Salix pedicellaris

Bog Willow

Salicaceae

Salix pedicellaris by Peter M. Dziuk, 2015

***Salix pedicellaris* 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

Salix pedicellaris (Bog Willow) is a clonal shrub in the Salicaceae. Although identification of willows is often difficult, *S. pedicellaris* is one of the more distinct species (Argus 2006). The shrubs are relatively short in stature, typically under a meter but sometimes up to 1.5 meters. Some of the sparsely-branched stems are upright but others lie on the ground with the tips turning upward. Roots may form at locations where stems are in contact with the substrate, developing into new plants that may eventually become separated from the parent. Twigs of *S. pedicellaris* are smooth and lack stipules. The alternate, smooth-margined leaves are oblong, widest in the middle and more narrow toward both ends, and range from 19–53 mm in length and 5–20 mm across. The leaves are usually bright green above and paler below, and they can become somewhat leathery as they age. A whitish, waxy coating may be present on one or both leaf surfaces but it is most often on the underside. Staminate and pistillate flowers are borne on separate plants. Both male and female *Salix* flowers are produced in cylindrical clusters known as catkins, and those of *S. pedicellaris* are somewhat loosely flowered. On female plants the smooth, reddish pistillate flowers (cover photo) and fruits stand out against the green leaves. (See Fernald 1909, Britton and Brown 1913, Fernald 1950, Gleason and Cronquist 1991, Argus 2020). In New Jersey, Bog Willow blooms from late April to May (Hough 1983).

Left: Britton and Brown 1913, courtesy USDA NRCS 2022a. Right: Peter M. Dziuk, 2015.

Staminate flowers (left) and fruits (right) by Peter M. Dziuk, 2015.

Pollinator Dynamics

The majority of *Salix* species are pollinated by insects (Hjelmqvist 1948). The genus has many adaptations that encourage insect pollination including heavy pollen grains, conspicuous catkins, abundant nectar, and a floral scent (Argus 1974). Clonal shrubs such as *Salix pedicellaris* can particularly benefit from insect pollination because the longer distance dispersal increases the opportunities for outcrossing in comparison to wind (Kevan et al. 1993).

Bees in particular are widely reported as visitors to *Salix* flowers. A review of *Vaccinium* pollinators that have also been recorded on *Salix* produced a list that spanned five families: Andrenidae, Apidae, Colletidae, Halictidae, and Megachilidae (Stubbs et al. 1992). The genera most frequently documented on *Salix* were *Andrena* (24 species), *Dialictus* (8 spp.), *Bombus* (6 spp.), *Evylaeus* (5 spp.), *Halictus* (4 spp.), *Lasioglossum* (3 spp.), *Sphecodes* (3 spp.), *Osmia* (3 spp.), and *Nomada* (2 spp.). Additional genera included *Agapostemon*, *Augochlorella*, *Ceratina*, and *Colletes*. All of those bees visit plants from multiple families, but some bees specialize on a single host plant family or genus. Fowler (2016a) identified nine species of miner bee (*Andrena*) that are *Salix* specialists in the New England area, while several additional species of *Andrena* that only visit *Salix* occur in the Mid-Atlantic region (Fowler 2016b).

Certain *Salix* species may utilize both insects and wind for pollination. Only a portion of the willows examined by Argus (1974) were able to set seed in the absence of insects, suggesting that not all *Salix* species have pollen that can be carried by wind. Four *Salix* species studied by Karrenberg et al. (2002) in Italy were primarily insect pollinated but were also capable of limited seed set if wind was the only available means of pollen transfer; however, the efficacy of wind-pollination as a backup mechanism varied between species. Although no specific pollination studies were found for *Salix pedicellaris*, it does not seem that fertilization is likely to be a limiting factor for Bog Willow.

Seed Dispersal

Salix fruits are two-parted capsules that split open when they are ripe, exposing the seeds. The capsules of *S. pedicellaris* are smooth and 4–8 mm long (Argus 2020) Although each Bog Willow ovary has 4–6 ovules not all of them develop, and natural seed set in the genus is generally less than 50% (Marchenko et al. 2021). In New Jersey, *Salix pedicellaris* normally produces fruits during July (Hough 1983).

On the end of each willow seed is an aril covered with long, silky hairs. Aided by the hairs, wind plays a role in releasing the seeds from the capsules and also in carrying them away from the parent plants. The seed coats are hydrophobic and the arils are unwettable, so seeds that land on water are able to float for several days (Steyn et al. 2004). In addition to maintaining buoyancy in the air, the hairs on willow seeds can further aid in water dispersal by acting as little sails (Boland 2014). Seiwa et al. (2008) reported that the hairs may also play a role in assuring that *Salix* seeds end up in favorable microsites for germination by trapping them on wet soil.

Most *Salix* seeds lack food reserves and have a very short period of viability (Argus 2006). While the seeds of some fall-dispersing willows can overwinter, those of summer-dispersing species like *Salix pedicellaris* are not dormant and typically germinate within 24 hours of reaching a suitable substrate (Densmore and Zasada 1983). Moisture is required in order for the seeds to retain viability for even a short time (Desmore and Zasada 1983), and Deno (1933) reported that *Salix* seeds can only remain viable for a few days and die quickly once they become dry. In addition to moisture, light is important for development. The seeds of summer-dispersed willows contain a significant amount of chlorophyll and have transparent seed coats; consequently germination increases with light (Densmore and Zasada 1983). Both resources continue to be important as young *Salix* plants develop. In a study of a western species (*S. lasiolepis*), lack of moisture was the main cause of seedling mortality (Sacchi and Price 1992), and seedling success for most willows is primarily dependent on adequate amounts of both moisture and light (Argus 2006).

Habitat

Salix pedicellaris is typically associated with bogs, fens, and swamps (Fairbrothers and Hough 1973, Rhoads and Block 2007, Argus 2020), but the willow's habitat has also been described as carrs, ditches, flats, glades, marshes, meadows, seeps, and thickets (Les 2017). Johnston et al. (2007) categorized *S. pedicellaris* as an indicator species of organic soils. Bog Willow can sometimes be found in calcareous fens (Johnson and Walz 2013) and all of New Jersey's extant populations are associated with limestone (NJNHP 2022). At sites where *S. pedicellaris* occurs, reported ranges of pH usually fall between 5.5 and 7.6 (Nichols and Sperduto 2012, Les 2017, Klinkenberg 2020), but one study in Saskatchewan found that the species was most abundant at sites with pH levels of 4.0–4.9 (Jeglum 1971). The water table in *S. pedicellaris* habitats is typically at or near the surface (Jeglum 1971, Klinkenberg 2020). Wei et al. (2017) examined optimum water levels for a number of poplars and willows, and their results indicated that *S. pedicellaris* had peak abundance where the water table was at or slightly above the surface but the shrub's basal area—which the authors used to predict fitness—was highest when the water

table was about 45 cm below the surface. At one New Hampshire site *S. pedicellaris* was found growing on hummocks averaging 33 cm in height (Nichols and Sperduto 2012). Occurrences of Bog Willow have been documented at locations ranging from 0–2140 meters in elevation (Argus 2020, Klinkenberg 2020).

Ten different plant associations were identified by Reinartz (1986) within a large Wisconsin bog, and the community where *Salix pedicellaris* was found was classified as a Bog Birch—Bog Willow Shrub Carr. Characteristic species included a number of other willows (*S. serissima, S. candida, S. petiolaris*) as well as *Betula pumila, Alnus rugosa, Spirea alba, Rosa palustris, Ilex verticillata,* and *Cornus stolonifera*. In a New Hampshire patterned fen community, other shrubs associated with *S. pedicellaris* were mainly ericaceous species (*Andromeda polifolia* var. *latifolia, Chamaedaphne calyculata, Kalmia angustifolia, Ledum groenlandicum*) while the stunted, moose-browsed trees at the site included *Thuja occidentalis, Larix laricina, Picea mariana,* and *Acer rubrum* (Nichols and Sperduto 2012). One habitat where *S. pedicellaris* was found in Minnesota was described as a rich swamp dominated by *Larix laricina* (Rowe et al. 2017).

Salix pedicellaris is known to utilize mycorrhizal fungi. Thormann et al. (1999) found that Bog Willow formed both external (ectomycorrhizal) and internal (endomycorrhizal) associations. The ectomycorrhizal fungus was the common and widespread *Cenococcum geophilum*, while the endomycorrhizal fungus was not identified. Another study of ectomycorrhizal associations in willows found that most *Salix spp*., including *S. pedicellaris*, were able to form associations with multiple kinds of fungi, and that the fungal partners of willows were likely to be influenced by habitat characteristics (Erlandson et al. 2015).

Wetland Indicator Status

Salix pedicellaris 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)

SAPE2

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 global distribution of *Salix pedicellaris* is limited to Canada and the northern United States (POWO 2022). The map in Figure 1 depicts the extent of the species in North America.

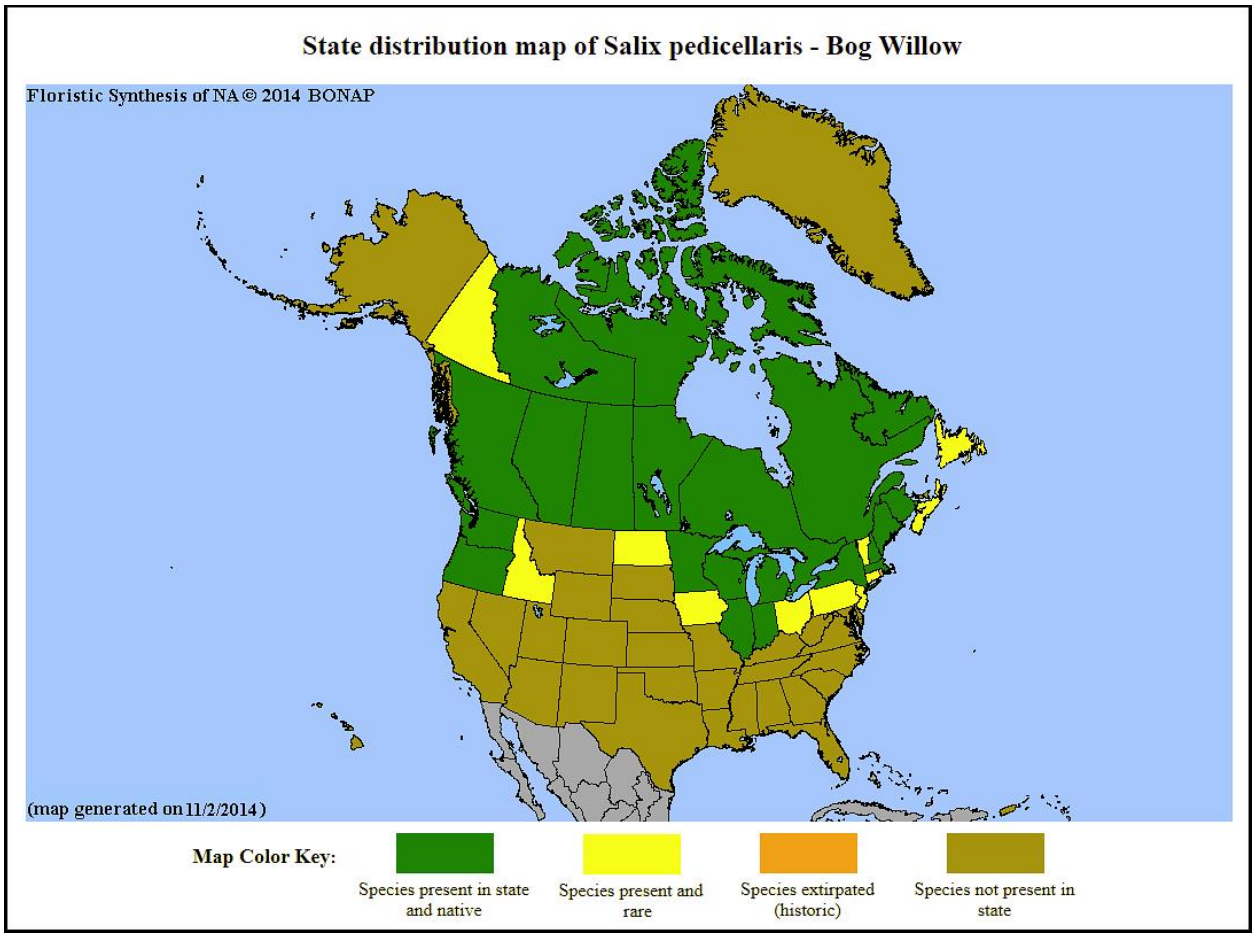

Figure 1. Distribution of S. pedicellaris in North America, adapted from BONAP (Kartesz 2015).

The USDA PLANTS Database (2022b) shows records of *Salix pedicellaris* in four New Jersey counties: Bergen, Morris, Sussex, and Warren (Figure 2 below). The data include historic observations and do not reflect the current distribution of the species.

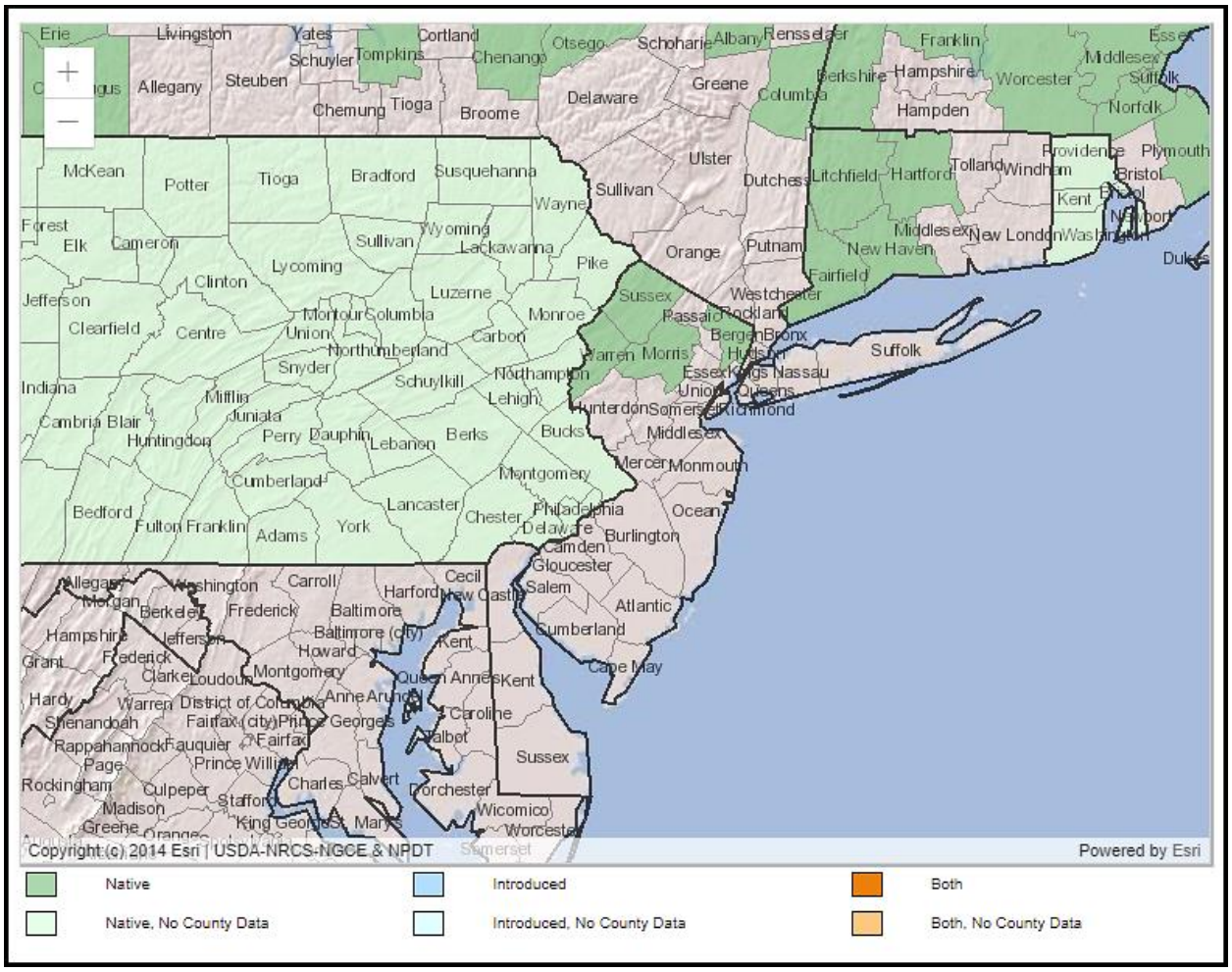

Figure 2. County records of S. pedicellaris in New Jersey and vicinity (USDA NRCS 2022b).

Conservation Status

Salix pedicellaris 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 2022). The map below (Figure 3) illustrates the conservation status of Bog Willow throughout its range. The shrub is critically imperiled (very high risk of extinction) in four states and one province, imperiled (high risk of extinction) in five states and two provinces, vulnerable (moderate risk of extinction) in one state and three provinces, and possibly extirpated in Rhode Island. In other parts of its range, *S. pedicellaris* is unranked or considered to be secure or apparently so. In Nunavut, which appears on the map as the northernmost territory in the species' range, the known occurrences of *S. pedicellaris* are actually located on islands near the southern end of Hudson Bay (Argus 2020).

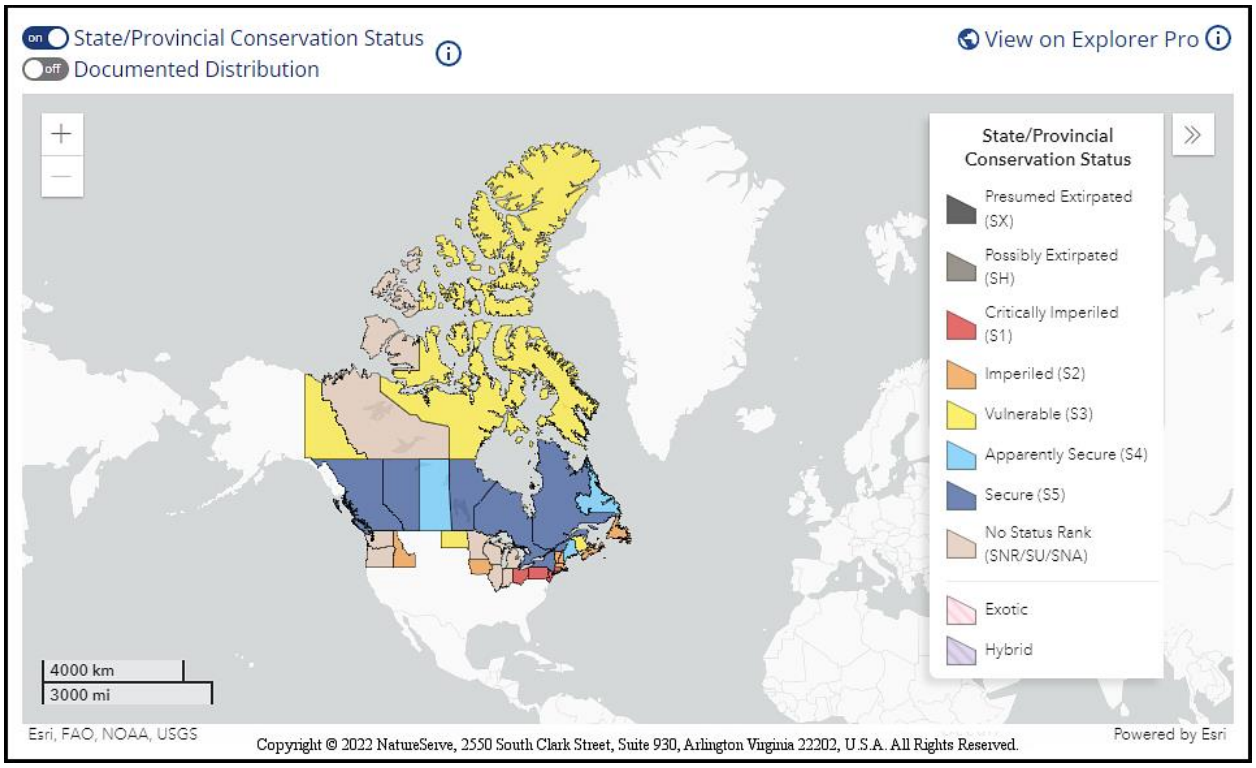

Figure 3. Conservation status of S. pedicellaris in North America (NatureServe 2022).

New Jersey is one of the states where *Salix pedicellaris* is critically imperiled (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. Bog Willow 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).

Early records of *Salix pedicellaris* in New Jersey were restricted to a single site in Morris County (Willis 1974, Britton 1889), but by the early 1900s it had also been discovered in Sussex County (Taylor 1915). Bog Willow was catalogued as endangered by Fairbrothers and Hough (1973), who indicated that the known populations were threatened by human activities. They reported the species as extant in Sussex, recently collected from Bergen, and historic in Morris County—apparently overlooking two previously documented occurrences in Warren County (NJNHP 2022). The Natural Heritage biotics database presently shows six extant occurrences of *S. pedicellaris* in northern New Jersey, with five others listed as historic and two as extirpated.

Threats

In areas where *Salix pedicellaris* is imperiled, the decline of the species has frequently been tied to habitat loss or degradation. One historic New Jersey population was extirpated as a result of peat mining (NJNHP 2022), and in Ohio a former peatland that once supported *S. pedicellaris* was turned into a landfill and subsequently became a county fairground (Andreas and Knoop 1992). Nekola (1994) reported that only 7% of the original (presettlement) fens in eastern Iowa were still extant by 1991. A decrease in peatlands has been identified as a problem worldwide (Rochefort and Lode 2006). On a global scale, half of all peatland losses are attributed to agriculture, 30% to forestry, and 10% to peat extraction, while the remaining 10% are directly or indirectly associated with development (Chapman et al. 2003). Drainage is a common factor in most anthropogenic disturbances, and even when farmed or mined peatlands have later been abandoned the ensuing vegetative cover seldom resembles that of the pre-disturbance communities (Rochefort et al. 2012). Drainage and oxidation of peat following agricultural usage can preclude the reintroduction of species like *Salix pedicellaris* that require organic soils (Christy and Garvey 2015).

Argus (2006) characterized willows as early succession species that are well-adapted to disturbance and Les (2017) indicated that most *Salix* species can regenerate quickly following natural disturbances such as those caused by fires or floods, but that may not always be the case. Even short-term disruptions of its peatland habitat can be detrimental to *Salix pedicellaris*. Echiverri (2021) examined the post-disturbance effects of linear deforested corridors created to search for fossil fuel reserves (seismic lines) on plants in fen communities. Negative impacts were found for *S. pedicellaris* at sites where multiple narrow seismic lines had been created 12–17 years earlier. The Bog Willow's decline at those locations was attributed to edge effects from surface drying that extended into habitat adjacent to the disturbed corridors. In another study, a comparison of pristine Tamarack swamp habitats to sites that had been disrupted by natural (fire) or anthropogenic (logging) events revealed that both disturbance types resulted in different trajectories for subsequent vegetative composition. Results of the analysis classified Bog Willow as an indicator species for undisturbed sites (Rowe et al. 2017).

Successional changes and the establishment of an invasive plant (*Microstegium vimineum*) observed at one New Jersey *S. pedicellaris* occurrence are likely to be symptoms of community changes that may threaten the rare species (NJNHP 2022). Vegetative succession and competition with weedy species are among the most common threats to rare plants in Sussex County, where most of the state's remaining Bog Willow populations are located (Breden et al. 2006). Additional threats to calcareous fen communities in New Jersey include overbrowsing and damage from recreational pursuits, particularly in locations where changes in hydrology have made sites more accessible to herbivores or off-road vehicles (Johnson and Walz 2013).

Fen habitats are also highly vulnerable to climate change, as shifting weather patterns can alter hydrological regimes in ways that make sites less suitable for specialists and more susceptible to generalist or invasive species (Johnson and Walz 2013). However, an assessment by Ring et al. (2013) concluded that the characteristics of *S. pedi*cellaris do not make the species itself particularly vulnerable to climate change. Bog Willow was ranked as Presumed Stable, meaning that available evidence did not suggest that its abundance and/or range extent within the state

would change substantially by 2050 although some range shifts might occur. The most significant risk identified for *S. pedicellaris* was limited dispersal, which could be restricted by a lack of connectivity between the habitats utilized by the species. Experiments with desiccation tolerance have shown that *Salix pedicellaris* is more drought tolerant than many other willows. While *S. pedicellaris* rapidly sheds leaves in response to drying of the substrate, it can replace most of the lost leaves (77.8%) following rehydration (Savage and Cavender-Bares 2011). Additional work by Savage and Cavender-Bares (2013) highlighted other factors that could affect the way willows adapt to climactic changes, including freezing tolerance and day length. More research is needed in order to understand how individual species' characteristics will impact the success of either southern willows that may expand their ranges northward or northern willows that may face additional competition from migrants in a warming climate.

Management Summary and Recommendations

Habitat integrity is critical to the long-term persistence of *Salix pedicellaris*, particularly in regions where the species is imperiled. Because a peatland can become susceptible to a cascade of threats if the substrate dries, the maintenance of natural hydrologic conditions is an essential component of conservation planning. Site-specific management may require the consideration of elements that extend beyond the immediate community such as protection of a water source or establishment of a buffer area. In New Jersey and other places where *S. pedicellaris* is endangered or threatened, extant populations should be monitored on a regular basis to evaluate habitat quality and stability. Early intervention is important because once the hydrology or soil composition of a site has substantially changed it can be very difficult for *Salix pedicellaris* to re-establish (Christy and Garvey 2015).

Concerns over the global loss of peatlands and recognition of their importance for long-term carbon storage have spawned a great deal of research on the fragile ecosystems in recent decades, some of which have been focused on the restoration of degraded habitats (Wieder and Vitt 2006). The first and most critical step is the re-establishment of natural hydrological processes, a complex and lengthy process that is likely to involve manipulation of a site's water budget, topography, and vegetative cover (Price et al. 2003). Nevertheless, advances have been made. Chimner et al. (2017) reviewed the first 25 years of efforts to restore peatlands that had been degraded by an array of activities, highlighting areas where progress has occurred and recommending topics for future research.

Synonyms

The accepted botanical name of the species is *Salix pedicellaris* Pursh. Orthographic variants, synonyms, and common names are listed below (ITIS 2021, USDA NRCS 2022b, POWO 2022).

Botanical Synonyms	Common Names
Salix fuscescens Andersson var. *hebecarpa* Fernald *Salix hebecarpa* (Fernald) Fernald	Bog Willow

Salix myrtilloides var. *hypoglauca* (Fernald) C.R. Ball
Salix myrtilloides var. *pedicellaris* (Pursh) Andersson
Salix pedicellaris var. *hypoglauca* Fernald
Salix pedicellaris var. *tenuescens* Fernald
Salix pedicellaris f. *tenuescens* (Fernald) C. K. Schneid.
Salix pedicellaris ssp. *hypoglauca* (Fernald) Piper & Beattie
Usionis pedicellaris (Pursh) Raf.

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