed shoreline.

Additional information on *L. sphaerocarpa*'s habitat requirements in other parts of its range would facilitate our understanding of habitat preferences in New England. New Jersey specimens deposited at Gray's Herbarium provide only general clues, including: white cedar swamp/roadside; wet peaty margin of large pond; bog; swale/pond margin; and marshy border of pond. *Ludwigia sphaerocarpa*'s affinity for remnant glacial lakes in the glaciated northeast may represent a distinct habitat preference within its range.

As discussed under the section on demographics, populations typically occur either in dense exclusive stands in sheltered areas, or mixed stands of less vigorous plants in exposed areas. The mixed stands in exposed shoreline habitats may potentially serve an important function. During times of prolonged high water levels, wave disturbance may provide the necessary conditions for species ordinarily adapted to water level fluctuations to persist (Keddy 1984). However, the degree of *L. sphaerocarpa*'s tolerance for water level fluctuations is not well understood, and the importance of wave action is difficult to predict at this time.

Lundgren (*unpublished data*) observed that *L. sphaerocarpa* occurs in a distinct zone on the shoreline, with a readily observed color band on the shore in August. Recognition of this color band can readily aid in species inventory and mapping: *Ludwigia sphaerocarpa* has a distinct orange color in September and October that can be recognized from several hundred meters away (B. Reid, *personal observation*). Note that two species that may co-occur with *L. sphaerocarpa*, Water Willow *(Decodon verticillatus),* and Purple Loosestrife *(Lythrum salicaria),* also display a similar color pattern, although they can often be distinguished at a distance by their profile and height.

Little is known about *L. sphaerocarpa* habitat within riparian systems. Historic occurrences in riparian habitat may indicate former oligotrophic conditions of river meadows. In southeastern Massachusetts, occasional patches of oligotrophic wetlands may occur along impounded stream reaches (B. Reid, *personal observation*). However, most of the riparian wetlands support plant species typical of mesotrophic or eutrophic conditions (Reid *et al.* 1998 and B. Reid, *personal observation*). Although habitat at historic stations along the Concord River (MA) remains to be investigated, changes in nutrient regime and shift in plant dominance may have eliminated the conditions favorable to *L. sphaerocarpa*, making re-introduction efforts futile. Plymouth Gentian *(Sabatia kennedyana),* Golden Club *(Orontium aquaticum),* and Long's Bullrush *(Scirpus longii),* rare species associated with oligotrophic wetlands, are also historic for Massachusetts rivers according to data from the Massachusetts Natural Heritage database). Note that new populations of *S. longii* have been recently discovered along the Charles River (Frances Clark, Carex Associates, *personal communication*) and the Taunton River (B. Reid, *personal observation*), providing examples of an oligotrophic species persisting under mesotrophic conditions.

THREATS TO TAXON

There are no immediate short-term threats to this species at any New England station. Invasive plants such as Common Reed (*Phragmites australis)* and Purple Loosestrife (*Lythrum salicaria)* are competing in a limited respect with *L. sphaerocarpa* populations at some stations. Eutrophication and consequent shift in plant dominance (Keddy and Wisheu 1989), and hydrologic stress from municipal water demand are possible long-term threats at some sites. One site occurs on an impounded stream reach and may not be sustainable in the long term. Evidence of insect damage to fruits was noted at one site; however, the extent of impact is not known. Direct impacts from private land use associated with pond-shore houses and cottages (including clearing, trampling, grading, and all-terrain vehicles) is considered a significant threat to pond-shore vegetation (Keddy and Wisheu 1989). At RI .001 (South Kingstown), portions of the *L. sphaerocarpa* population occurs along shores developed for residential use. Overall, the direct impacts of land use appear to be minimal. However, incompatible land use remains a potential long-term threat. Note that assessment of such direct threats is limited by poor population estimates and limited mapping efforts at some sites.

DISTRIBUTION AND STATUS

General status

In North America, *Ludwigia sphaerocarpa* ranges from Florida along the coastal plain to eastern Massachusetts, and along the Gulf Coast to Texas (Figure 1, Table 1). For a more detailed county distribution map, see Peng (1988). Disjunct populations occur at stations in Michigan, Indiana, Illinois, and Tennessee (Fernald and Griscom 1935, Fernald 1950, The Nature Conservancy and The Association for Biodiversity Information 1999). The species is secure along much of the southeast coastal plain and has an overall rank of G5 (The Nature Conservancy and The Association for Biodiversity Information 1999). Outside of New England, *L. sphaerocarpa* is tracked in New York (S2), North Carolina (S1), Pennsylvania (SX), and Virginia (S3). It is also tracked at disjunct stations, primarily in the Great Lakes region in Indiana (S1), Michigan (S1), and Tennessee (S1). It is apparently secure throughout the remainder of its range in New Jersey, Delaware, Maryland, South Carolina, Georgia, Florida, Louisiana, and Texas (The Nature Conservancy and The Association for Biodiversity Information 1999).

New England represents a northern limit of the range of *L. sphaerocarpa*, where the species is considered rare. *Ludwigia sphaerocarpa* is ranked as a Division 2 regionally rare species under the New England Plant Conservation Program (NEPCoP) *Flora Conservanda* list of plants in need of conservation (Brumback and Mehrhoff *et al.* 1996). It is listed as rare and tracked in Connecticut (S1 – Endangered), Massachusetts (S2 – Threatened), and Rhode Island (S1 – Endangered). See Figure 2 for the range of extant occurrences of *L. sphaerocarpa* and Figure 3 for the range of historic occurrences of *L. sphaerocarpa*.

Table 1. Occurrence and status of *Ludwigia sphaerocarpa* 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 UNVERIFIED	HISTORIC (LIKELY EXTIRPATED)
Connecticut (S1)	Virginia (S3)	Alabama (SR)	Pennsylvania (SX)
Indiana (S1)		Delaware (SR)	
Massachusetts (S2)		Florida (SR)	
Michigan (S1)		Georgia (SR)	
New York (S2)		Illinois (SR)	
North Carolina (S1)		Louisiana (SR)	
Rhode Island (S1)		Maryland (SR)	
Tennessee (S1)		New Jersey (SR)	
		South Carolina (SR)	
		Texas (SR)	

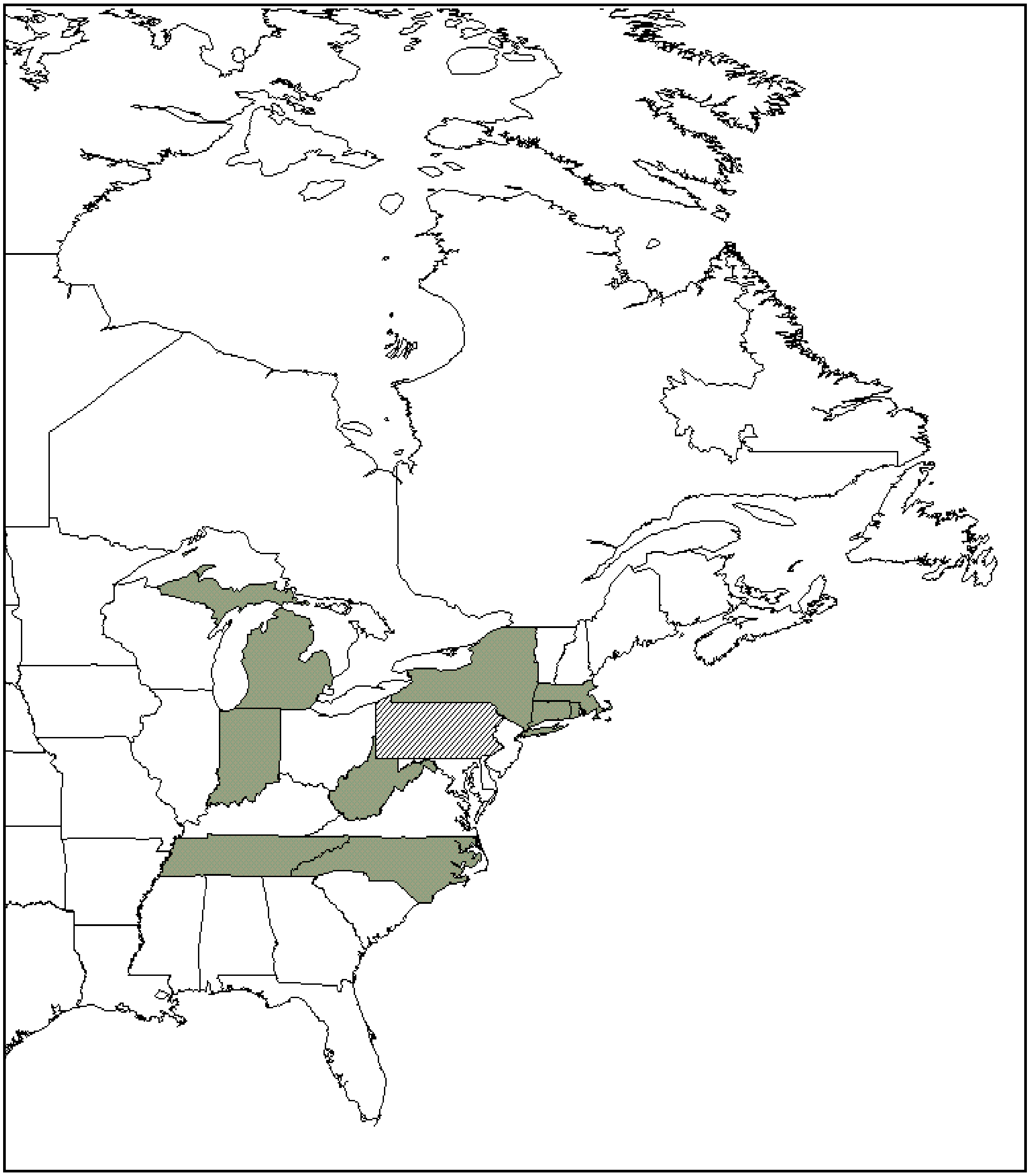

Figure 1. Occurrences of *Ludwigia sphaerocarpa* in North America. Shaded states and provinces have 1-5 extant occurrences or are noted simply as occurring. States with the taxon reported as “SR” (see Table 1 and Appendix for explanation of ranks) are generally not shaded on the map except where additional confirmation exists. States with diagonal hatching are designated “historic” or “presumed extirpated” (see Table 1), where *Ludwigia sphaerocarpa* no longer occurs.

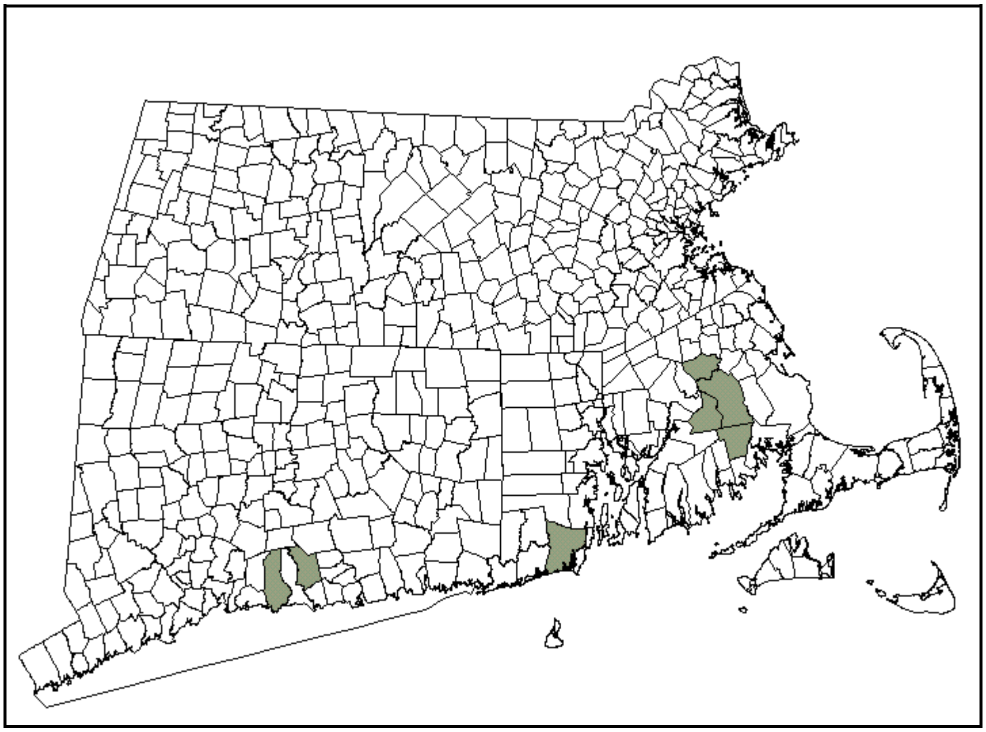

Figure 2. Extant occurrences of *Ludwigia sphaerocarpa* in New England. Town boundaries for Massachusetts, Rhode Island, and Connecticut are shown. Shaded towns have 1-5 extant occurrences.

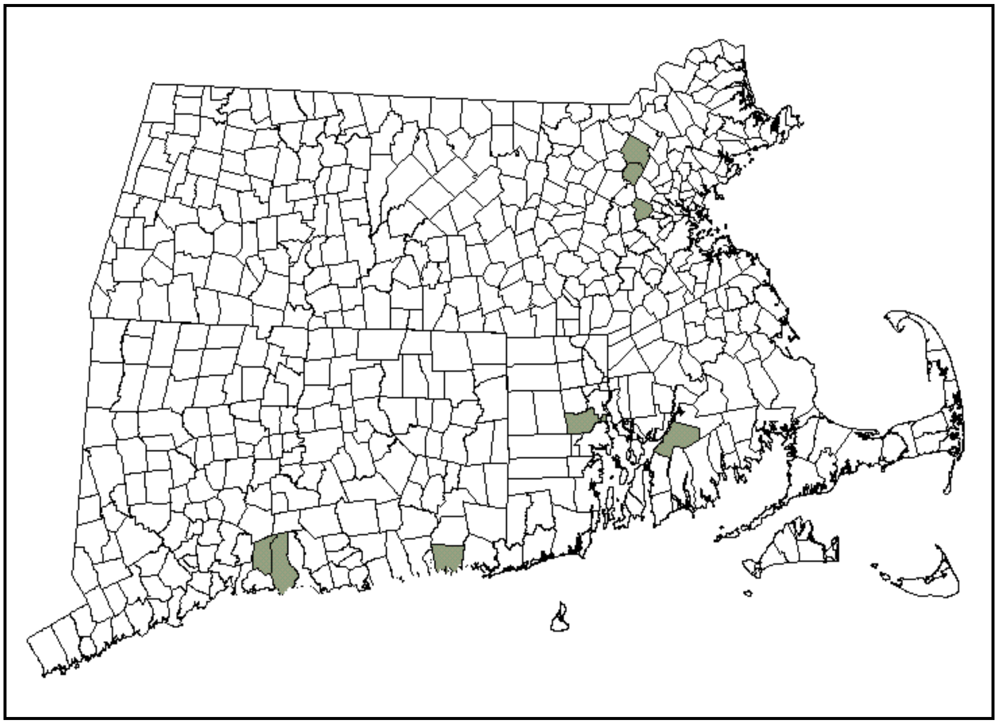

Figure 3. Historic occurrences of *Ludwigia sphaerocarpa* in New England. Town boundaries for Massachusetts, Rhode Island, and Connecticut are shown. Shaded towns have 1-5 historic occurrences.

Table 2. New England Occurrence Records for *Ludwigia sphaerocarpa* based on data from State Natural Heritage Programs. Shaded occurrences are considered extant.

State	EO #	County	Town
MA	**.001**	**Plymouth**	**Bridgewater**
MA	**.005**	**Plymouth**	**Rochester/ Lakeville**
MA	**New**	**Plymouth**	**Middleborough**
MA	None	Bristol	Fall River
MA	None	Middlesex	Bedford
MA	None	Middlesex	Billerica
MA	None	Middlesex	Waltham
RI	**.001**	**Washington**	**South Kingstown**
RI	None	Providence	Cranston
CT	**.001**	**New Haven**	**Guilford**
CT	**.002**	**Middlesex**	**Killingworth**
CT	None	New Haven	Guilford/North Branford
CT	None	New London	Groton

II. CONSERVATION

CONSERVATION OBJECTIVES FOR TAXON IN NEW ENGLAND

New England stations of *Ludwigia sphaerocarpa* and are at limited risk of extirpation. Widespread and vigorous populations are faced with limited short-term threats. The limiting factor in *L. sphaerocarpa's* abundance and distribution in New England appears to be a lack of suitable habitat across the landscape. Within each system habitat is not so limited. In the short-term, the most sensible conservation objective is to maintain stable populations and stable habitat at all six extant sites in New England.

Notwithstanding this, *L. sphaerocarpa* has clearly declined at stations on riparian systems, all but one (CT .002 [Killingworth]) being historic or presumed extirpated. Only limited efforts have been made to survey these populations. If they are still extant at riparian stations, conservation needs may be somewhat more immediate.

The question must be raised as to why attention should be paid to this plant, particularly since it often co-occurs with other more globally limited plants such as the Plymouth Gentian *(Sabatia kennedyana).* However, both in terms of conserving the range of genetic diversity and the conservation of ecosystem patterns, *L. sphaerocarpa* plays a potentially important role. Directional selection for plants at the edge of their range can be a strong force when these plants occupy habitats distinct from the population centers, particularly when these habitats are stressful (Lesica and Allendorf 1995). Limited information is available on typical habitat for the species at its population center (southeast coastal plain). It is highly likely that habitats in the glaciated northeast are distinct from southeastern coastal plain types.

As a potential indicator species, *L. sphaerocarpa's* selective appearance at only certain coastal plain types may provide an important role in the future management decisions at these sites. For instance, *L. sphaerocarpa* at RI .001 (South Kingstown) may better indicate the currently buffered hydrologic regime here. The globally rare *S. kennedyana*, which occurs in great numbers in more typical coastal plain ponds with widely fluctuating water levels, may in fact be more tolerant or even benefit from future hydrologic stress at this site.

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Assigning numeric goals for individual populations is complicated by vague estimates of population size for most stations. Determining minimum viable population (MVP) size also depends on species biology, which is only moderately well understood for this species. An estimate of MVP may not be achievable at this time; however, some conservation insight might be gained in view of what is already known about the species. The following factors are germane to any determination of MVP for *L. sphaerocarpa*:

- **Niche breadth** – the ability to persist in multiple microsite types (such as protected areas and exposed shores) may help buffer the species from environmental stochasticity (Menges 1991).
- **Phenotypic plasticity** (as evidenced by polymorphism) could compensate for low genetic variation (Menges 1991).
- **Plant size** is often the superior predictor of future demographic patterns (Dolan 1984, Menges 1991); *e.g.*, the more vigorous clonal plants in protected areas may provide the most significant contribution to the population.
- **Ability to self-pollinate and to ensure seed set** will buffer variations in pollinator availability *(L. sphaerocarpa* is capable of autogamy). Selfing, however, will result in lowered heterozygosity.
- **Number of ramets** may be critical in terms of short-term persistence, but the number of genets may be more important in the long term. In clonal plants, however, it is often difficult to distinguish genetic or otherwise physiologically distinct individuals (Menges 1991).

Plant populations on pond systems cannot be conserved effectively in isolation. Threats from nutrient enrichment, hydrologic stress, and invasive plants may be focused off-site, yet significantly impact the system on which the plants depend.

These points may facilitate establishing a minimum viable population size for *L. sphaerocarpa*. However, in light of the apparent stability of populations, the dependence on the health of the larger pond/lake system, and the prohibitive cost of the necessary investigation into genetic health of individual populations, it is not practical to assign minimum viable population sizes at this point. A habitat-based strategy is the best approach at this time. To this end, the following conservation objectives are proposed:

1. **Maintain stable populations** at all six extant sites in New England.
2. **Represent populations within sites in a natural range** of micro-habitat types, including exposed shores, sheltered nutrient rich areas, and riparian habitats if possible. This action should suffice until more information is available on the species biology and the significance of size classes (robust stand forming populations and the less vigorous scattered individuals in exposed areas).
3. **Manage the respective habitat** (pond or river system) to prevent adverse impacts from hydrologic stress, nutrient enrichment, and invasive plants.

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IV. APPENDICES

1. Herbarium documentation for *Ludwigia sphaerocarpa*

2. An explanation of conservation ranks used by The Nature Conservancy and the Association for Biodiversity Information

Appendix 1. Herbarium documentation for *Ludwigia sphaerocarpa*

MA.001 (Bridgewater)
Bridgewater, Plymouth County, 17 September 1935, Seymour;
Bridgewater, Plymouth County, 25 August 1980, B. A. Sorrie.

MA .005 (Rochester/Lakeville)
Lakeville, Plymouth County, 27 August 1899, W. P. Rich;
Lakeville, Plymouth County, 27 August 1899, H. A. Purdue;
Lakeville, Plymouth County, September 1900, John Murdoch;
Rochester, Plymouth County, 26 August 1980, B. A. Sorrie.

MA New EO (Middleborough)
Fall River, Bristol County, (no date), S. N. Sanford #401;
Fall River, Bristol County, 15 August 1913, S. N. Sanford.

MA Historic EO (Bedford)
Bedford, 1 October 1885, C. F. Batchelder.

MA Historic EO (Billerica)
Billerica, 1 September 1871, William Boot;
With *Nesala (?) verticillata*, 7 September 1879.

MA Historic EO (Waltham)
Asa Gray;
Waltham, 4 August 1881, C. E. Perkins.

RI .001 (South Kingstown)
South Kingstown, Washington County, August 16, 1930, Anderson, Collins, Lownes, and Weatherby;
South Kingstown, Washington County, September 23, 1988.

RI Historic EO (Cranston)
Cranston, Providence County, August 1907, Thomas Hope.

CT .001 (Guilford)
Guilford, New Haven County, 20 September 1904, G. H. Bartlett;
North Guilford, 23 September 1906, G. H. Bartlett;
North Guilford, New Haven County, 24 September 1906, G. H. Bartlett;
North Guilford, New Haven County, 21 September 1908, G. H. Bartlett;
North Guilford, New Haven County, 15 August 1912, R. W. Woodward;
Guilford, New Haven County, 15 August 1912, J. H. Sage
Guilford, New Haven County, 28 August 1930, E. H. Eames;
Guilford, New Haven County, 22 August 1932, E. H. Eames;

Guilford, New Haven County, 1872, W. R. Dudley.

CT .002 (Killingworth)
Killingworth, Middlesex County, 16 September 1929, E. H. Eames;
Killingworth, Middlesex County, 14 September 1932, E. H. Eames.

CT Historic EO (North Branford)
North Branford, New Haven County, 11 October 1935, E. H. Eames.

CT Historic EO (Groton)
Groton, New London County, 14 September 1924, K. P. Jansson;
Groton, New London County, 21 July 1927, K. P. Jansson;
Groton, New London County, 12 September 1930, K. P. Jansson;
Groton, New London County, 19 August 1931, C. B. Graves;
Groton, New London County, 9 September 1933, K. P. Jansson.

Appendix 2. An explanation of conservation ranks used by The Nature Conservancy and the Association for Biodiversity Information

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.