Triglochin maritima

Seaside Arrow-grass

Juncaginaceae

Triglochin maritima by Katy Chayka 2013

***Triglochin maritima* 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

Seaside Arrow-grass (*Triglochin maritima*) is New Jersey's only species in the Juncaginaceae, a family of monocots characterized by basal leaves, spicate inflorescences, and underground storage organs (von Mering 2013). *T. maritima* is a perennial species (Haynes and Hellquist 2020). It has a thickened caudex that is often surrounded by whitish leaf-bases and—unlike other North American members of the genus—does not have stolons (Britton and Brown 1913, Fernald 1950). It does, however, have horizontal rhizomes that produce adventitious roots along their undersides and aerial shoots at the tips of their branches (Davy and Bishop 1991). The leaves of Seaside Arrow-grass are erect and narrow (1–3 mm wide), and the inflorescence is a raceme 10–40 centimeters tall with small flowers and fruits (Gleason and Cronquist 1991). The flowers have six tepals, six stamens, and six carpels and they are protogynous, meaning that the stigmas develop before the anthers (Buzgo et al. 2006). An average inflorescence has about 250 flowers per scape (Looman 1976), and the plants may produce multiple flowering spikes throughout the growing season (Minnesota Wildflowers 2021). The above-ground portion of the plant dies at the end of the growing season (Van Der Wal et al. 2003). Arrow-grasses (*Triglochin* spp.) contain cyanogenic glycosides which are converted to hydrogen cyanide when the plant cells are damaged, and are capable of causing acute poisoning when ingested (Bohle and Hannaway 2018).

Foliage & flowers, Rob Routledge, Sault College, Bugwood.org


Fruits, J. S. Dodds, 2021

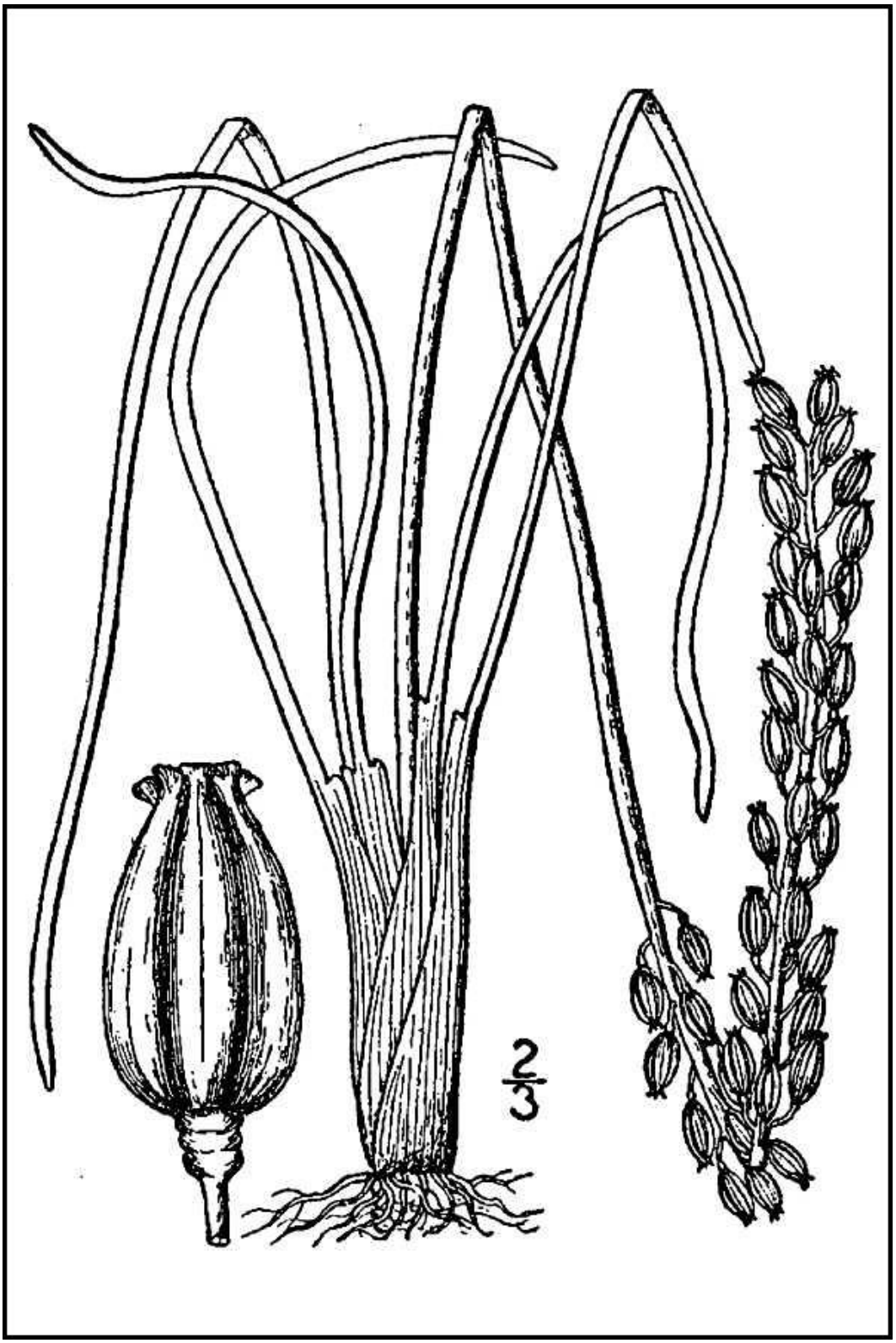

Illustration by Britton and Brown 1913, courtesy USDA NRCS 2022a.

Pollinator Dynamics

Like other species in the Juncaginaceae, *Triglochin maritima* is wind-pollinated (Gleason and Cronquist 1991). Anemophilous (wind-pollinated) plants are typically associated with open habitats. A suite of physical characteristics—including numerous small greenish or whitish flowers, absence of scent or nectaries, copious pollen production, feathery styles, and protogynous flowering—are frequently found in plants that rely on wind for pollination (Friedman and Barrett 2009). *Triglochin* utilizes a strategy employed by numerous vertical wind-pollinated inflorescences in order to reduce the likelihood of self-fertilization. In addition to bearing flowers that present their stigmas before releasing pollen, the flowers of an inflorescence are produced from the base upward so that the youngest are at the apex. The sequence of floral development prevents pollen from the higher flowers from falling onto the lower flowers of the same plant (Lloyd and Webb 1986).

Seed Dispersal

The fruits of *T. maritima* have six fertile carpels with one ovule per carpel (von Mering 2013). The seeds are yellowish-brown, triangular in cross-section, 3–4mm long and 0.5 mm wide (Looman 1976). Depending on plant vigor and site conditions, an inflorescence may produce between 150 and 1200 seeds. The seeds ripen in the fall, but may be retained on dead spikes for several months prior to release. In salt marshes the seeds are dispersed by water where they may float for up to five months, but in fresh water they remain afloat only for a few days (Davy and Bishop 1991). During the restoration of a salt marsh, Erfanzadeh et al. (2010) studied the re-colonization of the site's flora via natural processes (e.g. tidal inundation) and found that Seaside Arrow-grass fared poorly compared to most other native species. Davy and Bishop (1991) raised the possibility of waterfowl dispersal as the seeds had been found in the stomachs of ducks, but Bakker et al. (1985) did not find any viable *Triglochin* seeds in goose pellets or dung patches in an area where they were present in driftline material.

Seaside Arrow-grass is not entirely dependent on seeds for regeneration, as the rhizomatous plant is also capable of reproducing clonally. Looman (1976) reported that an average *T. maritima* plant had about ten well-developed shoots. Young genets typically form circular clumps with high shoot density, but as the clumps expand in diameter the central portions die off and the space may be colonized by other species. The clones continue to develop as expanding rings which eventually fragment into separate clumps (Davy and Bishop 1991).

Habitat

In North America, *Triglochin maritima* may be found in coastal and mountain marsh areas and moist alkaline meadows (Haynes and Hellquist 2020). The species prefers a sunny habitat with wet, often brackish or saline soils (Minnesota Wildflowers 2021). Seaside Arrow-grass has been associated with a number of herb-dominated vegetative communities that occur in New Jersey: Along the coast, it is most likely to be found in a *Spartina* high salt marsh or a brackish tidal marsh, while inland occurrences are typically located in a *Schoenoplectus acutus*–(*Schoenoplectus tabernaemontani*) semipermanently flooded herbaceous alliance (Breden et al.

2001). Havas and Vasari (1999) found that Seaside Arrow-grass plants in both coastal and inland habitats required soils with a high electrolyte content, but the sources were calcium in fens and sodium or chloride in coastal communities.

Data from British Columbia was used to calculate the species' microsite preferences such as elevation (0–1581 meters, average = 697m) and slope gradient (0–28 percent, average = 0%) (Klinkenberg 2020). Klinkenberg also quantified the most favorable moisture regime as 6 (hygric) on a scale of 0 (very xeric) to 8 (hydric) and identified the nutrient regime as D (rich). A more comprehensive description of the soil and moisture regimes is provided by the B. C. Ministry of Forests (1998). In a hygric water regime, the primary water source is seepage and the water is removed slowly enough to keep the soil wet throughout most of the growing season. A rich nutrient regime, in which available nutrients are plentiful, is associated with sites at which the water pH generally falls between 6.5 and 7.4.

Under certain circumstances *Triglochin maritima* is capable of modifying its habitat to make conditions more favorable for both itself and some associated species, a process known as ecosystem engineering. Fogel et al. (2004) found that the species increases its production of shallow roots in response to waterlogging, and the rings formed by the growth of the arrow-grass rhizomes trap dead vegetation and soil resulting in microsites that are slightly elevated (7 cm) above the surrounding substrate and have lower water content. In the saline pannes where the study was conducted, the elevated areas had significantly higher vegetative cover than the surrounding habitat and included some species that were absent from the adjacent muddy substrate.

Wetland Indicator Status

Seaside Arrow-grass 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)

TRMA20

Coefficient of Conservatism (Walz et al., 2018)

CoC = 10. Criteria for a value of 9 to 10: Native with a narrow range of ecological tolerances, high fidelity to particular habitat conditions, and sensitive to anthropogenic disturbance (Faber-Langendoen 2018).

Distribution and Range

The map in Figure 1 depicts the extent of Seaside Arrow-grass in the United States and Canada. Tiner (2009) reported that the species range extends south to Delaware and Maryland, and the USDA (2022b) also showed records in those states. *Triglochin maritima* also occurs in Mexico, South America, northern Europe and northern Asia (Haynes and Hellquist 2020). Results of a molecular study of the genus *Triglochin* indicated that *T. maritima* is a complex, and showed strong support for two distinct geographical clades in Eurasia and in the Americas (von Mering and Kadereit 2015).

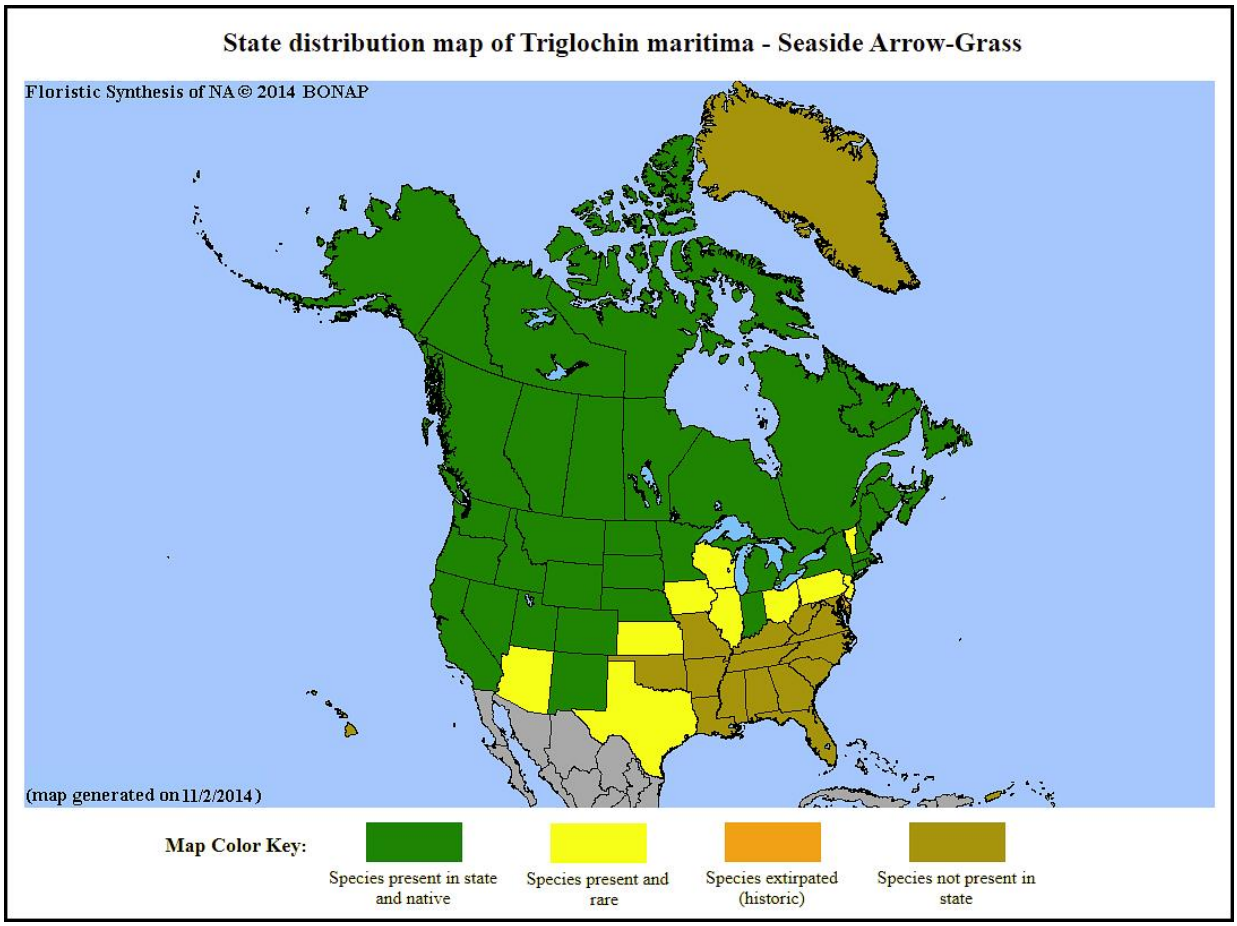

Figure 1. Distribution of T. maritima in North America, adapted from BONAP (Kartesz 2015).

The USDA PLANTS Database (2022b) shows records of Seaside Arrow-grass in five New Jersey counties: Hudson, Middlesex, Monmouth, Ocean and Sussex (Figure 2, below). The data include historic observations and do not reflect the current distribution of the species.

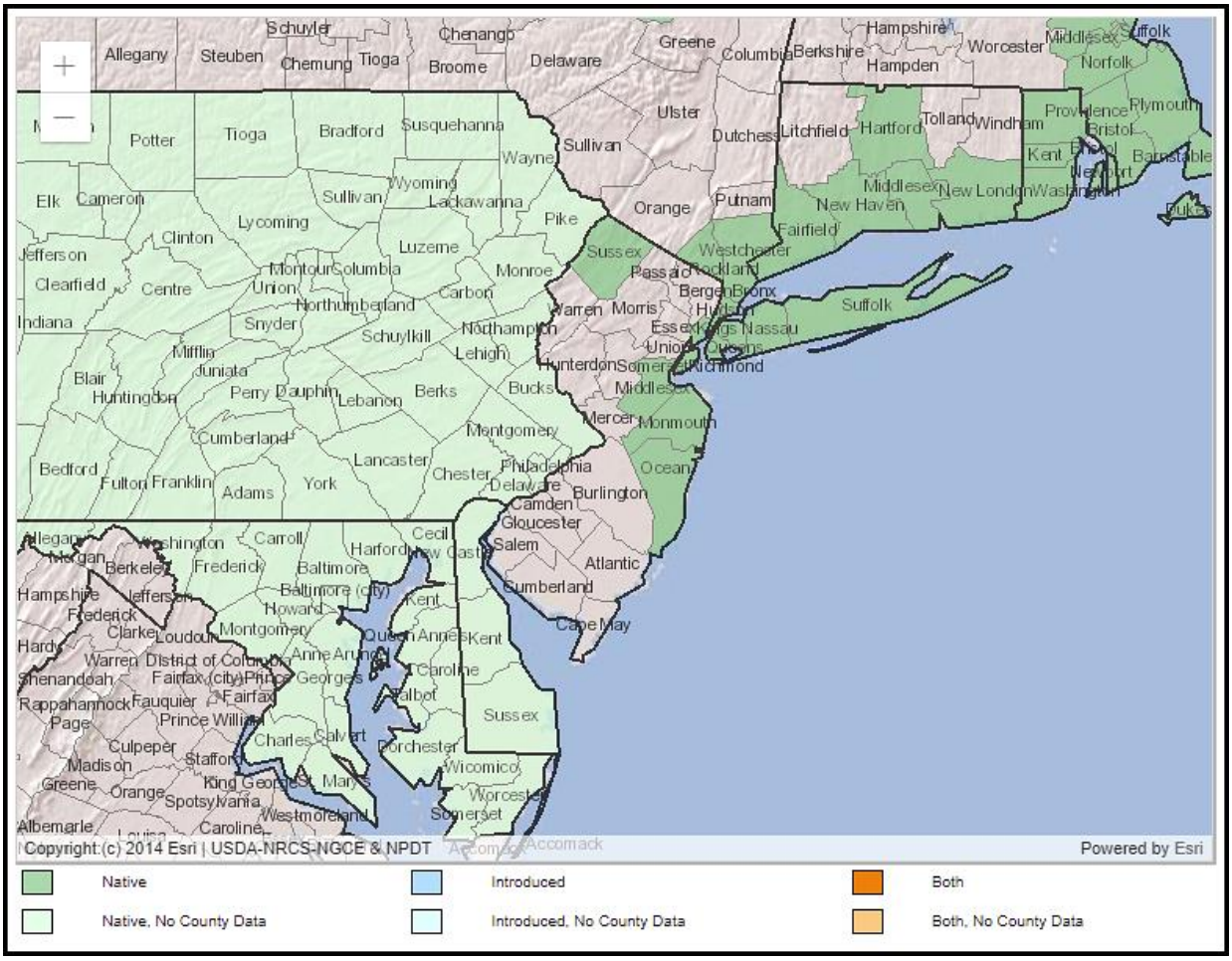

Figure 2. County records of T. maritima in New Jersey and vicinity (USDA NRCS 2022b).

Conservation Status

Triglochin maritima is considered globally secure. The G5 rank means the plant has an extensive range, abundant occurrences, and little cause for concern due to declines or threats (NatureServe 2021). However, the map in Figure 3 shows that the species is in a weaker position along the southern edge of its range. It is listed as critically imperiled (very high risk of extinction) in four states, imperiled (high risk of extinction) in three, and vulnerable (moderate risk of extinction) in one.

New Jersey is one of the four states where Seaside Arrow-grass is critically imperiled (S1) (NJNHP 2022). The 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. *Triglochin maritima* 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 arrow-grass signify that the species is eligible for some safeguards under the jurisdictions of the Highlands Preservation Area (HL) and in the New Jersey Pinelands (LP) (NJNHP 2010).

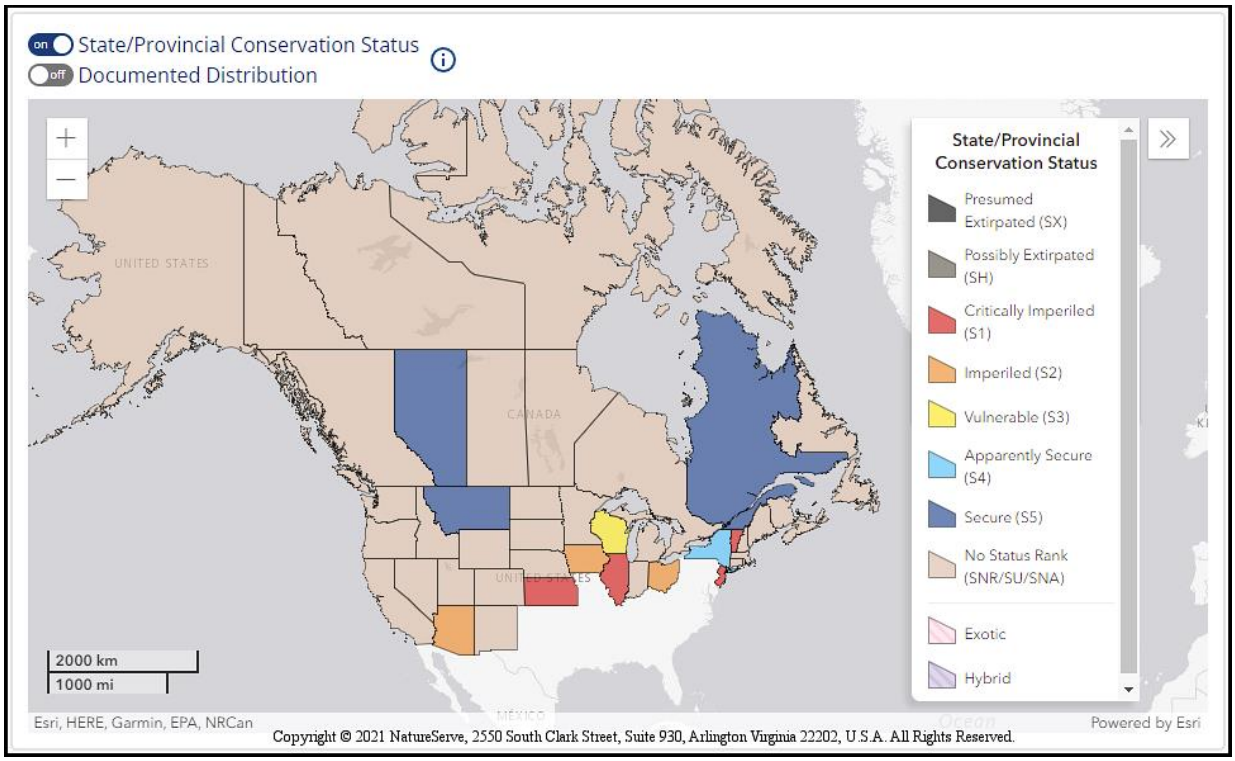

Figure 3: Conservation Status of T. maritima in North America (NatureServe 2021).

It appears that Seaside Arrow-grass has never been abundant in New Jersey. Stone (1911) reported that the plant was known from the edges of salt marshes in Monmouth and Ocean counties. Even then, the species was apparently rare, as he referred to a particular Ocean County colony as having been "rediscovered" and "still flourishing" in 1902. A collection made from a fen in the northern part of the state in 1920 included the notation "very rare in NJ" (Mackenzie 1920). Fairbrothers and Hough (1973) reported two extant colonies—one in Sussex County and one in Ocean—and historic records from Monmouth and Hudson. In a compilation of records from the state herbarium, Hough (1983) indicated that the records from three of the four counties where it was documented pre-dated 1930 and remarked that it "appears irregularly". Snyder (2000) described *T. maritima* as "an extremely rare and declining species in the state" and noted that it was historically known from only seven locations.

Triglochin is presently confirmed as extant at a single location in the state (NJNHP 2022). Viability of the inland occurrence was ranked as 'fair' based on the last formal survey in 2007. The species was still persisting at the site in 2021, although the full extent of the population was not recorded.

Threats

Habitat Destruction:
Triglochin maritima was extirpated from several of its former locations in New Jersey by activities such as peat mining, dredging, and construction. Although the state's remaining occurrence is now on protected land, other kinds of human disturbance still threaten its fragile habitat. Evidence of frequent foot traffic in the fen where *T. maritima* resides has raised concerns about trampling or soil compaction. A trail in the forest immediately adjacent to the wetlands has been noted for frequent use by off-road vehicles, which may lead to soil erosion and subsequent siltation that change the nature of the community (NJNHP 2022).

Herbivory:
Davy and Bishop (1991) reviewed an assortment of animal species reported as feeding on Seaside Arrow-grass. Five of those were insects, and no information was provided suggesting long term impacts to the *T. maritima* plants. Waterfowl have been widely reported to feed on the species, particularly Snow Geese (*Anser caerulescens*), Canada Geese (*Branta canadensis*), Brant (*Branta bernicla*), American Widgeons (*Anas americana*) and Mallards (*Anas platyrhynchos*) (Prevett et al. 1985, Davy and Bishop 1991). Rabbits and hares were reported to eat the flowering heads and leaves respectively, grazing by domestic livestock was noted, and the list even included historic use of the plant as human food (Davy and Bishop 1991). In New Jersey, herbivory by White-tailed Deer (*Odocoileus virginianus*) would also be expected, particularly in non-saline communities. While the cyanogenic aspect of arrow-grasses may deter some herbivores, the species is not poisonous when it is growing with adequate moisture. Toxicity kicks in when growth is stressed or stunted by desiccation or frost, and also during regrowth following damage to the plants (USDA Agricultural Research Service 2018). Consequently, the healthiest plants are most susceptible to herbivory.

Competition:
A study of *Triglochin maritima* in a salt marsh habitat found that competition sometimes poses a greater threat to the species than herbivory. Van Der Wal et al. (2003) evaluated the intersecting impacts of resource competition and herbivores and found that herbivory took a heavier toll in early-successional habitats but competition for light became increasingly important as the community developed. The results suggests that successional changes are detrimental to Seaside Arrow-grass, which relies on an open habitat for both adequate light and enhanced opportunities for wind pollination.

Disease:
In 2004, the first known record of the powdery mildew *Leveillula taurica* on *Triglochin maritima* was documented in the state of Washington. The initial observation was made in a greenhouse, where the fungus had caused significant damage to the host plants (Glawe et al. 2005). The introduced fungus, which affects a broad range of plants (1000+ species) including a number of agricultural crops, was initially limited to the western part of the United States (Evans et al. 2008). Recent records indicate that *L. taurica* has made its way to the east coast,

and it has been reported in nearby states including New York and Maryland (Invasive Species Compendium 2021).

Climate Change:
In New Jersey, *T. maritimum* has been known from either calcareous or saline habitats, both of which are vulnerable to effects from climate change. Changes already underway in the state include increasing temperatures, altered precipitation patterns, rising seas and retreating shores (USEPA 2016). Continued warming trends in salt marshes are likely to reduce diversity by replacing a number of species, including Saltmarsh Arrow-grass, with *Spartina patens* (Gedan and Bertness 2009) and rising seas will eventually erode and inundate coastal plant communities. Changing weather patterns are also expected to take a toll on inland communities. Ring et al. (2013) evaluated the risks posed by climate change to 70 plants identified as Species of Greatest Conservation Need in the state's 2017 Wildlife Action Plan. *Triglochin maritima* was ranked as Moderately Vulnerable, signifying that the species abundance or range in northern New Jersey is likely to decrease by 2050.

Management Summary and Recommendations

Due to the precarious status of the species in New Jersey, regular monitoring of the extant occurrence of Seaside Arrow-grass is important. Periodic site visits should be conducted in order to watch for emerging threats to the species or its critical habitat. It may also be worthwhile to invest some effort in searching for the species at historical locations where suitable habitat still exists. At two locations where *T. maritima* has not been seen for decades, data from the most recently reported excursions to the former sites indicated that suitable habitat was still present (NJNHP 2022).

Habitat integrity is critical for *Triglochin maritima*, particularly in the calcareous habitats that are likely to be altered by succession. In northern New Jersey, there are a number of invasive plant species known to frequent fen communities. Once established, species such as Common Reed (*Phragmites australis ssp. australis*) and Autumn Olive (*Elaeagnus umbellata*) can spread rapidly and substantially alter the open wetland habitats. Both species are rated by the New Jersey Invasive Species Strike Team (2021) as highly threatening to native communities. A third species, Purple Loosestrife (*Lythrum salicaria*), is rated as a moderate threat but can dominate a wetland if allowed to spread unchecked. To the greatest extent possible, those species and other non-native plants identified as significant threats should be removed from habitats that support the endangered arrow-grass.

Additional information is needed about the extent of the threat posed by the powdery mildew *Leveillula taurica*. Care should be taken to monitor the spread of the fungus in the northeastern United States, and to avoid introducing it into fragile native ecosystems.

Fogel et al. (2004) suggested that the conservation of *Triglochin maritima* may be important because the plant's ecosystem engineering capabilities could serve as a tool for preserving species in salt marsh habitats as sea levels rise. Perhaps it will be helpful in coastal regions

where the arrow-grass is more abundant, but it remains to be seen whether the rate of hydrologic change will exceed the plant's ability to modify the environment.

Faced with an uncertain future due to the changing climate, some land managers are considering a strategy called Assisted Migration in order to plan for the preservation of species at risk. The controversial strategy involves moving endangered plants or their progeny to comparable habitats at higher latitudes, and Nielsen (2013) reviews some of the pros and cons. Because *T. maritima* has a wide range and is considered globally secure this seems unnecessary at present, but as molecular studies of the complex progress the concept may be worthy of consideration in the interest of preserving genetic diversity.

Synonyms

The accepted botanical name of the species is *Triglochin maritima* L. Orthographic variants, synonyms, and common names are listed below (ITIS 2021, NatureServe 2021).

Botanical Synonyms	Common Names
Triglochin maritimum L.	Seaside Arrow-grass
Triglochin concinnum Burtt Davy	Arrow-grass
Triglochin debile (M.E. Jones) Á. Löve & D. Löve	Troscart Maritime (French)
Triglochin elatum Nutt.	Common Bog Arrow-grass
Triglochin concinnum var. *debile* (M.E. Jones) J.T. Howell	
Triglochin maritimum var. *elatum* (Nutt.) A. Gray	
Triglochin debilis (M.E. Jones) Á. Löve & D. Löve	
Triglochin concinna Burtt Davy	
Triglochin elata Nutt.	
Triglochin concinna var. *concinna* Burtt Davy	
Triglochin maritima var. *elata* (Nutt.) A. Gray	
Triglochin concinna var. *debilis* (M.E. Jones) J.T. Howell	

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