Phacelia bipinnatifida

Fern-leaf Scorpion-flower

Boraginaceae

Phacelia bipinnatifida courtesy Alan Cressler, Lady Bird Johnson Wildflower Center

***Phacelia bipinnatifida* 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

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Life History

Phacelia bipinnatifida (Fern-leaf Scorpion-flower) is a biennial herb that—according to Meehan (1878)—"will commend itself to all lovers of wild flowers by its simple beauty." *Phacelia* was traditionally part of the Hydrophyllaceae but that entire family was transferred into the Boraginaceae (APG II 2003, Kartesz 2015). The common name reflects the scorpioid inflorescence that is characteristic of the genus: The flower clusters are one-sided and have coiled clusters of buds, thus resembling curled scorpion tails as they unfurl (Wilson 1960).

Left: Britton and Brown 1913, courtesy USDA NRCS 2024a. Right: Meehan 1878.

Phacelia bipinnatifida has erect, branching stems up to 6 dm in height that are hairy throughout and glandular near the top. The leaves are alternate, long-stalked, and pinnately divided into segments that are usually lobed. The flowers are 10–15 mm wide with five lavender to blue petals that may be smooth or rough on the margins but not fringed. The five stamens extend beyond the corolla and the style is deeply divided. The fruit is a round capsule 4–6 mm in diameter. (See Britton and Brown 1913, Constance 1949, Fernald 1950, Gleason and Cronquist 1991, Walden and Patterson 2012). *Hydrophyllum virginianum* is similar to *P. bipinnatifida* in appearance but lacks glands on the stems of the inflorescence, and the styles of *Hydrophyllum* flowers are only divided at the tip while those in *Phacelia* are divided nearly to the middle (Westmoreland 1981, Hilty 2020).


Courtesy Alan Cressler (2009 and 2013), Lady Bird Johnson Wildflower Center

Phacelia bipinnatifida has a strictly biennial life cycle (Baskin et al. 1986). First year plants are vegetative and under 1.5 dm in height. The leaves remain green with hints of purple during the fall and sometimes through the winter, although they frequently die back late in the season and the plants persist as ground-level buds until the following spring when they shoot up and bloom. After the plants have flowered and released their seeds they die (Withrow 1932, McDonald 1937, Mount Cuba Center 2024, Toadshade Wildflower Farm 2024).

Flowering and fruiting take place throughout the spring (Weakley et al. 2024) and both can occur simultaneously because capsules may already be developing near the base of the stalks while new blooms are opening at the top of the coils (Wilson 1960). Thornton et al. (2024) tracked the developmental stages of *P. bipinnatifida* plants in Tennessee from mid-February through mid-June. They were in leaf during February, bloomed from March through mid-May, and fruited from late April through mid-June. Some plants were already senescing in mid-May while others were still in flower or fruit. In New Jersey, *P. bipinnatifida* has been seen in bloom during late April and early May (NJNHP 2024). Frett (2012) noted that late June was the best time to find *P. bipinnatifida* seeds in the mid-Atlantic region.

Pollinator Dynamics

Hansgirg (1897) reported that the pollen of *Phacelia bipinnatifida* maintained good viability despite the fact that the protruding anthers were regularly exposed it to moisture. Coulter (1876) indicated that the flowers produced a "peculiar pungent odor" although it is not clear whether the scent facilitates pollination. Nevertheless, the nectar-producing flowers of *P. bipinnatifida* are attractive to an assortment of insects including long- and short-tongued bees, skippers, butterflies, and wasps. The primary pollinators are bees (Hilty 2020). A few bees specialize on *Phacelia* flowers, including *Andrena lamelliterga* and *A. phaceliae*, while *Hoplitis simplex* is a specialist on *Phacelia* and *Nemophila*. The two *Andrena* species have a more southern distribution but *H. simplex* can be found in New Jersey (Fowler and Droege 2020). Neff (2009) observed *Hoplitis simplex* visiting the flowers of *Nemophila phacelioides*—which are similar to those of *P. bipinnatifida*—and noted that the bees perched on the anthers, allowing them to forage for nectar and pollen simultaneously.

The cross-fertilization of *Phacelia bipinnatifida* is not completely dependent on specialist bees. *Andrena carlini* is a generalist pollinator that has been observed on *P. bipinnatifida*, and *A. distans* has also been collected on Fern-leaf Scorpion-flower although that insect usually restricts its foraging to *Geranium maculatum*. Other generalist bees known to visit the blooms of *Phacelia* species include *Andrena barbilabris, A. cerasifolii, A. cressonii, A. imitatrix, A. thaspii, A. w-scripta, Ceratina dupla*, and *Megachile melanophaea* (LaBerge 1986, Stubbs et al. 1992). Gillett (1964) examined ten species of *Phacelia* and found that they were primarily outcrossers but were also self-compatible. Unfortunately *P. bipinnatifida* was not included in his study.

Seed Dispersal and Establishment

Each *Phacelia bipinnatifida* flower produces four keeled seeds that have rough, net-veined coats (Gillett 1968). Populations of Fern-leaf Scorpion-flower often include thousands of plants (eg. Coulter 1876, Farmer et al. 1982, NJNHP 2024, Thornton et al. 2024), which suggests that most of the species' seeds are locally dispersed. The propagules have no apparent adaptations for long-distance dispersal, although some seeds may occasionally adhere to muddy feet or wet fur. Humans can also serve as agents of dispersal, as *Phacelia bipinnatifida* is popular with gardeners and sometimes persists or spreads in places where it was planted (Weakley et al. 2024).

Deno (1998) had difficulty germinating *Phacelia bipinnatifida* under laboratory conditions but the species usually reproduces readily from seed when growing outdoors (Mount Cuba Center 2024, NCCE 2024). *P. bipinnatifida* seeds are dormant at maturity and require a period of cold stratification in order to germinate (Gamboa-deBuen and Orozco-Segovia 2008). Baskin and Baskin (1988) found that the majority of the species' seeds germinated the first spring after dispersal but sporadic germination continued during autumn and spring seasons over a period of five years. When topsoils from nearby forests were used to restore the site of a former mining operation in Tennessee, *P. bipinnatifida* emerged from the seed bank in profusion (Farmer et al. 1982).

Habitat

Phacelia bipinnatifida can thrive in a variety of habitats. The species may be found high on mountain slopes or in lower, flatter terrain at the bottom of ravines or canyons (Small and Vail 1894, Wofford et al. 1979, Joyner and Chester 1994, Huskins and Shaw 2010, Kent 2011, Evans et al. 2016). It is usually associated with sedimentary substrates like limestone, sandstone, or shale (Constance 1949, Duncan 1955, Carr 1965, Rogers 1979, Ogle 1980, Clements and Wofford 1991, Basinger 1998, Hill 2005, Thompson et al. 2005, Levy 2021, NJNHP 2024). The soils may be alkaline (Duncan 1955) or acidic (Campbell and Meijer 1989, Levy 2021); they are generally mesic but some are subxeric (Withrow 1932, Rayner et al. 1979, Rogers 1979, Schafale and Weakley 1990, Campbell et al 1995, Basinger 1998, Kent 2011, Evans et al. 2016). Lowland habitats that are utilized by *P. bipinnatifida* usually flood infrequently and drain rapidly so the soils do not remain saturated for long (Joyner and Chester 1994). Fern-leaf Scorpion-flower sometimes grows in rocky places, including ridges, outcrops, shelves, crevices, or talus slopes (Carr 1965, Huskins and Shaw 2010). Although the species cannot grow directly on rock

it is tolerant of thin soils (Hilty 2020). With the exception of one record from the walls of an abandoned quarry (Thompson et al. 2005), no reports were found of *P. bipinnatifida* growing in disturbed habitats.

Even though *Phacelia bipinnatifida* is able to tolerate more open conditions it is usually found in shady locations (Weakley et al. 2024). Peattie (1930) noted that it was often found growing in sites that were shaded by shrubs or taller herbs. In forested sites, the species' most vigorous growth and reproduction takes place early in the season when light availability is greater (Hilty 2020). The canopies are usually dominated by deciduous hardwoods such as *Acer saccharum*, *Fagus grandifolia*, *Liriodendron tulipifera*, *Aesculus flava*, or *Quercus* spp. (Ogle 1980, Farmer et al. 1982, Schmalzer et al. 1985, Schafale and Weakley 1990, Campbell et al. 1995, Hill 2007, Evans et al. 2016) but *P. bipinnatifida* has also been found in hemlock (*Tsuga*) coves (Huskins and Shaw 2010). Typical herbaceous associates may include *Arisaema triphyllum*, *Asarum canadense*, *Caulophyllum thalictroides*, *Dicentra cucullaria*, *Geranium maculatum*, *Hepatica nobilis*, *Mitella diphylla*, *Phlox divaricata*, *Podophyllum peltatum*, *Polygonatum biflorum*, *Sedum ternatum*, or *Silene virginica* (Cain and Friesner 1929, Kent 2011, NJNHP 2024).

Wetland Indicator Status

Phacelia bipinnatifida is not included on the National Wetlands Plant List (NWPL). Any species not on the NWPL is considered to be Upland (UPL) in all regions where it occurs. The UPL designation means that it almost never occurs in wetlands (U. S. Army Corps of Engineers 2020).

USDA Plants Code (USDA, NRCS 2024b)

PHBI2

Coefficient of Conservancy (Walz et al. 2020)

CoC = 9. 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 range of *Phacelia bipinnatifida* is restricted to the eastern and central United States (POWO 2024). The map in Figure 1 depicts the extent of Fern-leaf Scorpion-flower in North America. The USDA PLANTS Database (2024b) shows records of *Phacelia bipinnatifida* in one New Jersey county: Sussex County (Figure 2). The map accurately reflects the known distribution of the species in the state.

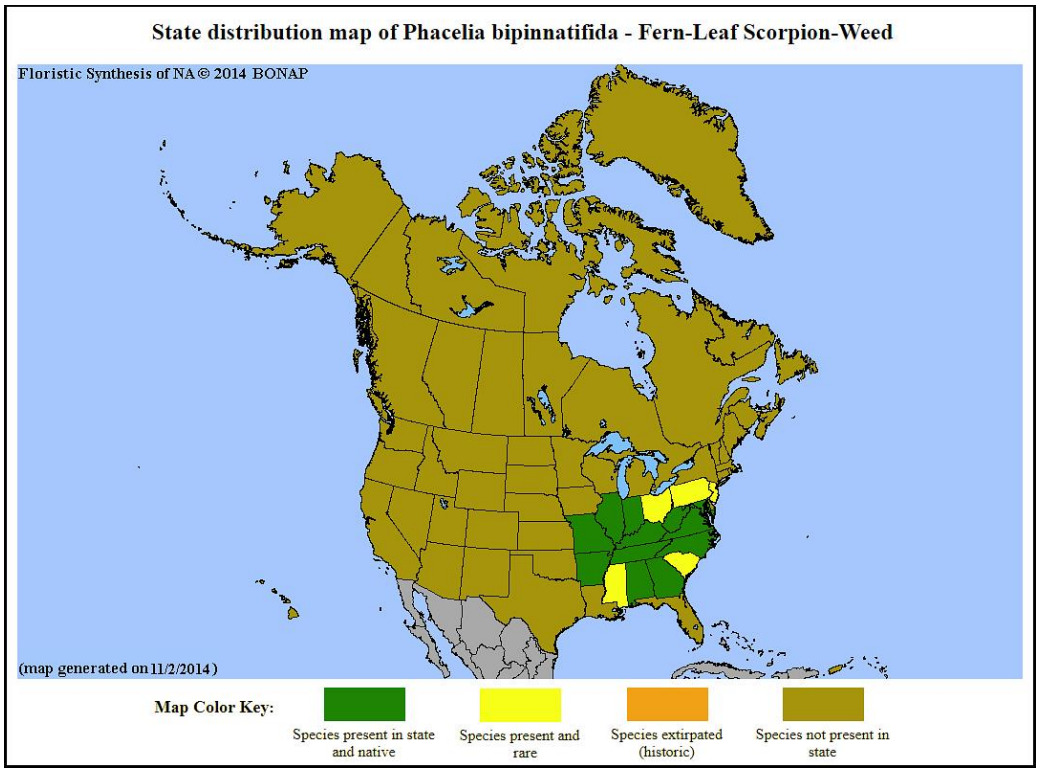

Figure 1. Distribution of P. bipinnatifida in North America, adapted from BONAP (Kartesz 2015).

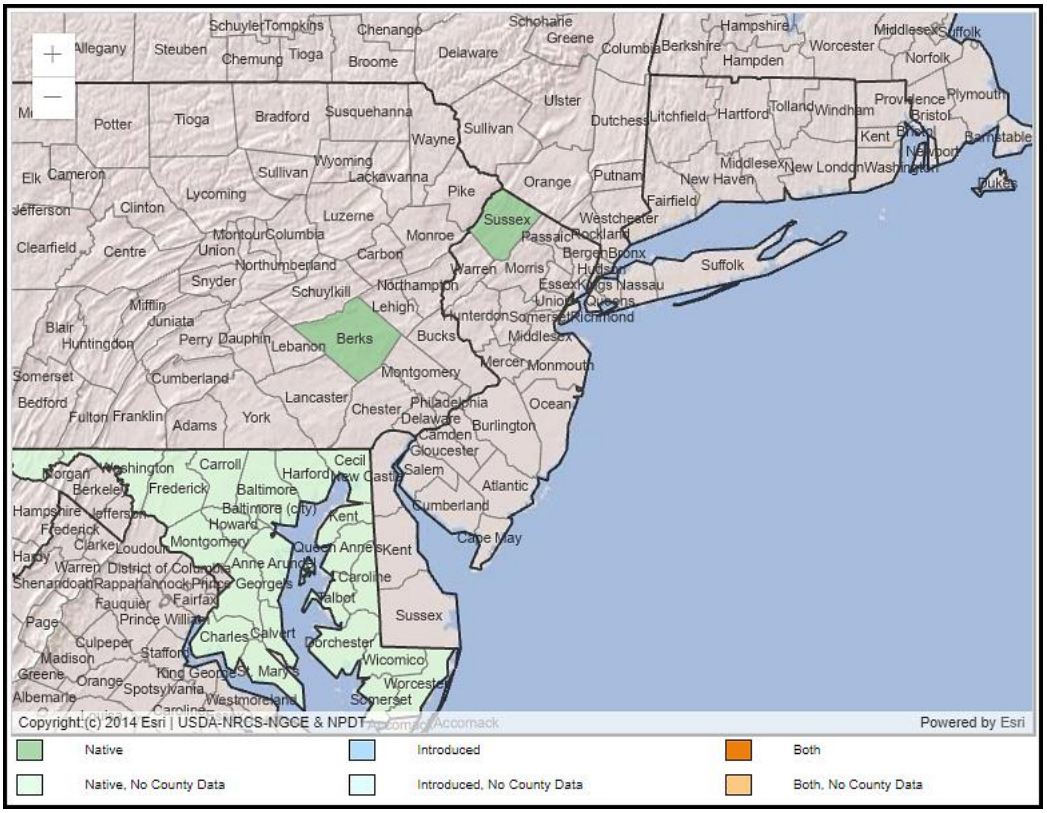

Figure 2. County records of P. bipinnatifida in New Jersey and vicinity (USDA NRCS 2024b).

Conservation Status

Phacelia bipinnatifida 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 2024). The map below (Figure 3) illustrates the conservation status of *P. bipinnatifida* throughout its range. Fern-leaf Scorpion-flower is critically imperiled (very high risk of extinction) in three states and vulnerable (moderate risk of extinction) in two states. It is secure, apparently secure, or unranked in other states where it occurs.

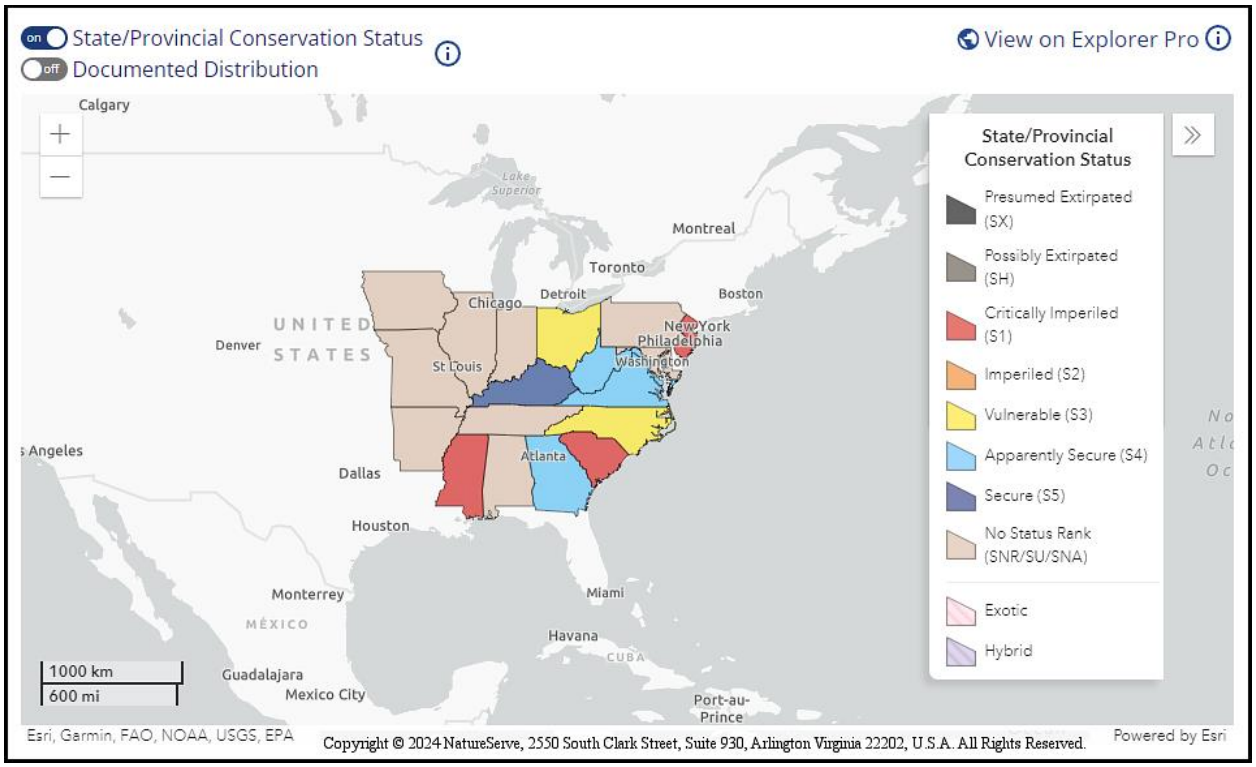

Figure 3. Conservation status of P. bipinnatifida in North America (NatureServe 2024).

Phacelia bipinnatifida is ranked S1.1 in New Jersey (NJNHP 2024), meaning that it is critically imperiled due to extreme rarity. A species with an S1.1 rank has only ever been documented at a single location in the state. *P. bipinnatifida* is also listed as an endangered species (E) in New Jersey, meaning that without intervention it has a high likelihood of extinction. Although the presence of endangered flora may restrict development in certain communities, being listed does not currently provide broad statewide protection for plants. Additional regional status codes assigned to the scorpion-flower signify that the species is eligible for protection under the jurisdictions of the Highlands Preservation Area (HL) and the New Jersey Pinelands (LP) (NJNHP 2010). The only known occurrence of *P. bipinnatifida* in the state was discovered in 2008 (NJNHP 2024).

Threats

When last observed, New Jersey's population of *Phacelia bipinnatifida* appeared to be large, healthy and vigorous. However, a number of invasive plant species were observed at the site including *Berberis thunbergii*, *Rosa multiflora*, *Lonicera morrowii*, *Alliaria petiolata*, *Ligustrum sinense*, and *Persicaria maculosa*. The first four species are highly threatening to native communities (Van Clef 2009, FoHVOS 2023). *Berberis thunbergii* is particularly troublesome in northern New Jersey, where it often forms dense thickets and dominates the understory to such an extent that few other species can persist. The competitive abilities of *Phacelia bipinnatifida* have not been studied. Although the scorpion-flower is not troubled by shading, it may be affected by belowground competition for resources such as water and nutrients or by a shortage of suitable germination sites. The leaf litter of *Berberis thunbergii* can also alter local soil chemistry, often to the detriment of native plants (Kaufman and Kaufman 2007).

There do not seem to be widespread threats to *Phacelia bipinnatifida* populations in other parts of the species' range. No reports of disease were found. When Arthur (1908) experimentally sowed the spores of a rust fungus on *P. bipinnatifida* no infection resulted. Some insects feed on *Phacelia* foliage, including a skeletonizing leaf beetle (*Scelolyperus wilcoxi*) and the larvae of a moth (*Ethmia zelleriella*), but neither species appears to be present in New Jersey (Braun 1925, Clark 1996, Hilty 2020, BugGuide 2024). Clausen and Tepper (2021) rated *P. bipinnatifida* as highly deer resistant, noting that a few flowers may occasionally be nipped off but the foliage is rarely browsed.

As with any upland species, *P. bipinnatifida* occurrences on land that has not been protected could be vulnerable to habitat loss resulting from development or other human activities. The habitats of some Fern-leaf Scorpion-flower populations in the Great Smoky Mountains have been destroyed by feral hog (*Sus scrofa*) rooting behaviors, which occur with the greatest frequency during late spring (Bratton 1974). Feral swine have been recorded in New Jersey and are identified as an emerging threat in the state (USDA 2013, FoHVOS 2023).

Climate Change Vulnerability

Information from the references cited in this profile was used to evaluate the vulnerability of New Jersey's *Phacelia bipinnatifida* population 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 the state climactic computations by Ring et al. (2013). Based on available data *P. bipinnatifida* 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 warming trend could compound the effects of other factors that have been identified as potentially problematic.

In New Jersey, the impacts of climate change include both elevated temperatures and an increase in extreme conditions such as droughts and floods (Hill et al. 2020). *Phacelia bipinnatifida* is at the northern end of its range in New Jersey so it would be expected to adapt to warmer

temperatures and a longer growing season. Nevertheless, there is little information available regarding the effects of climactic factors on the species' life cycle or environmental tolerances. Climate has been demonstrated to affect the initiation of flowering—for example, a study in an Indiana gorge found that warmer temperatures caused *P. bipinnatifida* plants on south facing slopes to bloom 11 days earlier than those on north facing slopes (Jackson 1966). Coulter (1876) noted that a local *P. bipinnatifida* population was very large but seemed to fluctuate considerably in size—his observation may have been at least partially attributable to the species' biennial cycle but since germination can be deferred for several years (Baskin and Baskin 1988) it is also possible that environmental conditions play a role in triggering seedling emergence.

A threat from the proliferation of invasive flora has been inferred from documented impacts on many other herbaceous plants, although the specific responses of *P. bipinnatifida* to competition have not been examined. Invasive plant species are likely to become an even greater threat in New Jersey as the climate continues to warm. Some of the aggressively competitive species which have already gained a foothold in the northeast are expected to become more abundant (Dukes et al. 2009, Coville et al. 2021, O'Uhuru 2022), and both the northeastern and mid-Atlantic regions are predicted to become hotspots for the establishment of additional nonnative plants (Bellard et al. 2013, Salva and Bradley 2023).

Management Summary and Recommendations

New Jersey's population of *Phacelia bipinnatifida* is particularly significant because it is marks the northeastern limit of the species' range. The viability of the occurrence was initially assessed as excellent in terms of population vigor and habitat quality, although some invasive plants were noted to be present. A decade has passed since the site was last observed and a monitoring visit is recommended to reevaluate the status of the population and habitat conditions. Some action is likely to be needed to control the spread of invasive flora in the area.

Despite the horticultural popularity of *Phacelia bipinnatifida* there are still some gaps in information about the species' life history and ecology. Suggested topics for further research include self-compatibility; possible mechanisms for long-distance dispersal; fungal associations; responses to competition; the role of climactic factors in germination, establishment, and survival; and the effects of fire.

Synonyms

The accepted botanical name of the species is *Phacelia bipinnatifida* Michx. Orthographic variants, synonyms, and common names are listed below (ITIS 2024, POWO 2024, USDA NRCS 2024b).

Botanical Synonyms	Common Names
Phacelia bipinnatifida var. *brevistylis* (Buckley) A. Gray	Fern-leaf Scorpion-flower
Phacelia bipinnatifida var. *plummeri* Alph. Wood	Fernleaf Phacelia

Phacelia brevistyla Buckley	Forest Phacelia
Phacelia simplex Pers.	Purple Phacelia
Endiplus bifidus Raf.	Purple Bee's Friend
Endiplus phacelioides Raf.	

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