Symphyotrichum praealtum var. *angustior*

Willow-leaf Aster

Asteraceae

Symphyotrichum praealtum var. angustior by Bonnie Semmling, 2020

***Symphyotrichum praealtum var. angustior* Rare Plant Profile**

New Jersey Department of Environmental Protection
State Parks, Forests & Historic Sites
Forests & Natural Lands
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

February, 2024

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

This report should be cited as follows: Dodds, Jill S. 2024. *Symphyotrichum praealtum* var. *angustior* Rare Plant Profile. New Jersey Department of Environmental Protection, State Parks, Forests & Historic Sites, Forests & Natural Lands, Office of Natural Lands Management, New Jersey Natural Heritage Program, Trenton, NJ. 17 pp.

Life History

Symphyotrichum praealtum var. *angustior* (Willow-leaf Aster) is a rhizomatous perennial herb in the composite family. Although the varieties of *S. praealtum* are not uniformly agreed upon by botanists (see Synonyms and Taxonomy section), var. *angustior* is the only one that occurs in New Jersey (Snyder 1985). *S. praealtum* var. *praealtum* and *S. praealtum* var. *angustior* have different chromosome numbers (32 and 64 respectively) and their geographical ranges do not overlap (Semple et al. 1983).

Snyder 1982, courtesy Steere Herbarium.


Bonnie Semmling, 2020.

Symphyotrichum praealtum reproduces vegetatively via long, stoloniferous rhizomes, often forming large clonal stands. Young shoots emerge at some distance from the bases of established stems, and the rhizomes can persist for several growing seasons (Jones 1978). The stems are stout and may reach up to two meters in height. Basal leaves usually disappear by flowering time but the stem leaves are distinctive: They are alternate, the margins often roll inward, and the undersides have a characteristic network of veins with squarish gaps in between. The leaves of *S. praealtum* var. *angustior* are particularly long and narrow—they are about 11 times as long as wide and smooth along the edges. Rich (1902) observed that *S. praealtum* var. *angustior* was one of the last plants to flower, beginning after the first of October in Massachusetts. New Jersey plants are also typically seen in bloom during early October (NJNHP 2022). As with many other members of the aster family, the flowers of *S. praealtum* are composite heads of both ray and disc florets. The heads occur in dense clusters on leafy

stems. The ray florets are pistillate and the disc florets are perfect, but both are fertile. The 20–30 disc florets are initially yellow but turn purplish with age. The 20–35 ray florets are 6–15 mm long and may vary from blue-purple to white in color. Both purple and white-flowered plants have been observed in New Jersey (Snyder 1985). Detailed descriptions of the involucral bracts and the pappus surrounding the disc florets are available in Semple and Brouillet (1980) and Semple and Hood (2005), respectively. The fruits are purplish achenes (cypselae) 1.5–2 mm in length, each bearing a pappus of 40–60 white bristles that are 4–6.5 mm long. (See Wiegand 1933, Fernald 1950, Hill 1980, Gleason and Cronquist 1991, Nesom 2000, Brouillet et al. 2020).

Symphyotrichum was formerly included in *Aster*, a huge and difficult genus encompassing about 450 species worldwide (Yatskievych 2005). Nesom (1994) restructured the original taxon, transferring most of the New World species to eleven other genera, but *Symphyotrichum* is still quite large and it includes nearly 100 North American species (Weakley et al 2022). Some botanists have further divided *Symphyotrichum* into subgenera, sections, and subsections. *Symphyotrichum praealtum* was placed in subgenus *Symphyotrichum* by Nesom (1994) and by Semple and Hood (2005), and although the two systems differed in the names they applied to the lower sections and subsections the final species groups which included *S. praealtum* were comparable. Other members of the group that occur in New Jersey include *S. boreale*, *S. lanceolatum, S. lateriflorum, S. racemosum,* and *S. tradescantii*.

The perennial rhizomatous species of *Symphyotrichum* usually follow a similar seasonal cycle. During the latter part of the summer the plants produce either rhizome buds or rosettes of scale leaves that persist through the winter months. New shoots develop the following spring, and their emergence is generally triggered by local climactic conditions (Chmielewski and Semple 2001).

Pollinator Dynamics

In a typical aster, the pistillate ray florets are the first to become receptive. As the bisexual disc florets open their styles elongate and push the pollen to the end of the corolla tubes, coating the stigmas in the process. However, that generally does not result in fertilization because many perennial asters like *Symphyotrichum praealtum* are highly self-incompatible and primarily depend on insects for the production of viable seeds (Jones 1978, Bertin et al. 2010). Low seed set has been observed in some of the other perennial *Symphyotrichum* species (eg. Jones 1978, Chmielewski and Semple 2001 & 2003), and that could be a consequence of limited opportunities for outcrossing in clonal populations.

North American *Symphyotrichum* species utilize a wide variety of pollinators (Robertson 1929, Jones 1978) and *S. praealtum* is visited by an assortment of bees, flies, butterflies, and skippers (Hilty 2020). In the northeast, at least six native bees have been identified as specialist pollinators of *Symphyotrichum* and related plants in the Asteraceae (Fowler 2016). Butterflies observed on *S. praealtum* have included *Colias eurytheme, C. philodice, Eurema lisa, Pontia protodice,* and *Phyciodes tharos* (Sites and McPherson 1981) and bees collected on the flowers included *Agapostemon sericeus, A. splendens, Andrena asteris, A. nubecula, Ceratina calcarata, Lasioglossum fuscipenne, Melissodes wheeleri, Pseudopanurgus nebrascensis,* and *Sphecodes*

stygius (Arduser 2010). Jones (1978) noted that many asters close at dusk, folding in their rays to preserve pollen for the next day. However, that does not occur in all species and may not apply to *Symphyotrichum praealtum*.

Seed Dispersal and Establishment

The pappus on a *Symphyotrichum praealtum* cypsela is 2–3 times the length of the small seed. (Brouillet et al. 2020). A pappus generally aids in wind dispersal by acting as a parachute, although differences in the morphology of both seeds and pappi determine how far the propagules of any given species are able to travel (Greene and Johnson 1990, Anderson 1993). Dispersal distances are also affected by wind velocity and the relative openness of the habitat (Lacroix et al. 2007). Regeneration from rhizome fragments has been documented in *Symphyotrichum* (Leck and Leck 1998) so vegetative dispersal might occasionally result from the movement of soil.

Symphyotrichum species typically disperse their propagules in the fall and germinate in the spring. Nearly all of the species examined have benefitted from a period of stratification, although some were able to germinate immediately after dispersal in controlled settings. Germination requires light, moisture, and warm temperatures and is inhibited by cold or darkness (Jones 1978, Baskin and Baskin 1979 & 1988, Deno 1993, Chmielewski and Ruit 2002). Nutrient availability may also affect the germination rates of some species (Nešić et al. 2022).

Symphyotrichum seeds have occasionally been found in seed banks at sites where mature plants were not present, suggesting some potential for persistence, although longevity of the propagules has not been established (Leck and Simpson 1995, Leck and Leck 1998). Chmielewski and Semple (2003) noted that seedling development was not well documented in the clonal members of genus but indicated that young plants typically generate a few flowering stalks the first year and then invest in the production of more numerous shoots for the following season. It is not clear whether *S. praealtum* is mycorrhizal but fungal associations have been reported in a number of other *Symphyotrichum* species (Wang and Qui 2006, Wolfe et al. 2006, Bainard et al. 2011, Bauer et al. 2012).

Habitat

Symphyotrichum praealtum var. *angustior* may occur in calcareous wetlands (Bousquet and Fleming 2017, Weakley et al. 2022) but it is not limited to such sites. While it is usually associated with moist or boggy ground it may be found in open fields, thickets, woodlands, or roadside habitats (Rhoads and Block 2007). Jones (1978) noted that *Symphyotrichum praealtum* was more likely to flower when growing in open habitats and to rely on clonal growth in shaded sites. Rich (1902) referred to a Massachusetts occurrence of *S. praealtum* var. *angustior* as "a restricted colony in damp shade" while Hill (1980) observed that the variety was rare in wooded sites in Virginia.

The habitats of various New Jersey populations of *S. praealtum* var. *angustior* have been described as an overgrown field, a roadside thicket, a brushy floodplain meadow, and a utility right-of-way in a wooded floodplain (Snyder 1985, NJNHP 2022). Herbaceous associates noted for extant occurrences included *Euthamia graminifolia*, *Solidago altissima*, *S. rugosa*, *Symphyotrichum novae-angliae*, *Cirsium discolor*, *Agrimonia parviflora*, and *Sorghastrum nutans* (NJNHP 2022).

Wetland Indicator Status

Symphyotrichum praealtum is a facultative wetland species, meaning that it usually occurs in wetlands but may occur in nonwetlands (U. S. Army Corps of Engineers 2020).

USDA Plants Code (USDA, NRCS 2024)

SYPRA

Coefficient of Conservancy (Walz et al. 2020)

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

The map in Figure 1 illustrates the extent of *Symphyotrichum praealtum* var. *angustior* in North America (Kartesz 2015). The variety also reportedly occurs north to Maine and south to North Carolina (Weakley et al. 2022, USDA NRCS 2024).

The USDA PLANTS Database (2024) shows records of *Symphyotrichum praealtum* var. *angustior* in one New Jersey county: Sussex County (Figure 2). Hough (1983) noted that earlier reports of occurrences in Mercer, Morris and Warren counties had been based on misidentified specimens. Currently accepted historic and extant observations of Willow-leaf Aster in the state are limited to Hunterdon and Somerset counties (NJNHP 2022).

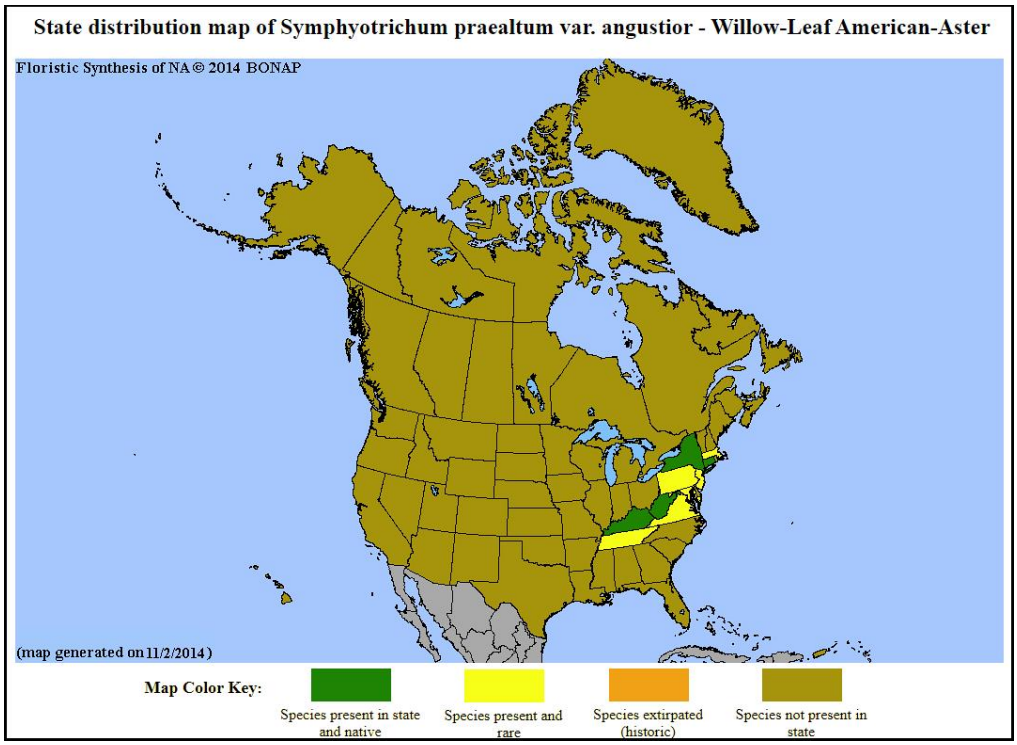

Figure 1. Distribution of S. praealtum var. angustior in North America, adapted from BONAP (Kartesz 2015).

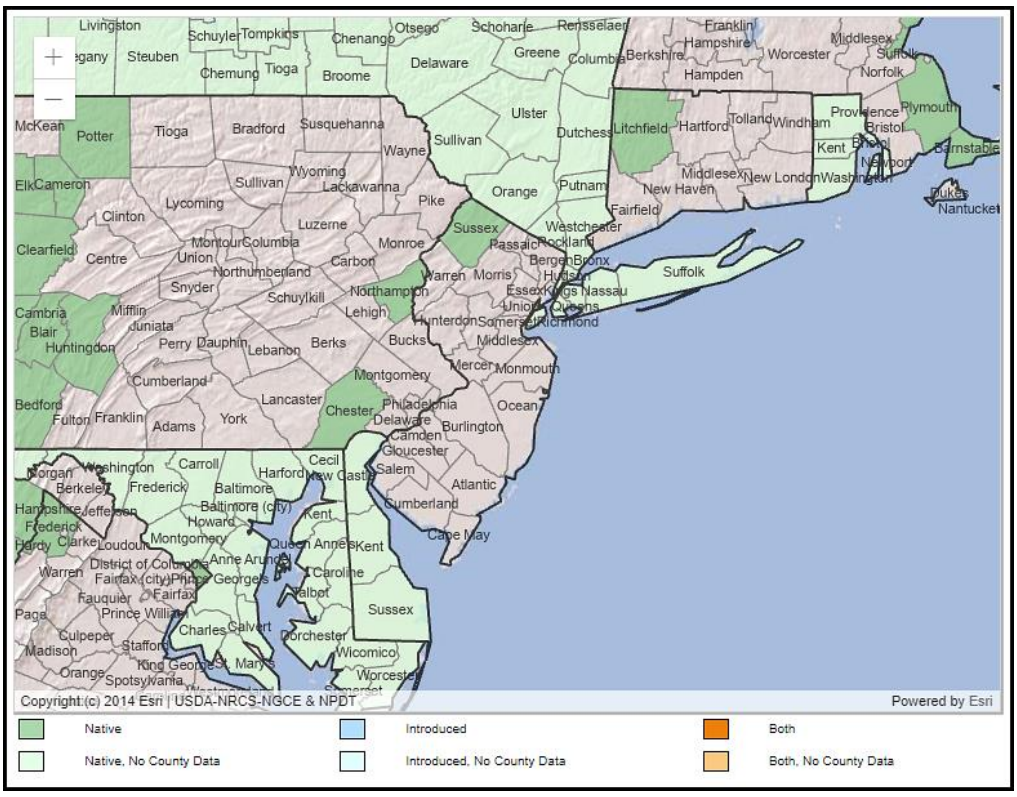

Figure 2. County records of S. praealtum var. angustior in New Jersey and vicinity (USDA NRCS 2024).

Conservation Status

The global rank of *Symphyotrichum praealtum* var. *angustior* is G5T4. G5 means the species as a whole 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, and T4 means the variety 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 recent local declines, threats, or other factors. The variety was last reviewed in 1988 and an updated global status assessment is needed (NatureServe 2024).

The map below (Figure 3) illustrates the conservation status of *Symphyotrichum praealtum* var. *angustior* throughout its range, showing it as critically imperiled (very high risk of extinction) in Virginia. *S. praealtum* var. *angustior* is also critically imperiled in New Jersey (NJNHP 2022), although that status is not depicted on the map. According to Brumback and Gerke (2013), Willow Aster is rare in New England and has been over-reported: Their summary showed *S. praealtum* var. *angustior* as historical in Massachusetts, unrankable in Connecticut, and absent in the other states. However a single population was recently observed in Massachusetts (MANHESP 2015). Rhoads and Block (2007) noted that the aster was rare in Pennsylvania and Morton and Speedy (2011) showed an S3 rank for *S. praealtum* var. *angustior* in that state.

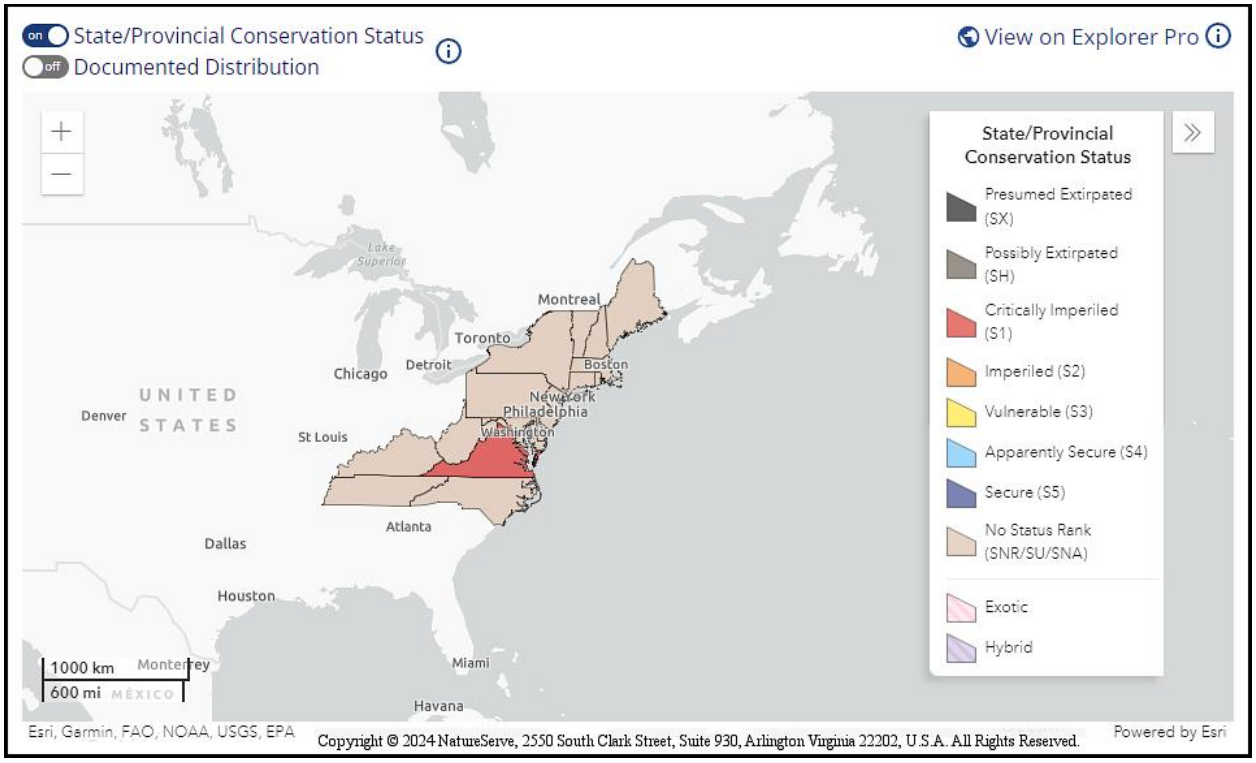

Figure 3. Conservation status of S. praealtum var. angustior in North America (NatureServe 2024).

In New Jersey, the critically imperiled (S1) rank for *Symphyotrichum praealtum* var. *angustior* signifies five or fewer occurrences statewide. 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. *S. praealtum* var. *angustior* 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 Willow-leaf Aster 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).

Symphyotrichum praealtum var. *angustior* was collected in Hunterdon County during 1896 but the aster was not documented again in the state until 1982 when Snyder (1985) discovered two populations—one in Hunterdon County and one in Somerset County. Both populations were still thought to be present around the turn of the century (Breden et al. 2006) but the Hunterdon occurrence was subsequently re-ranked as extirpated. Snyder discovered three additional populations in Somerset County between 2011 and 2018, so four populations are presently considered extant in New Jersey (NJNHP 2022).

Threats

Successional changes to its habitat appear to pose a significant threat to *Symphyotrichum praealtum* var. *angustior* populations. A New Jersey occurrence that Snyder (1985) initially described as a "sizeable colony" disappeared after the site became overgrown with woody species. The decline was likely exacerbated by invasive plants such as *Elaeagnus umbellata*, *Rosa multiflora*, and *Celastrus orbiculatus* (NJNHP 2022). The latter two species, along with non-native shrub honeysuckles (*Lonicera* spp.) were also noted as threats to the sole extant Willow-leaf Aster population in Massachusetts (MANHESP 2015). As previously mentioned, *S. praealtum* becomes increasingly reliant on clonal growth in sites with limited light availability (Jones 1978). Established plants may be able to persist for a while because their long rhizomes could allow them to "explore" the local environment and situate new rosettes in the most favorable microsites (Waller 1988), but their reserves can eventually become exhausted in permanently shaded habitats. The Massachusetts population of *Symphyotrichum praealtum* var. *angustior* has been managed by mowing the site where it occurs about every three years in order to maintain suitable habitat (MANHESP 2015). Although mowing can be beneficial, it could also be a threat to a Willow-leaf Aster colony if carried out too frequently or at the wrong time of year (NJNHP 2022).

Herbivory is likely to have an impact on certain populations of *Symphyotrichum praealtum*. In some areas, seedlings of the species are an important winter food source for rabbits (Smith 1940). Foliage of *S. praealtum* may also be consumed by deer or turkeys, as well as larval butterflies and moths (Hilty 2020). *Symphyotrichum praealtum* is also a host plant for the larvae of a fruit-fly (*Paroxyna albiceps*) which feed on the flower heads and can destroy developing fruits. Apparently *P. albiceps* is restricted to the northeastern states and its range extends south into New Jersey. Novak and Foote (1968) recorded infestation rates of 6–42% in *S. praealtum* populations but noted that even the most heavily infested plants were likely to produce some

seeds because the larvae concentrated their activities on fruits near the center of a receptacle, allowing the outer florets to develop.

Climate Change Vulnerability

Information from the references cited in this profile was used to evaluate the vulnerability of New Jersey's *Symphyotrichum praealtum* var. *angustior* populations to climate change. The species was assigned a rank from NatureServe's Climate Change Vulnerability Index using the associated tool (Version 3.02) to estimate its exposure, sensitivity, and adaptive capacity to changing climactic conditions in accordance with the guidelines described by Young et al. (2016) and historical state climactic computations by Ring et al. (2013). Based on available data *S. praealtum* var. *angustior* was assessed as Less Vulnerable, meaning that climate change is not expected to have a notable detrimental impact on its extent in New Jersey by 2050. However, the conclusion was reached with only moderate confidence due to gaps in information regarding the species' ecological requirements.

Shifting climactic conditions in New Jersey are resulting in higher temperatures, more frequent and intense precipitation events, and lengthier periods of drought. The greatest seasonal temperature increases are occurring during the winter months (Hill et al. 2020). Because the seasonal cycle of *Symphyotrichum praealtum* appears to be highly dependent on climactic cues the species may be affected by droughts or unusual temperature patterns. Smith (1940) observed that germination of the aster was typically promoted by autumn rainfall and seedlings had failed to emerge during an especially dry season the preceding year. As previously discussed, germination in *Symphyotrichum* is generally temperature dependent and the springtime growth of clonal shoots is also triggered by environmental conditions. Therefore, unusually warm winter temperatures might interfere with seed stratification or encourage the premature emergence of shoots before the danger of frost has passed.

There are some indications that *Symphyotrichum praealtum* var. *angustior* populations can decline as the result of competition, particularly following the proliferation of non-native plants. Invasive plant species are likely to become an even greater threat in New Jersey as the climate continues to warm. Bellard et al. (2013) identified the northeastern United States as a probable hotspot for new invasions by nonnative flora, and other evaluations have projected that a number of exotic plants which have already gained a foothold in the region are likely to become more abundant (Dukes et al. 2009, Coville et al. 2021, O'Uhuru 2022). Salva and Bradley (2023) recently identified more than a dozen new range-shifting species that could have significant detrimental impacts on New Jersey's plant communities by 2050.

Management Summary and Recommendations

Much of the information regarding the attributes of *Symphyotrichum praealtum* var. *angustior* was derived from research on other members of the genus so species-specific studies of topics such as self-compatibility, germination and establishment requirements, or mycorrhizal associations would be valuable. It is also unclear whether var. *angustior* differs from other

varieties of *Symphyotrichum praealtum* in terms of its ecological requirements or environmental tolerances.

Although no specific studies were found, observational evidence suggests a sensitivity to natural succession and competition with invasive species. Populations of *Symphyotrichum praealtum* var. *angustior* in New Jersey are likely to benefit from management activities that maintain open habitat conditions. Periodic winter mowing may help to reduce the establishment of woody plants without harming the aster but more detailed information regarding optimal mowing frequency and timing would be helpful.

The relatively rapid decline of a former New Jersey *Symphyotrichum praealtum* var. *angustior* population underscores the need for regular monitoring of extant occurrences. In addition to assessing population status and evaluating habitat conditions, site visits could serve as an opportunity to gather information regarding poorly understood potential threats like herbivore damage. One recently discovered *S. praealtum* var. *angustior* occurrence in the state has not yet been formally surveyed, and the former location reported for a historical population has not been searched (NJNHP 2022). The majority of extant New Jersey occurrences were only documented during the past decade or so and additional populations may have been overlooked due to the species' similarity to more common asters. In Massachusetts, it was noted that the resemblance of *S. praealtum* var. *angustior* to other *Symphyotrichum* species could result in a failure to protect vulnerable populations (MANHESP 2015).

Synonyms and Taxonomy

The accepted botanical name of the species is *Symphyotrichum praealtum* var. *angustior* (Wiegand) Nesom. Orthographic variants, synonyms, and common names are listed below (USDA NRCS 2024, Weakley et al. 2022). The name *Aster salicifolius* was incorrectly applied to some eastern specimens (eg. Rich 1902) which were later relabeled by Wiegand (1933). A number of varieties of *S. praealtum* have been described (Wiegand 1933, Nesom 1997) but some sources do not recognize any subtaxons (eg. Brouillet et al. 2020, ITIS 2024, POWO 2024). Haines (2010) proposed the classification of *angustior* as a subspecies rather than a variety based on differences in chromosomes, morphology, and distribution.

Botanical Synonyms	**Common Names**
Aster praealtus Poir. var. *angustior* Wiegand	Willow-leaf Aster
Symphyotrichum praealtum ssp. *angustior* (Wiegand) A. Haines	Willow Aster
	Narrowleaf Willow Aster
	Veiny-leaf Aster

References

Anderson, Mark C. 1993. Diaspore morphology and seed dispersal in several wind-dispersed Asteraceae. American Journal of Botany 80(5): 487–492.

Arduser, Mike. 2010. Bees (Hymenoptera: Apoidea) of the Kitty Todd Preserve, Lucas County, Ohio The Great Lakes Entomologist 43(1-4): 45–68.

Bainard, L. D., J. D. Bainard, S. G. Newmaster, and J. N. Klironomos. 2011. Mycorrhizal symbiosis stimulates endoreduplication in angiosperms. Plant, Cell and Environment 34: 1577–1585.

Baskin, Jerry M. and Carol C. Baskin. 1979. The germination strategy of Oldfield Aster (*Aster pilosus*). American Journal of Botany 66(1): 1–5.

Baskin, Carol C. and Jerry M. Baskin. 1988. Germination ecophysiology of herbaceous plant species in a temperate region. American Journal of Botany 75(2): 286–305.

Bauer, Jonathan T., Nathan M. Kleczewski, James D. Bever, Keith Clay, and Heather L. Reynolds. 2012. Nitrogen-fixing bacteria, arbuscular mycorrhizal fungi, and the productivity and structure of prairie grassland communities. Oecologia 170: 1089–1098.

Bellard, C., W. Thuiller, B. Leroy, P. Genovesi, M. Bakkenes, and F. Courchamp. 2013. Will climate change promote future invasions? Global Change Biology 19(12): 3740–3748.

Bertin, Robert I., Daniel B. Connors, and Holly M. Kleinman. 2010. Differential herbivory on disk and ray flowers of gynomonoecious asters and goldenrods (Asteraceae). Biological Journal of the Linnean Society 101: 544–552.

Bousquet, Woodward S. and Gary P. Fleming. 2017. Floristics of the Abrams Creek wetlands, a calcareous fen complex in Winchester City and Frederick County, Virginia. Castanea 82(2): 132–155.

Breden, T. F., J. M. Hartman, M. Anzelone and J. F. Kelly. 2006. Endangered Plant Species Populations in New Jersey: Health and Threats. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Natural Heritage Program, Trenton, NJ. 198 pp.

Brouillet, Luc, John C. Semple, Geraldine A. Allen, Kenton L. Chambers, and Scott D. Sundberg. Page updated November 5, 2020. *Symphyotrichum praealtum* (Poiret) G. L. Nesom. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico [Online]. 22+ vols. New York and Oxford. Accessed June 26, 2023 at http://floranorthamerica.org/Symphyotrichum_praealtum

Brumback, William E. and Jessica Gerke. 2013. Flora Conservanda: New England 2012. The New England Plant Conservation Program (NEPCoP) list of plants in need of conservation. Rhodora 115(964): 313–408.

Chmielewski, Jerry G. and Sonam Ruit. 2002. Interrelationships among achene weight, orientation, and germination in the asters *Doellingeria umbellata* var. *umbellata*, *Symphyotrichum novae-angliae*, and *S. puniceum*. Bartonia 61: 15–26.

Chmielewski, Jerry G. and John C. Semple. 2001. The biology of Canadian weeds. 113. *Symphyotrichum lanceolatum* (Willd.) Nesom [*Aster lanceolatus* Willd.] and *S. lateriflorum* (L.) Löve & Löve [*Aster lateriflorus* (L.) Britt.] Canadian Journal of Plant Science 81(4): 829–849.

Chmielewski, J. G. and J. C. Semple. 2003. The biology of Canadian weeds. 125. *Symphyotrichum ericoides* (L.) Nesom (*Aster ericoides* L.) and *S. novae-angliae* (L.) Nesom (*A. novae-angliae* L.). Canadian Journal of Plant Science 83(4): 1017–1037.

Coville, William, Bridget J. Griffin, and Bethany A. Bradley. 2021. Identifying high-impact invasive plants likely to shift into northern New England with climate change. Invasive Plant Science and Management 14(2): 57–63.

Deno, Norman C. 1993. Seed Germination Theory and Practice. Second Edition. Pennsylvania State University, State College, PA. 242 pp.

Dukes, Jeffrey S., Jennifer Pontius, David Orwig, Jeffrey R. Garnas, Vikki L. Rodgers, Nicholas Brazee, Barry Cooke, Kathleen A. Theoharides, Erik E. Stange, Robin Harrington, Joan Ehrenfeld, Jessica Gurevitch, Manuel Lerdau, Kristina Stinson, Robert Wick, and Matthew Ayres. 2009. Responses of insect pests, pathogens, and invasive plant species to climate change in the forests of northeastern North America: What can we predict? Canadian Journal of Forest Research 39: 231–248.

Faber-Langendoen, D. 2018. Northeast Regional Floristic Quality Assessment Tools for Wetland Assessments. NatureServe, Arlington, VA. 52 pp.

Fernald, M. L. 1950. Gray's Manual of Botany. Dioscorides Press, Portland, OR. 1632 pp.

Fowler, Jarrod. 2016. Specialist bees of the northeast: Host plants and habitat conservation. Northeastern Naturalist 23(2): 305–320.

Gleason, H. A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. Second Edition. The New York Botanical Garden, Bronx, NY. 910 pp.

Greene, D. F. and Johnson, E. A. 1990. The aerodynamics of plumed seeds. Functional Ecology 4: 117–125.

Haines, Arthur. 2010. New combinations in the New England Tracheophyte flora. Stantec Botanical Notes 13: 1–8.

Hill, L. Michael. 1980. The genus *Aster* (Asteraceae) in Virginia. Castanea 45(2): 104–124.

Hill, Rebecca, Megan M. Rutkowski, Lori A. Lester, Heather Genievich, and Nicholas A. Procopio (eds.). 2020. New Jersey Scientific Report on Climate Change, Version 1.0. New Jersey Department of Environmental Protection, Trenton, NJ. 184 pp.

Hilty, John. 2020. Willow Aster, *Symphyotrichum praealtum*. Illinois Wildflowers. Accessed February 6, 2024 at https://www.illinoiswildflowers.info/prairie/plantx/willow_asterx.htm

Hough, Mary Y. 1983. New Jersey Wild Plants. Harmony Press, Harmony, NJ. 414 pp.

ITIS (Integrated Taxonomic Information System). Accessed February 6, 2024 at http://www.itis.gov

Jones, Almut G. 1978. Observations on reproduction and phenology in some perennial asters. The American Midland Naturalist 99(1): 184–197.

Kartesz, J. T. 2015. The Biota of North America Program (BONAP). Taxonomic Data Center. (http://www.bonap.net/tdc). Chapel Hill, NC. [Maps generated from Kartesz, J. T. 2015. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP) (in press)].

Lacroix, Christian R., Royce Stevens, and Joni F. Kemp. 2007. Floral development, fruit set, and dispersal of the Gulf of St. Lawrence Aster (*Symphyotrichum laurentianum*) (Fernald) Nesom. Canadian Journal of Botany 85: 331–341.

Leck, Mary Allessio and Charles F. Leck. 1998. A ten-year seed bank study of old field succession in central New Jersey. Journal of the Torrey Botanical Society 125(1): 11–32.

Leck, Mary Allessio and Robert L. Simpson. 1995. Ten year seed bank and vegetation dynamics of a tidal freshwater marsh. American Journal of Botany 82(12): 1547–1557.

MANHESP (Massachusetts Natural Heritage and Endangered Species Program). 2015. *Symphyotrichum praealtum*. Species profile available at https://www.mass.gov/files/documents/2016/08/no/symphyotrichum-praealtum.pdf

Morton, Cynthia M. and Loree Speedy. 2011. Checklist of the vascular plants of Indiana County, Pennsylvania. Journal of the Botanical Research Institute of Texas 5(2): 871–888.

NatureServe. 2024. NatureServe Explorer [web application]. NatureServe, Arlington, VA. Accessed February 6, 2024 at https://explorer.natureserve.org/

Nešić, Marija, Dragica Obratov-Petković, Dragana Skočajić, Ivana Bjedov, and Nevena Čule. 2022. Factors affecting seed germination of the invasive species *Symphyotrichum lanceolatum* and their implication for invasion success. Plants 11(7): Article 969.

Nesom, Guy L. 1994. Review of the taxonomy of *Aster* sensu lato (Asteraceae: Astereae), emphasizing the new world species. Phytologia 77(3): 141–297.

Nesom, G. L. 1997. Taxonomic adjustments in North American *Aster* sensu latissimo (Asteraceae: Astereae). Phytologia 82: 281–288.

Nesom, G. L. 2000. Generic conspectus of the tribe Astereae (Asteraceae) in North America and Central America, the Antilles, and Hawaii. Available online at https://www.guynesom.com/GenericConspectusAstereaeWEB.htm

NJNHP (New Jersey Natural Heritage Program). 2010. Explanation of Codes Used in Natural Heritage Reports. Updated March 2010. Available at https://nj.gov/dep/parksandforests/natural/docs/nhpcodes_2010.pdf

NJNHP (New Jersey Natural Heritage Program). 2022. Biotics 5 Database. NatureServe, Arlington, VA. Accessed February 1, 2022.

Novak, John A. and B. A. Foote. 1968. Biology and immature stages of fruit flies: *Paroxyna albiceps* (Diptera: Tephritidae). Journal of the Kansas Entomological Society 41(1): 108–119.

O'Uhuru, Ayodelé C. 2022. Identifying New Invasives In The Face Of Climate Change: A Focus On Sleeper Populations. Master's Thesis, University of Massachusetts, Amherst, MA. 32 pp.

POWO. 2024. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Accessed February 6, 2024 at http://www.plantsoftheworldonline.org/

Rhoads, Ann Fowler and Timothy A. Block. 2007. The Plants of Pennsylvania. University of Pennsylvania Press, Philadelphia, PA. 1042 pp.

Rich, Wm. P. 1902. Oak Island and its flora. Rhodora 4(41): 87–94.

Ring, Richard M., Elizabeth A. Spencer, and Kathleen Strakosch Walz. 2013. Vulnerability of 70 Plant Species of Greatest Conservation Need to Climate Change in New Jersey. New York Natural Heritage Program, Albany, NY and New Jersey Natural Heritage Program, Department of Environmental Protection, Office of Natural Lands Management, Trenton, NJ, for NatureServe #DDCF-0F-001a, Arlington, VA. 38 pp.

Robertson, Charles. 1929. Flowers and Insects: Lists of Visitors of Four Hundred and Fifty-three Flowers. Science Press Printing Company, Lancaster, PA. 221 pp.

Salva, Justin D. and Bethany A. Bradley. 2023. High-impact invasive plants expanding into mid-Atlantic states: Identifying priority range-shifting species for monitoring in light of climate change. Invasive Plant Science and Management 16: 197–206.

Semmling, Bonnie. 2020. Two photos of *Symphyotrichum praealtum* var. *angustior* from New Jersey. Used with permission.

Semple, J. C. and L. Brouillet. 1980. A synopsis of the North American Asters: The subgenera, sections, and subsections of *Aster* and *Lasallea*. American Journal of Botany 67: 1010–1026.

Semple, John C. and Jennifer L. A. Hood. 2005. Pappus variation in North American asters. I. Double, triple and quadruple pappus in *Symphyotrichum* and related aster genera (Asteraceae: Astereae). Sida 21(4): 2141–2159.

Semple, J. C., J. G. Chmielewski, and C. C. Chinnappa. 1983. Chromosome number determinations in *Aster* L. (Compositae) with comments on cytogeography, phylogeny, and chromosome morphology. American Journal of Botany 70: 1432–1443.

Sites, R. W. and J. E. McPherson. 1981. A List of the butterflies (Lepidoptera: Papilionoidea) of the La Rue-Pine Hills Ecological Area. The Great Lakes Entomologist 14(2): 81–85.

Smith, Charles C. 1940. Notes on the food and parasites of the rabbits of a lowland area in Oklahoma. The Journal of Wildlife Management 4(4): 429–431.

Snyder, D. B. 1982. Specimen of *Symphyotrichum praealtum* var. *angustior* collected in New Jersey on October 10, 1982. Scan of herbarium sheet courtesy of New York Botanical Garden Steere Herbarium via MidAtlantic Herbaria, licensed by https://creativecommons.org/licenses/by/3.0/. Image modified to remove location information.

Snyder, David B. 1985. Additions to New Jersey's Flora. Bartonia 51: 95–98.

U. S. Army Corps of Engineers. 2020. National Wetland Plant List, version 3.5. https://cwbi-app.sec.usace.army.mil/nwpl_static/v34/home/home.html U. S. Army Corps of Engineers Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH.

USDA, NRCS (U. S. Dept. of Agriculture, Natural Resources Conservation Service). 2024. PLANTS profile for *Symphyotrichum praealtum var. angustior* (Willowleaf Aster). The PLANTS Database, National Plant Data Team, Greensboro, NC. Accessed February 6, 2024 at http://plants.usda.gov

Waller, Donald M. 1988. Plant morphology and reproduction. In Jon Lovett Doust and Lesley Lovett Doust (ed.). Plant Reproductive Ecology: Patterns and Strategies. Oxford University Press, New York, NY.

Walz, Kathleen S., Jason L. Hafstad, Linda Kelly, and Karl Anderson. 2020. Floristic Quality Assessment Index for Vascular Plants of New Jersey: Coefficient of Conservancy (CoC) Values for Species and Genera (update to 2017 list). New Jersey Department of Environmental Protection, New Jersey Forest Service, Office of Natural Lands Management, Trenton, NJ.

Wang, B., and Y. L. Qiu. 2006. Phylogenetic distribution and evolution of mycorrhizas in land plants. Mycorrhiza 16(5): 299–363.

Weakley, A. S. and Southeastern Flora Team. 2022. Flora of the Southeastern United States. University of North Carolina Herbarium, North Carolina Botanical Garden, Chapel Hill, NC. 2022 pp.

Wiegand, K. M. 1933. *Aster paniculatus* and some of its relatives. Rhodora 35: 16–38.

Wolfe, Benjamin E., Peter A. Weishampel, and John N. Klironomos. 2006. Arbuscular mycorrhizal fungi and water table affect wetland plant community composition. Journal of Ecology 94: 905–914.

Yatskievych, George. 2005. How to faster master the *Aster* disaster: A primer on the changing nomenclature of Missouri Asters. Missouriensis 25: 26–32.

Young, Bruce E., Elizabeth Byers, Geoff Hammerson, Anne Frances, Leah Oliver, and Amanda Treher. 2016. Guidelines for Using the NatureServe Climate Change Vulnerability Index, Release 3.02, 1 June 2016. NatureServe, Arlington, VA. 65 pp.