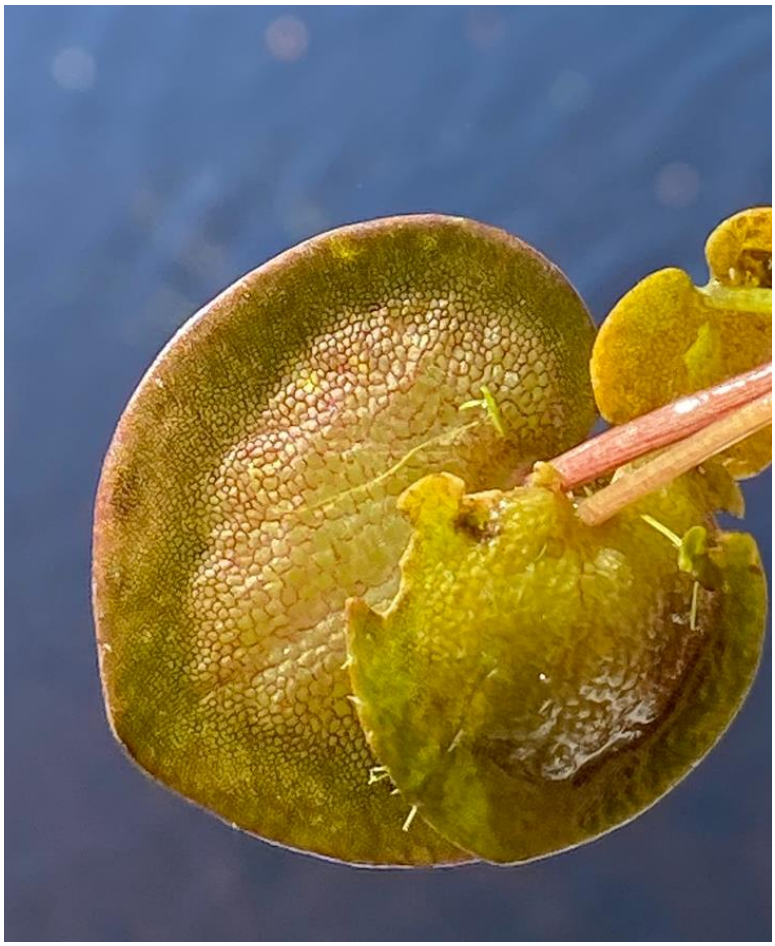
Limnobium spongia

American Frog's-bit

Hydrocharitaceae



Limnobium spongia by Liz Childress, 2021

***Limnobium spongia* Rare Plant Profile**

New Jersey Department of Environmental Protection
State Parks, Forests & Historic Sites
State Forest Fire Service & Forestry
Office of Natural Lands Management
New Jersey Natural Heritage Program

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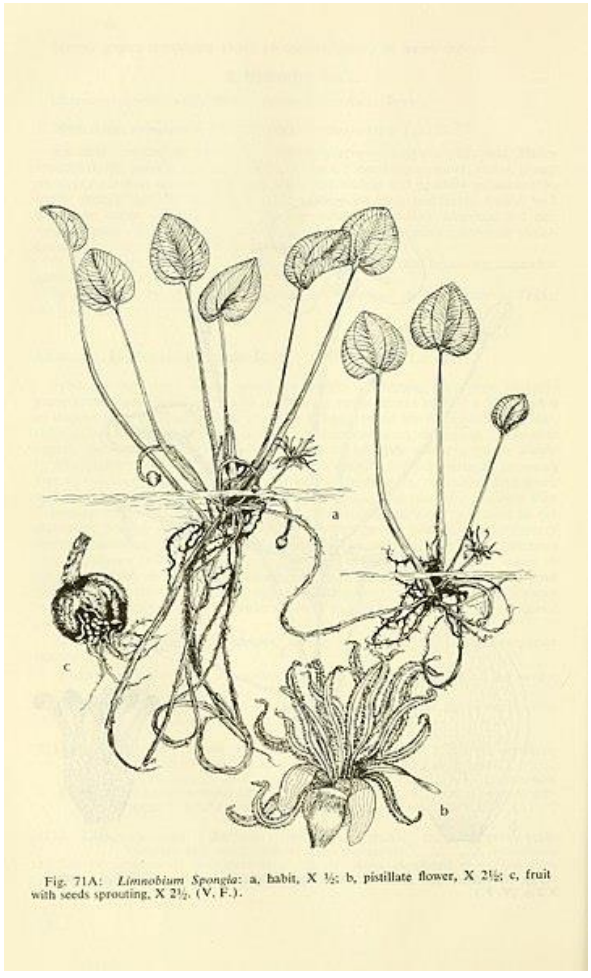
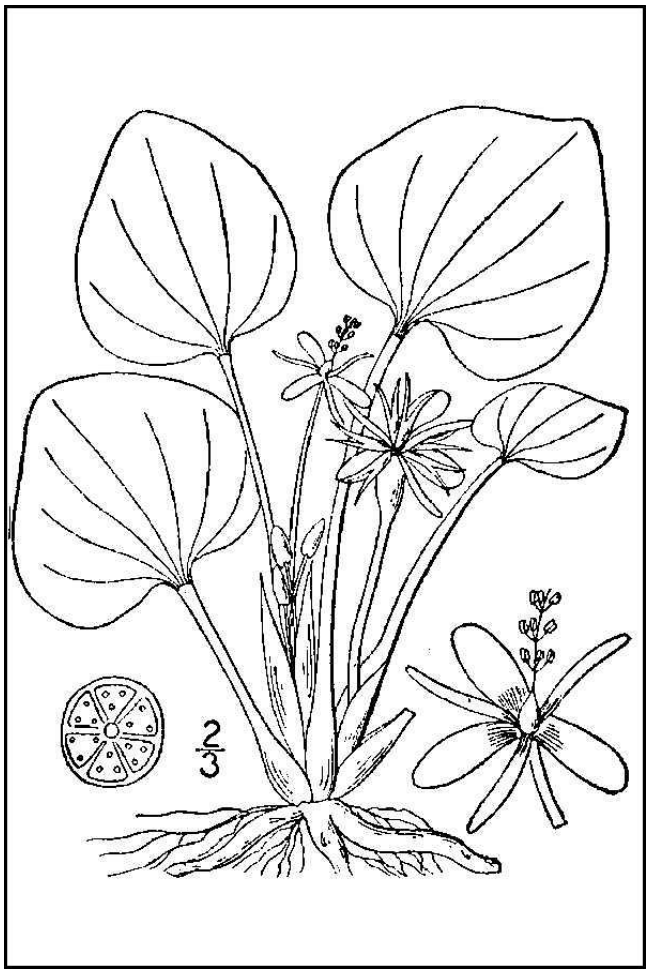
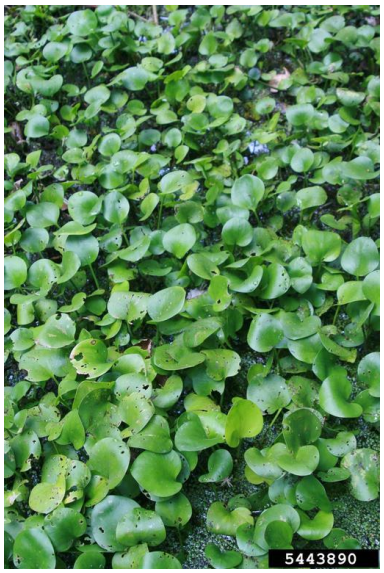
Life History

Limnobium spongia (American Frog's-bit) is a perennial aquatic herb that may be rooted or free-floating. The leaves are tufted, stalked, and rounded or notched (heart or kidney-shaped) at the base. Young or floating leaves have a broad patch of spongy tissue on the underside while the upright aerial leaves are flat and leathery. The plants reproduce vegetatively by stolons that develop roots and shoots at the nodes. Sexual reproduction occurs primarily on plants that have roots and emergent leaves. The species is monoecious, producing separate male and female flowers on the same plant. The flowers have three sepals and three narrow, whitish petals. Male flowers are erect on long (up to 7.5 cm), thin peduncles and have 9–12 stamens of unequal size, with the filaments united in a basal column and the anthers diverging above. Female flowers have shorter (up to 2.5 cm), stouter peduncles and bear one ovary with 6–9 carpels, each of which has a style up to 20 millimeters long that is split nearly to the base. (See Britton and Brown 1913, Fernald 1950, Gleason and Cronquist 1991, Tiner 2009, Haynes 2020, Les 2020). A detailed study of the species' growth and development was conducted by Wilder (1974). The plants bloom between June and September (Weakley 2015), and as the fruits mature the pedicels recurve and become submerged in water or mud (Fassett 1957, Haynes and Holm-Nielsen 2001).





Left: Correll and Correll 1972, public domain via Wikimedia Commons. Right: Britton and Brown 1913, courtesy USDA NRCS 2022a.



Left: Chris Evans, University of Illinois, Bugwood.org. Center: Shaun Winterton, Aquarium and Pond Plants of the World, Edition 3, USDA APHIS PPQ, Bugwood.org. Right: Diana Soteropoulos, 2019.

Although *Limnobium spongia* is the only native member of its genus in North America (Kartesz 2015), there are several other aquatic plants with which it may be confused. *Limnobium laevigatum* (West Indian Spongeplant) is native to Central and South America but is closely related and has even been described as a subspecies of *L. spongia* (Lowden 1992). The West Indian Spongeplant is marketed for use in aquariums and ornamental ponds and occasionally escapes. In comparison to *L. spongia*, the floating leaves of *L. laevigatum* are rarely heart-shaped, the female flowers have 0–2 petals and fewer stigmas, and the male flowers have fewer fertile stamens (Lowden 1992). *Hydrocharis morsus-ranae* (Common Frog-bit) is a European species that became established in Canada in 1939 and has slowly spread throughout the northeast (Catling and Dore 1982). The *Hydrocharis* has been documented in New York and may already be present in New Jersey (Kartesz 2015). In comparison to *L. spongia*, the floating leaves of *H. morsus-ranae* have only a narrow band of spongy tissue near the base of the central vein, and the stolon buds of *Hydrocharis* initially develop a single root at the base while the buds of *L. spongia* develop numerous roots simultaneously (Catling and Dore 1982). UF/IFAS (2022) have also noted a superficial foliar resemblance between *Limnobium spongia* and the invasive Water-hyacinth (*Eichhornia crassipes*), but the latter plant has leaves without notches, different venation, and fleshy, often bulbous, stems.

Pollinator Dynamics

Plants in the Hydrocharitaceae employ a broad range of pollination strategies—many of which are highly specialized (Zomlefer 1994)—and *Limnobium* is the only strictly wind-pollinated genus in the family (Philbrick and Les 1996). As pollen is discharged from the anthers, some of it may be blown away immediately but much of it falls downward and is captured by the sepals of the male flower (Cook 1998). The arched petals help to keep the pollen dry, protecting it from rain or wave splashes, and if the flowers become immersed the sepals rest against the petals and

form an air bubble around the pollen (Cook 1988). Pollen placed on the open sepals may be further transported by wind or it may fall downward as the sepals wither (Cook 1998). The release of pollen by decaying sepals may cause it to land on lower female flowers of the same plant, resulting in self-fertilization (Les 2020). *Limnobium spongia* is also reportedly visited by a number of small insects, but no specific role in pollination has been documented (Missouriplants.com 2021).

Seed Dispersal

The fruit of *Limnobium spongia* is a fleshy, many-seeded berry 4–12 millimeters in diameter; Haynes (2020) reports 200 ovules per ovary. The seeds are covered with spike-like hairs (Godfrey and Wooten 1981). The fruits ripen in the water or mud, and when the ovary disintegrates the seeds are released in a gelatinous mass that may be transported for a limited distance by water (Kaul 1970, Hilty 2020). In northern parts of the species' range, the seeds can remain in coherent masses to overwinter (Les and Capers 1999).

The most frequently suggested means of long-distance dispersal in *Limnobium spongia* is by waterfowl. The gelatinous, spiny seeds may adhere to the feathers and feet of the birds and be transported between wetland habitats (Hilty 2020, Les 2020). The fruits are also consumed by numerous waterfowl species and marsh birds as well as alligators and manatees (McAtee 1918, Fassett 1957, Les and Capers 1999, Hilty 2020, Platt et al. 2013, Guterres-Pazin et al. 2012). As most seeds ingested by manatees are not intact after passing through the digestive system the mammals are not good dispersers (Guterres-Pazin et al. 2012), and post-egestion viability of seeds dispersed by alligators has not been well-studied (Platt et al. 2013). The dispersal of viable seeds following ingestion by waterfowl is well-documented, although results vary widely depending on both plant species and seed retention time (Soons et al. 2008, Wongsriphuek et al. 2008, Farmer et al. 2017). No information was found regarding post-consumption viability of *Limnobium spongia* seeds.

Limnobium spongia maintains a seed bank, but the length of time that the seeds may persist is uncertain (Les 2020). *L. spongia* seeds were successfully germinated from soil collections made following a water level drawdown at a location that had been continuously flooded for 10 years, but the plant was abundant prior to the drawdown so the age of the seeds cannot be inferred from the site characteristics (Howard and Wells 2007). The seeds of *Limnobium spongia* initially germinate underwater, rising to the surface where the young plants may be dispersed by currents (Les 2020). After shedding their coats the small seedlings float at the surface with a rounded upper side emerging into the air, resembling young water-ferns or duckweeds (Cook 1998).

Limnobium spongia is not entirely dependent on seeds for propagation or for persisting through winters in the colder portions of its range. Vegetative reproduction via the development of new rosettes at intervals along a growing stolon is copious, sometimes to the point where the plants form dense mats and become a nuisance. In the south where winter temperatures remain above freezing *L. spongia* plants can remain green year-round, but at northern latitudes the plants form starchy winter buds (turions) that sink below the surface to survive the colder months (Les and Capers 1999, Hilty 2020). Middleton (2003) cited *Limnobium spongia* as a species primarily

dispersed by vegetative organs, but it was not clear whether the reference was to movement of the young seedlings or the winter buds.

Habitat

Limnobium spongia is most likely to be found in quiet, shallow waters. An assortment of habitats have been cited, including marshes (tidal and nontidal), bayous, lakes, lagoons, ponds (including beaver ponds), pools, swamps, slow-flowing streams or rivers, ditches, and canals (Godfrey and Wooten 1981, Haynes 1980, Ringelman 1991, Tiner 2009, Walley 2007, Weakley 2015). Specific community associations reported include Bald Cypress (*Taxodium distichum*) swamps (Hilty 2020) and Sweetgum—(Red Maple) [*Liquidambar styraciflua*—(*Acer rubrum*)] seasonally flooded forest alliance (Breden et al. 2001). Wetland sites range from high quality to disturbed (Hilty 2020). Sometimes *L. spongia* grows where it has become stranded along a shoreline (Haynes 2020): The first documented Connecticut occurrence was a group of young plants rooted in moist sand near a small pond (Les and Capers 1999). The species is typically associated with alkaline, hard water, nutrient-rich sites, and Les and Capers (1999) suggested that its lack of establishment in the northeast could be due to the predominance of acidic, soft water habitats in that region.

Wetland Indicator Status

Limnobium spongia is an obligate wetland species, meaning that it almost always occurs in wetlands (U. S. Army Corps of Engineers 2020).

USDA Plants Code (USDA, NRCS 2022b)

LISP2

Coefficient of Conservatism (Walz et al. 2018)

CoC = 8. Criteria for a value of 6 to 8: Native with a narrow range of ecological tolerances and typically associated with a stable community (Faber-Langendoen 2018).

Distribution and Range

Limnobium spongia is native to the southeastern and central U. S. and introduced in Puerto Rico (POWO 2022). The map in Figure 1 illustrates the range and status of the species in the United States and Canada.

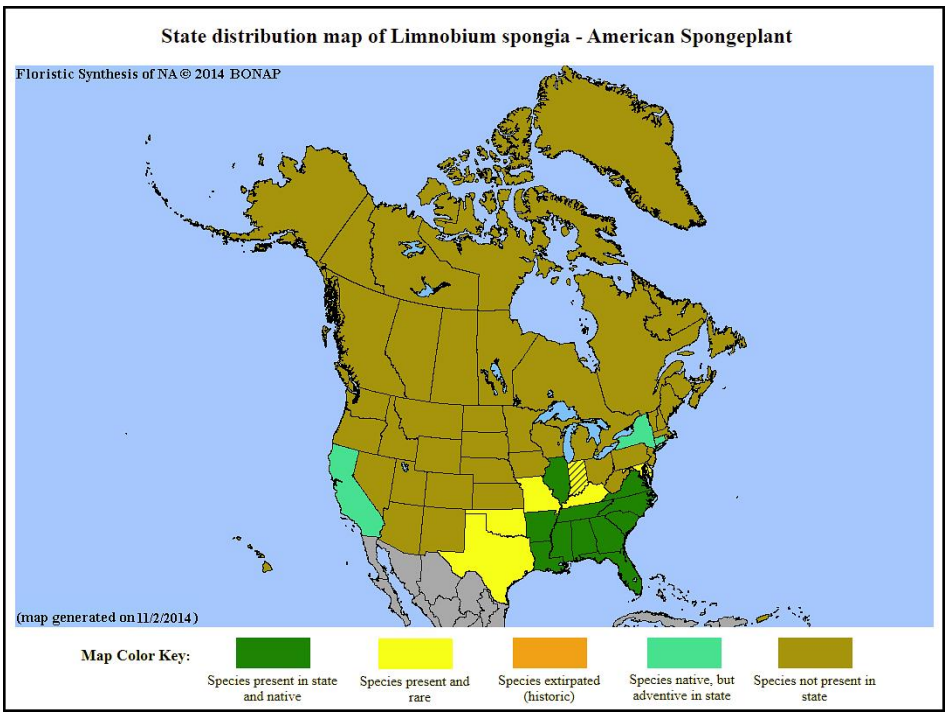


Figure 1. Distribution of L. spongia in North America, adapted from BONAP (Kartesz 2015). Cross-hatching indicates a questionable status.

The USDA PLANTS Database (2022b) shows records of *Limnobium spongia* in only one New Jersey county: Monmouth County (Figure 2). The record is based on a historic observation and does not reflect the current distribution of the species.

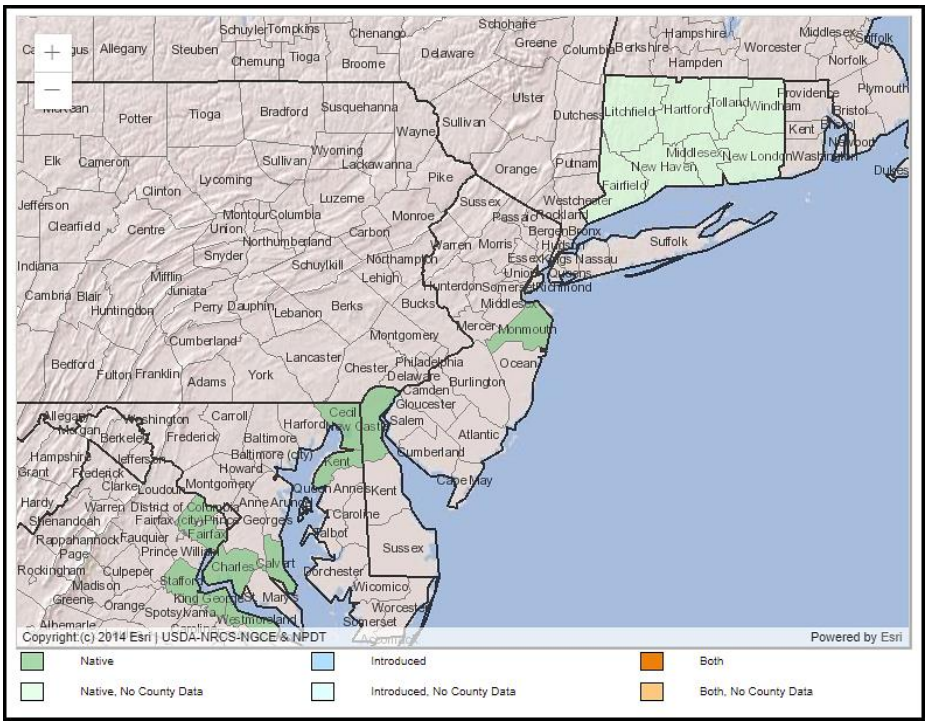


Figure 2. County records of L. spongia in New Jersey and vicinity (USDA NRCS 2022b).

Conservation Status

Limnobium spongia is apparently secure at a global scale. The G4 rank means the species is at fairly low risk of extinction or collapse due to an extensive range and/or many populations or occurrences, although there is some cause for concern as a result of local recent declines, threats, or other factors (NatureServe 2022). The map in Figure 3 illustrates the conservation status of *L. spongia* throughout its range. American Frog's-bit is critically imperiled (very high risk of extinction) in six states, imperiled (high risk of extinction) in four states, and vulnerable (moderate risk of extinction) in two states. The species is considered exotic in New York, and is unranked in most other states where it occurs.

Limnobium spongia is listed as an invasive plant in California (Swearington and Bargeron 2018) and, due to its habit of forming dense mats that crowd out other plant species, it is also considered a nuisance in some of the states where it is native (Godfrey and Wooten 1981, UF/IFAS 2022). Herbicides have been used to control the species in Texas because floating mats of *Limnobium* block navigation, affect water quality for fish and wildlife, and interfere with the recreational use of waterways (Madsen et al. 1998).

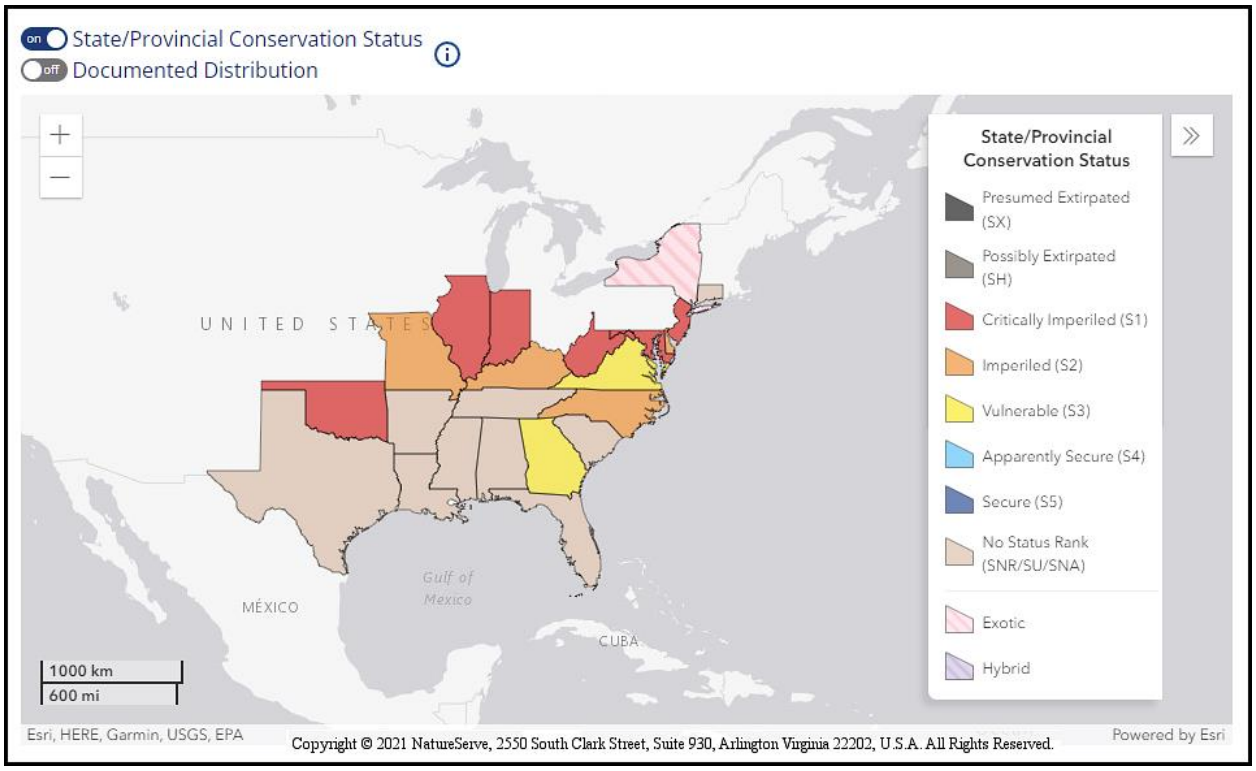


Figure 3. Conservation status of L. spongia in North America (NatureServe 2022).

New Jersey is one of the six states where *Limnobium spongia* is critically imperiled. *L. spongia* is ranked S1.1 in New Jersey (NJNHP 2022), meaning that it is critically imperiled due to extreme rarity. A species with an S1.1 rank has only ever been documented at a single location in the state. American Frog's-bit is also listed as an endangered species (E) in New Jersey, meaning that without intervention it has a high likelihood of extinction in the state. Although the presence of endangered flora may restrict development in certain communities such as

wetlands or coastal habitats, being listed does not currently provide broad statewide protection for the plants. Additional regional status codes assigned to the plant signify that the species is eligible for protection under the jurisdictions of the Highlands Preservation Area (HL) and the New Jersey Pinelands (LP) (NJNHP 2010).

The original report of *Limnobium spongia* in New Jersey was made by Knieskern (1856), who stated that he had personally found and examined the plant in Monmouth County within the previous 10–12 years. While his record was widely accepted at the time (e.g. Willis 1877, Britton 1889, Keller and Brown 1905) it appears that no one ever documented the observation, as noted by Taylor (1909). Mackenzie (1922) referred to Knieskern's report as "*one of the most interesting and at the same time troublesome records for New Jersey*" due to the lack of a specimen. Based on the absence of subsequent records, Fables (1956) believed the species to be extinct in New Jersey. The only confirmed occurrence of *L. spongia* in New Jersey was discovered by David Snyder in Gloucester County during 2002, and the population currently has an estimated viability rank of 'Excellent' (NJNHP 2022).

Threats

Because *Limnobium spongia* is an obligate wetland plant, the draining of a wetland habitat where the species was established would threaten that occurrence. Howard and Wells (2007) conducted a study of vegetation responses to short-term drawdown at a site that had been continuously flooded for ten years. Prior to the drawdown, *L. spongia* was one of the most abundant plants on the site. Its prevalence decreased during the drawdown period and rose after the water levels were raised again, but significantly lower numbers of the plants were found during the year that followed the drawdown.

Although American Frog's-bit has been known to form dense masses that can dominate an aquatic community, it may be a poor competitor when sharing a habitat with other species that have the same tendency. A two-year evaluation of competition between native and exotic aquatic macrophytes in Louisiana sampled vegetation in canals, bayous, lakes, and swamps. *Limnobium spongia* showed a decrease in both percent cover and mean biomass in all four habitat types during the study period (Walley 2007). Monitoring notes from New Jersey's *L. spongia* population indicate that the frog's-bit has recently decreased in abundance as a result of the aggressive growth of Floating Marsh-pennywort (*Hydrocotyle ranunculoides*) (NJNHP 2022). Another kind of marsh-pennywort, *Hydrocotyle umbellata*, uses alternate growth forms in mixed cultures or monocultures, making it a stronger competitor when growing with other species (Gopal and Goel 1993). Gopal and Goel also noted that species dominance could vary between sites depending on the interaction of multiple factors including light, temperature, and nutrients.

A number of faunal and fungal interactions have been reported that may do some damage to *Limnobium spongia* plants, but do not appear to threaten the species. Leaf herbivory by turtles, moths, a leaf-mining fly and a beetle has been documented (Harms 2009, Hilty 2020). Frog's-bit plants are also susceptible to a leaf-spot fungus, *Cercospora limnobii* (Conway 1978). While a

Cercospora infection results in patches of necrotic tissue that may lead to leaf loss, serious harm to the plants has not been documented (Hilty 2020, WIDNR 2022).

No studies were found regarding the potential response of *Limnobium spongia* to climate change. The stark differences in the species abundance between the northern and southern portions of its range might be related to temperature, as plants at northern latitudes have a shorter growing season and require an investment in the development of special organs in order to persist through the winter months. If that is the case, rising temperatures may allow the species to expand its range northward. Expected trends in New Jersey include both extended summer droughts and increasing salinity in coastal areas (USEPA 2016), both of which could be detrimental to *L. spongia* in affected areas.

Management Summary and Recommendations

Management of extant *Limnobium spongia* populations in states where the species is imperiled can begin with preservation of habitat at the sites where it occurs. While many wetland types already enjoy some kind of legal protection, fewer safeguards are available for those that are small or isolated (Kirkman et al. 1999).

Additional knowledge concerning certain aspects of the life history of *Limnobium spongia* would provide a better foundation for conservation planning. Research on seed viability in the species is needed, both to determine the length of time *L. spongia* is able persist in the seed bank and to evaluate the effectiveness of dispersal by the waterfowl that eat its fruits. It would be helpful to identify the factors that drive competitive success or failure for the species when it shares a habitat with other native or exotic plants, and a study of *L. spongia*'s temperature tolerances might shed some light on the disparity between the vigor of northern and southern populations and lead to a better understanding of its potential responses to shifting climactic conditions.

Synonyms

The accepted botanical name of the species is *Limnobium spongia* (Bosc) Rich. ex Steud. Orthographic variants, synonyms, and common names are listed below (ITIS 2021, USDA 2022b, Haynes 2020, POWO 2022).

Botanical Synonyms	Common Names
Hydrocharis cordifolia Nutt.	American Frog's-bit
Hydrocharis spongia Bosc	American Frogbit
Limnobium spongia ssp. *spongia* (Bosc) Rich. ex Steud.	American Spongeplant
Limnobium boscii Rich	Frogbite
Rhizakenia ovata Raf.	

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Childress, Liz. 2021. Cover photo of *Limnobium spongia* leaf underside from Florida (slightly cropped). Shared via iNaturalist at https://www.inaturalist.org/observations/70768810, licensed by https://creativecommons.org/licenses/by-nc/4.0/

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