Myriophyllum pinnatum

Cutleaf Water-milfoil

Haloragaceae

Myriophyllum pinnatum by Richard J. Abbott, 2020

***Myriophyllum pinnatum* 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

501 E. State St.
PO Box 420
Trenton, NJ 08625-0420

Prepared by:
Jill S. Dodds
jsdodds@biostarassociates.com

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For:
New Jersey Department of Environmental Protection
Office of Natural Lands Management
New Jersey Natural Heritage Program
natlands@dep.nj.gov

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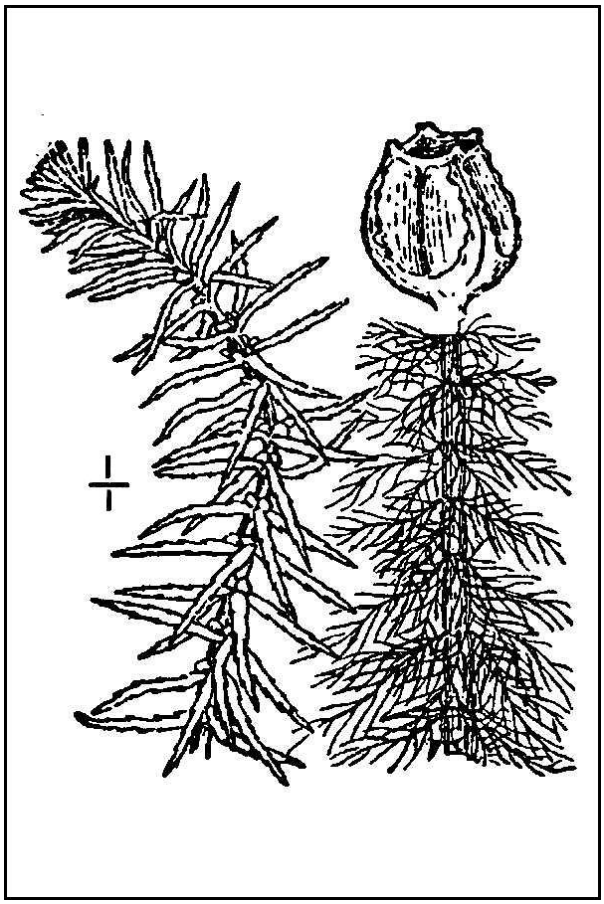
Life History

Myriophyllum pinnatum (Cutleaf Water-milfoil) is a perennial aquatic or semi-aquatic plant in the Haloragaceae. The species is highly variable in its morphology, typically developing long stems with whorls of pectinate (comblike) leaves underwater but branched stems and shorter, more variable leaves when growing on the shore. Some *M. pinnatum* plants that develop on mud flats are diminutive but others may become fairly large. *M. pinnatum* grows as an emergent plant more frequently than other species of *Myriophyllum*, but even in aquatic individuals the flowering stems develop above the surface of the water and produce different leaves than the submersed stems (Scribailo and Alix 2002, Les 2017).



Left: Correll 1969, courtesy Harvard University Herbaria. Right: Britton and Brown 1913, courtesy USDA NRCS 2023a.

The stems of *M. pinnatum* may be up to a meter long. Many of the leaves are whorled or nearly whorled but some of them can be alternate. The leaves on emersed stems are narrowly lanceolate in outline but they may be shallowly toothed or deeply pectinate. *Myriophyllum pinnatum* produces separate male and female flowers on the same plant. The lowest flowers on a stem are pistillate while those near the top are staminate, and some in the middle may have both pistils and stamens. Flowers develop in the axils of emergent stem leaves. The flowers have tiny sepals (less than 0.3 mm long) and cream to purple petals up to 1.7 mm in length that are quickly shed in the pistillate flowers but persist in the staminate ones. The four anthers range

from 0.7–1.5 mm in length and the pistils are capped with red-purple stigmas about 0.5 mm long. The fruits split into four parts (mericarps), each of which is less than 2 mm long, flattened, and has two rough longitudinal ridges with prominent undulating, ribbed wings. (See Britton and Brown 1913, Fernald 1950, Fassett 1957, Gleason and Cronquist 1991, Scribailo and Alix 2022).

Jim Keesling, 2017.

Richard J. Abbott, 2020.

In New Jersey, *Myriophyllum pinnatum* can flower and fruit from June through October (Stone 1911, Hough 1983) but in other parts of its range blooming may begin as early as March (Scribailo and Alix 2022, Weakley et al. 2022). Research on *Myriophyllum heterophyllum*—which also has variable leaf shapes—revealed that that the formation of aerial leaves was initiated while the stems were still underwater and that after flowering the leaf shape reverted to the underwater type. Consequently the developmental process appears to be driven by the plant's seasonal reproductive cycle rather than by environmental conditions (England and Tolbert 1964). Most species of *Myriophyllum*, including *M. pinnatum*, reproduce vegetatively by rooting at lateral stem nodes and new plants can readily develop from stem fragments (Patten 1956, Les 2017, Scribailo and Alix 2022). *M. pinnatum* showed a high capacity for shoot formation when grown from defoliated stem segments in a laboratory setting (Kane and Gilman 1991).

Because most of the water-milfoils can exhibit some plasticity when growing in different environments some flowers, fruits or DNA are needed to make a positive species identification. Fully developed fruits obtained from the lowest part of a stem usually have the best diagnostic characters (Scribailo and Alix 2022). Species most likely to be confused with *Myriophyllum pinnatum* include *M. farwellii*, *M. laxum*, *M. hippuroides*, and *M. heterophyllum* (Aiken 1981, Moody and Les 2010, Thum et al. 2011, Scribailo and Alix 2022), but the first three have not been documented in New Jersey. *Myriophyllum heterophyllum* is relatively rare (S3) in the state (NJNHP 2022) but in Europe and some parts of the United States it is considered invasive (Gross et al. 2020). The sale of *M. heterophyllum* is prohibited but the species has frequently been mislabeled as *M. pinnatum* and marketed as an aquarium plant (Thum et al. 2012). Initial reports

of hybridization between *Myriophyllum pinnatum* and *M. heterophyllum* were found to be in error due to confusion between *M. pinnatum* and *M. laxum* (Moody and Les 2002, 2010); however, new evidence for hybridization between *M. pinnatum* and *M. heterophyllum* was subsequently found (Thum et al. 2011).

Pollinator Dynamics

Myriophyllum species with emergent flowering stems are generally pollinated by wind (Patten 1956, Cook 1988, Haynes 1988). A number of the floral characteristics of *M. pinnatum* make it particularly well-suited for wind-pollination, including the reduced perianths, deciduous petals on pistillate flowers, and long-filamented anthers (Cook 1988). Both self-pollination and the production of cleistogamous flowers (those that self-fertilize without opening) are common in *Myriophyllum* (Philbrick and Les 1996) but neither has been documented in *M. pinnatum*. Although self-fertilization is likely to be deterred by separation of the male and female flowers on a single stem, flowers may receive pollen from related plants on nearby stems because of the high rate of clonal reproduction in the plants (Patten 1956).

Seed Dispersal

When ripe, the fruits of *Myriophyllum pinnatum* split into four one-seeded mericarps (Gleason and Cronquist 1991, Scribailo and Alix 2022). Despite the high rate of vegetative reproduction, fruiting is common in the species (Les 2017). *Myriophyllum* seeds have a hard endocarp that prevents rapid germination so they remain dormant until the seed coat has broken down as a result of age, exposure, drying and rewetting, freezing, scarification, or other processes (Patten 1956, Brock 1991, Wani and Arshid 2013).

Studies of some related water-milfoils found that the seeds began to drop from the plants in the fall, with those in aquatic settings sinking to the bottom near the parent plants where they could become part of the seed bank (Brock 1991, Wani and Arshid 2013). Observations of an *M. spicatum* population in New Jersey indicated that some of the achenes remained attached through the early part of the winter, often becoming embedded a layer of ice (Patten 1956). Long-distance dispersal is probably dependent on birds (Les 2017). Waterfowl often consume *Myriophyllum* seeds, although they do not seem to be a preferred food source, and some may be inadvertently ingested by ducks as they root in the mud for invertebrates (McAtee 1918, Fassett 1957, Dirschl 1969, Drobney and Fredrickson 1979). *Myriophyllum* seeds are also occasionally eaten by fish (Patten 1956). Passage through the digestive tracts of vertebrates can weaken the seed coats and facilitate germination, and waterfowl can play a particularly important role in the long-distance dispersal of aquatic plants (Wongsriphuek et al. 2008).

Because *Myriophyllum* species can readily reproduce vegetatively the plants are also able to spread via the dispersal of stem fragments. The aggressive proliferation of *Myriophyllum heterophyllum* in Europe has been attributed to vegetative dispersal since the species has not been known to produce viable seeds on that continent (Gross et al. 2020). Patten (1956) observed that both flowering and nonflowering stems of *M. spicatum* began to fragment in the

fall, floating to new locations and accumulating along the shorelines where they produced buds, branches and roots before winter set in. While *Myriophyllum* seeds usually sink quickly, floating stem fragments with attached fruits could also result in the aquatic dispersal of some sexual propagules. Water-milfoils are sometimes dispersed anthropogenically because their long stems get tangled in boat motors and trailers and the fragments are subsequently carried to new locations (Philbrick and Les 1996).

Habitat

Myriophyllum pinnatum can grow in an assortment of aquatic or semi-aquatic habitats at elevations up to 700 meters above sea level (Scribailo and Alix 2022). Aquatic habitats reported for the species include canals, ditches, lakes, lagoons, marshes, ponds, pools, rivers, sloughs, streams and swamps (Radford 1951, Hough 1983, Urquiola Cruz and Betancourt Gandul 2000, Scribailo and Alix 2002, Les 2017, Weakley et al. 2022). *M. pinnatum* can also be found on wet, peaty or muddy substrates in places where the water level is variable such as borrow pits, ephemeral ponds, and shorelines (Coddington and Field 1978, Crow and Hellquist 1983, Hough 1983, Scribailo and Alix 2002, MacRoberts et al. 2014, Les 2017). *M. pinnatum* habitat may be oligotrophic or mesotrophic (Scribailo and Alix 2022), but during a comparative study of nine Florida lakes it was only found in oligotrophic sites where it was often one of the dominant species (Maceina et al. 1984).

Cutleaf Water-milfoil appears to tolerate a certain amount of salinity. Along the Atlantic coast the species has been found in brackish ponds and marshes (Radford 1951, Sorrie 1987, Nichols et al. 2013). Coastal salt pond marsh communities are primarily fed by fresh water but can be subject to occasional incursions of salt water (Nichols et al. 2013). In Louisiana *Myriophyllum pinnatum* has been reported growing in saline prairies, inland grassland habitats characterized by poor drainage and high levels of sodium (Reid et al. 2010). New Jersey's extant population of *M. pinnatum* is located in a shallow, presumably fresh water pond situated in the upper reach of a fresh to brackish coastal marsh (NJNHP 2022) where it could occasionally be flooded by salt water during exceptionally high tides.

Myriophyllum pinnatum usually requires high light levels to establish and thrive (Les 2017), although it has been documented in a swamp beneath a canopy of *Nyssa aquatica*, *N. biflora*, and *Taxodium distichum* (Hall and Penfound 1943). In shallow water and shoreline habitats, *M. pinnatum* can co-occur with a wide variety of aquatic and emergent species (Hall and Penfound 1943, Sorrie 1987, Scribailo and Alix 2002). In places where *Myriophyllum pinnatum* has been reported as a dominant species, its most abundant associates were bladderworts (*Utricularia* spp.), Fragrant Water-lily (*Nymphaea odorata* ssp. *odorata*), and Small's Yellow-eyed-grass (*Xyris smalliana*). Big Floatingheart (*Nymphoides aquatica*) was also important at some sites (Eyles 1941, Maceina et al. 1984).

Wetland Indicator Status

Myriophyllum pinnatum 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 2023b)

MYPI

Coefficient of Conservatism (Walz et al. 2018)

CoC = 5. Criteria for a value of 3 to 5: Native with an intermediate range of ecological tolerances and may typify a stable native community, but may also persist under some anthropogenic disturbance (Faber-Langendoen 2018).

Distribution and Range

The native range of *Myriophyllum pinnatum* is restricted to North America, where it extends from southern Canada to central Mexico (POWO 2023). It has also been documented in Jamaica (Proctor 1982) and Cuba (Urquiola Cruz and Betancourt Gandul 2000). The map in Figure 1 depicts the extent of *M. pinnatum* in the United States and Canada.

The USDA PLANTS Database (2023b) shows records of *Myriophyllum pinnatum* in seven New Jersey counties: Burlington, Camden, Cape May, Cumberland, Gloucester, Monmouth, and Salem (Figure 2). The data include historic observations and do not reflect the current distribution of the species.

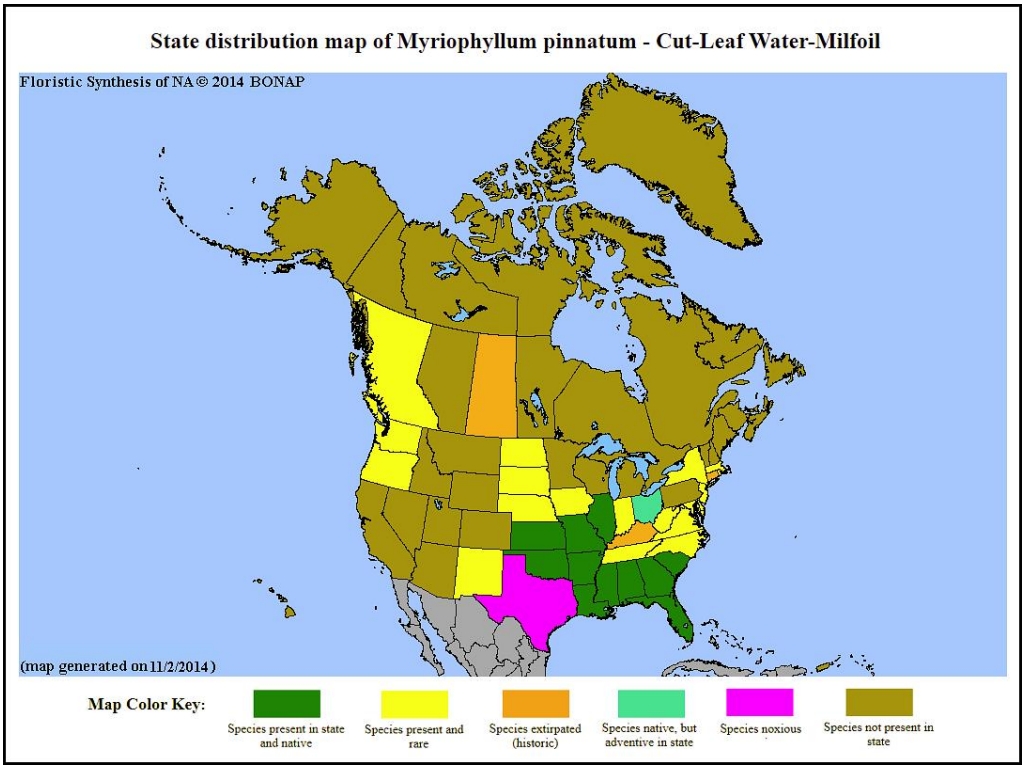


Figure 1. Distribution of M. pinnatum in The United States and Canada, adapted from BONAP (Kartesz 2015).

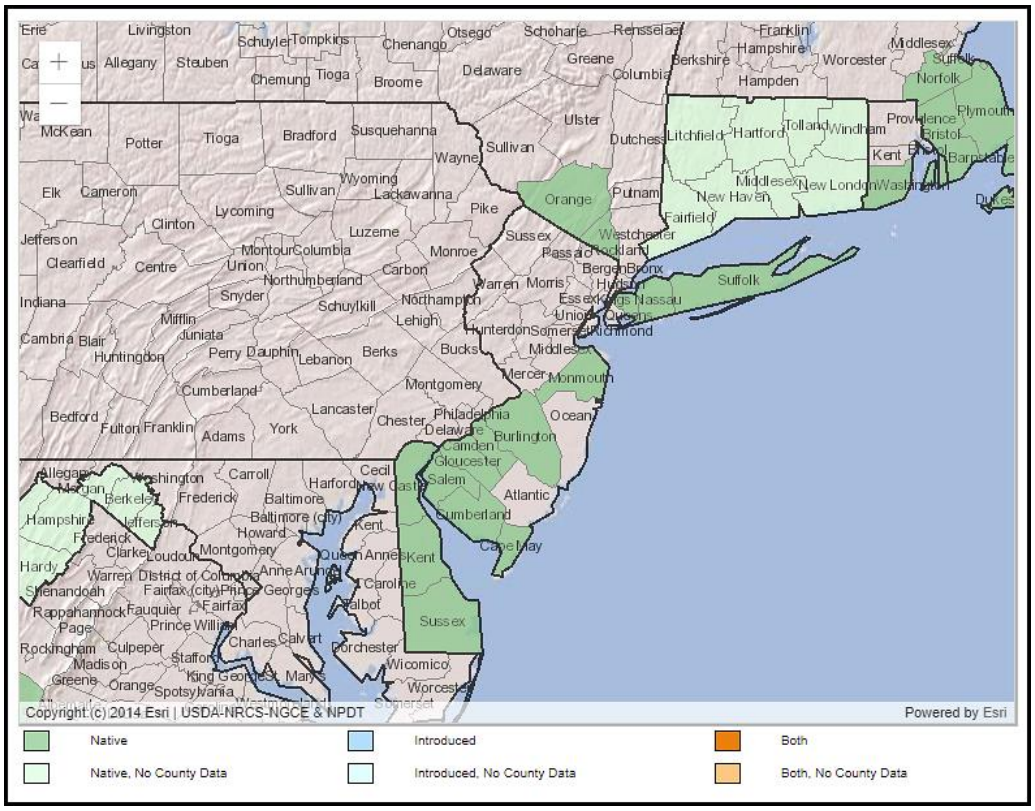


Figure 2. County records of M. pinnatum in New Jersey and vicinity (USDA NRCS 2023b).

Conservation Status

Myriophyllum pinnatum is considered globally secure. The G5 rank means the species has a very low risk of extinction or collapse due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats (NatureServe 2023). In Cuba, *M. pinnatum* has been listed as an invasive species (Oviedo Prieto et al. 2012). The map below (Figure 3) illustrates the conservation status of Cutleaf Water-milfoil throughout its range. *M. pinnatum* is vulnerable (moderate risk of extinction) in one state, imperiled (high risk of extinction) in four states, critically imperiled (very high risk of extinction) in ten states and one province, and possibly extirpated in Kentucky. The species has not been ranked in other districts where it occurs.

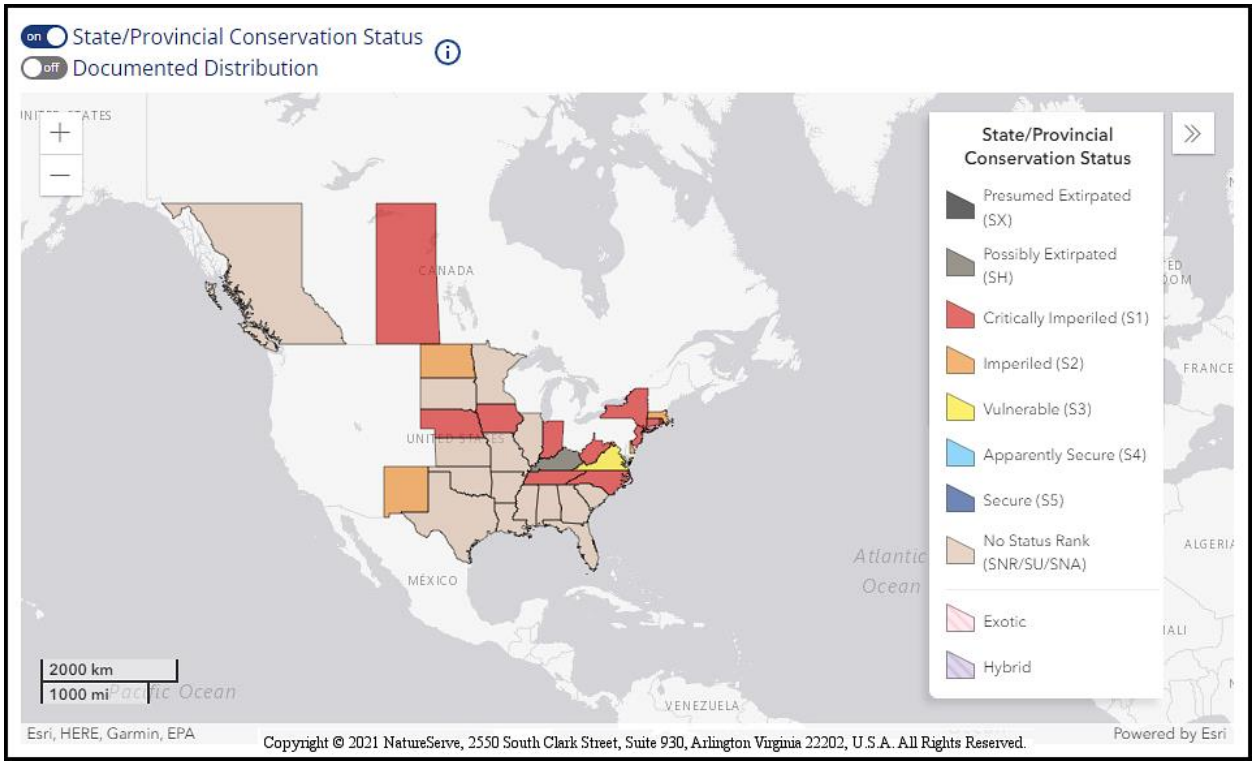


Figure 3. Conservation status of M. pinnatum in North America (NatureServe 2023).

New Jersey is one of the states where *Myriophyllum pinnatum* is critically imperiled (NJNHP 2022). The S1 rank signifies five or fewer occurrences in the state. A species with an S1 rank is typically either restricted to specialized habitats, geographically limited to a small area of the state, or significantly reduced in number from its previous status. *M. pinnatum* 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 *M. pinnatum* 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).

During the late 1800s and early 1900s there were scattered records of *Myriophyllum pinnatum* from most New Jersey's coastal plain counties, although it was not found in the Pine Barrens (Britton 1889, Keller and Brown 1905, Taylor 1915). Stone (1911) described it as frequent in the southern part of the state. Hough (1983) indicated that state records of the species from everywhere other than Cumberland and Salem counties predated 1930. Some of the old sites were searched in recent years but none of the *M. pinnatum* populations were relocated. Snyder (2000) discovered a new population in Cape May County during 1996 and that is the only New Jersey occurrence known to be extant. Eight other locations where the species was once documented have been ranked as historical (NJNHP 2022).

Threats

When New Jersey's extant occurrence of *Myriophyllum pinnatum* was last monitored the population was vigorous, but a developing stand of Common Reed (*Phragmites australis* ssp. *australis*) was noted as a concern (NJNHP 2022). The abundance of Common Reed has also been noted as a threat to some Massachusetts populations of *M. pinnatum* (Sorrie 1987). The invasive grass often forms dense monospecific stands, replacing native flora. *Myriophyllum pinnatum* might also be threatened by competition from invasive aquatic plants: For example, a Florida study showed that *M. pinnatum* was prevalent at some sites but none where Water-thyme (*Hydrilla verticillata*) was dominant (Maceina et al. 1984). While the competitive interactions of *M. pinnatum* were not specifically investigated, *Hydrilla verticillata* is a widely recognized threat to native aquatic ecosystems that frequently displaces native vegetation (Kaufman and Kaufman 2007, Jacono et al. 2023).

A non-native fish introduced for weed management could have some detrimental effects on *Myriophyllum pinnatum*. The Grass Carp (*Ctenopharyngodon idella*) was experimentally released to control invasive flora in a number of Arkansas lakes, but prior to more widespread distribution of the fish additional testing was carried out to check for potential collateral damage to native species. Initial studies found that the Grass Carp readily consumed *Myriophyllum* but the type of water-milfoil was not noted (Willey et al. 1974). Hybrid fish developed from crosses between *C. idella* and *Cyprinus carpio* resulted in fish that fed on *Myriophyllum pinnatum* only minimally (Duthu and Kilgen 1975), and similar results were obtained from crosses between *C. idella* and *Hypophthalmicthys nobilis* (Cassani 1981). When present in low densities the carp generally do little damage to non-preferred plant species, and the potential for harm to native aquatic plants has been minimized by the current practice of releasing only sterile triploid Grass Carp for aquatic weed control (Pípalová 2006).

As the climate continues to warm, plant communities in New Jersey are increasingly exposed to higher temperatures, shifting precipitation patterns that increase the frequency and intensity of local droughts and floods, and rising sea levels along the coast (Hill et al. 2020). Available information about *Myriophyllum pinnatum* suggests that the species might be somewhat resilient to climate change: It can thrive in a variety of habitats, utilize multiple means of dispersal, and proliferate rapidly. According to Les (2017), *M. pinnatum* can withstand water temperatures up to 25^{o}C. However, Les also indicated that the species can only tolerate low levels of salinity, and although *M. pinnatum* has been reported from some saline habitats those are primarily fresh

water systems that occasionally experience salt water incursions (Nichols et al. 2013). Unfortunately, New Jersey's sole extant population of *M. pinnatum* is located in close proximity to the coast where it is particularly vulnerable to rising seas, and the site is likely to become increasingly saline and to experience more frequent storm surges. If Cutleaf Water-milfoil does not establish some new colonies in the state it seems probable that climate change will hasten its local extinction.

Management Summary and Recommendations

The most immediate threat to *Myriophyllum pinnatum* in New Jersey appears to be *Phragmites*. The invasive grass was identified as a potential concern nearly 15 years ago, so an updated evaluation of the site's condition is required and additional action may be needed. Established stands of *Phragmites* are difficult to eradicate, but containment of its spread might allow Cutleaf Water-milfoil to persevere at that location. Reviews of some potential management techniques for the Common Reed are available from OMNR (2011) and Hazelton et al. (2014).

Much of what is currently known about *Myriophyllum pinnatum* has been derived from investigations of other species. Available knowledge does not adequately explain why *M. pinnatum* is dominant—or even invasive—in some locations and imperiled in others. The species is easy to propagate in laboratory settings (Kane and Gilman 1991), making it an ideal subject for research. Studies of *M. pinnatum* should focus on identifying the aspects of its life history and community-level interactions that govern its success or failure in different circumstances or places.

Synonyms

The accepted botanical name of the species is *Myriophyllum pinnatum* (Walter) Britton, Sterns & Poggenb. Orthographic variants, synonyms, and common names are listed below (ITIS 2021, POWO 2023, USDA NRCS 2023b).

Botanical Synonyms	Common Names
Myriophyllum scabratum Michx.	Cutleaf Water-milfoil
Myriophyllum verticillatum var. *cheneyi* Fassett	Alternate-leaved Water-milfoil
Potamogeton pinnatum Walter	Green Parrotfeather
	Pinnate Water Milfoil

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