# *Sibbaldiopsis tridentata*

**Three-toothed Cinquefoil**

**Rosaceae**

*Sibbaldiopsis tridentata* courtesy R. W. Smith, Lady Bird Johnson Wildflower Center

***Sibbaldiopsis tridentata* 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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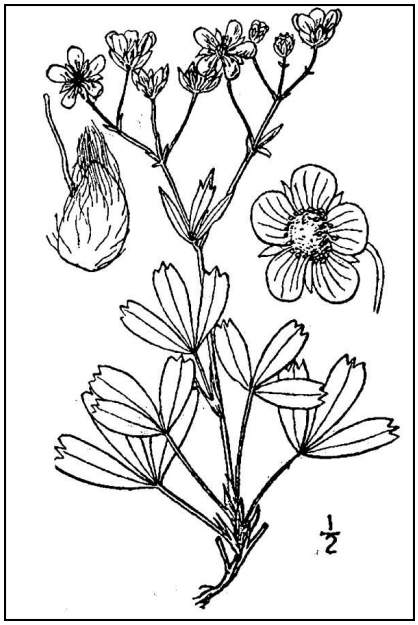
## Life History

Three-toothed Cinquefoil (*Sibbaldiopsis tridentata*) is a perennial plant primarily of boreal and arctic regions. Once considered a member of the Potentilla family it has been reclassified as a member of the Rosaceae. It is a low growing subshrub (10–30 cm tall) often forming mounds or clumps. The stems arise from a caudex, each stem having a somewhat woody base, and the plants readily produce rhizomes and stolons (Chafin 2020; Muma 2012; NatureServe 2024; PNHP 2019; Smreciu et al. 2013).

The alternate, oblong-lanceolate leaves are firm and evergreen, with toothed margins. Glabrous and shiny dark green above, they are slightly hairy and lighter green underneath. Lower leaves are stalked with a winged stipule sheath and reach 5 cm in length (PNHP 2019); the upper leaves are usually stalkless and tri-foliate, each leaflet having three notched "teeth" at the tip. Those leaves are (0.5–)1–3(–4) x 0.4–1.5(–1.8) cm in length (Gleason and Cronquist 1963; Ertter and Reveal 2020). The older leaves typically turn maroon in the winter (Gleason and Cronquist 1963; LeGrand et al. 2024; Weakley et al. 2024).




Left: Britton and Brown 1913, courtesy USDA NRCS 2024a. Right: Stuart Tingley, 2020.

The small white to pinkish flowers are borne on a separate stalk in flat clusters on panicles of 3 to 25 flowers. The flowering stalk sometimes extends 15 cm in height (PNHP 2019), although is usually shorter. Each flower has five egg shaped petals, (4–)5–8[–11] mm in length, which are longer than the sepals with numerous, often reddish anthers (0.3–0.6 mm) (Ertter and Reveal 2020; Native Plant Trust 2024). The flowers hang downward when fully open (Minnesota Wildflowers 2024). Three-toothed Cinquefoil blooms between June and August, and as early as May in some locations (Gleason and Cronquist 1963; PNHP 2019).

The fruits are dark brown, dry, slightly hairy aggregated achenes that do not split open when ripe, each 1.2–1.5 mm in length. One to five seeds are produced per fruit (Ertter and Reveal 2020; LBJWC 2023; Native Plant Trust 2024; Strausbaugh and Core 1978). Three-toothed

Cinquefoil does not produce clonal plantlets such as bulbils or bulblets (Native Plant Trust 2024).

## Pollinator Dynamics

The flowers of Three-toothed Cinquefoil are insect pollinated and while the pollinators are not known, they are likely to be small bees such as mason bees (*Osmia* spp.), small carpenter bees (*Ceratina* spp.), Halictid bees, and Syrphid flies, similar to those that pollinate other Cinquefoil species (Hilty 2020). Interestingly, there are three bee species from the Eastern United States that are considered specialist bees on plants in the *Potentilla* genus, including *Andrena melanochroa*, *Andrena ziziaeformis*, and *Panurginus potentillae* (Fowler 2016a, b; Fowler and Droege 2020). All three species occur in New Jersey, but it is not known whether they pollinate *S. tridentata*. Three-toothed Cinquefoil is unlikely to rely on those bees for pollination as two of the three bee species are most active earlier in the season (April to May) before *S. tridentata* would be in full bloom, though there is some overlap in phenology. It is also unclear whether *S. tridentata* can self-pollinate as does *Sibbaldia procumbens*, a related boreal plant (Svalbardflora 2020).

## Seed Dispersal

The fruits of *Sibbaldiopsis* are aggregated achenes growing in a stalked cluster with one to five seeds produced per fruit. Each seed is oval, 1 mm long, dry and hairy (Chafin 2020; LBJWC 2023; PNHP 2019). Fruiting occurs from July through September, depending on location (Weakley et al. 2024).

Seed dispersal in *Sibbaldopsis tridentata* is likely to be passive, with the small achenes or seeds spread in precipitation runoff from exposed higher elevation rocks or unintentionally moved by animals. It has been conjectured that the seeds of the related boreal plant *Sibbaldia procumbens* are dispersed occasionally by birds, as its seeds (nutlets) are found in the digestive tracts of Snow Buntings (*Plectrophenax nivalis*) potentially allowing for longer distance dispersal and colonization of new habitats (Svalbardflora 2020). Hilty (2020) hypothesized that other cinquefoils such as Common Cinquefoil (*Potentilla simplex*) may be dispersed when seeds are inadvertently consumed by browsing small mammals such as rabbits (*Sylvilagus* spp.) or groundhogs (*Marmota* spp.) and passed through their digestive tracts. Lastly, wind has been identified as a potential seed disperser for four of six alpine plant species observed in a seed rain study at Franconia Ridge, White Mountain National Forest, NH (Marchand and Roach 1980). Although no seeds of *S. tridentata* were trapped during this experiment, Three-toothed Cinquefoil was identified as a primary component of that plant community, and it might be possible that wind plays a role in dispersal for that species under certain conditions.

Seed production in *S. tridentata* is reported to be low (Chafin 2020). The average number of seeds produced per flower in Marchand and Roach's 1980 study was only 10.3 ±2.9. Optimal germination temperatures were 21–26 °C (70–79 °F), which is considered relatively warm for those high mountain sites. Marchand and Roach (1980) observed germination rates of 52% in

their lab studies with only 6% germination in the field during the first growing season, and 10% germination of seeds that overwintered to sprout the following spring.

In tundra environments, plant dispersal via sexual reproduction is often unreliable (Bliss 1971; Marchand and Roach 1980) and given the low seed production, low germination rates, and poor seed dispersal that Marchand and Roach observed in their study, Three-toothed Cinquefoil faces similar challenges. Instead, Three-toothed Cinquefoil spreads quite well vegetatively by underground rhizomes (Chafin 2020; Hilty 2020; Marchand and Roach 1980; Newcomb 1977) and may only reproduce sexually under optimal conditions (Marchand and Roach 1980).

The seeds of Three-toothed Cinquefoil can be collected from fruiting stalks and air dried, then stored in sealed, refrigerated containers, as cold/moist stratification is required for six weeks up to three months (LBJWC 2023; Schultz et al. 2002). Seeds lose viability after one year in storage (Smreciu et al. 2013). Seeds sown in the fall are reported to germinate the following spring but do not flower for two years (LBJWC 2023). The North Carolina Extension Gardener Plant Toolbox website (2024) suggests that plants can live up to ten years under ideal conditions. It is not known how this applies to wild populations but the fact that New Jersey's single known population is still extant after more than 100 years illustrates the potential longevity of a population if not individual plants.

## Habitat

Range wide, the plant favors rocky or gravelly soil (often slightly acidic with a pH of < 6.8) on exposed bedrock outcrops, in rock crevices, or along rocky shores. It also occurs in openings in grassy balds and high elevation glades, dry meadows in montane conifer forests, and alpine tundra (Britton and Brown 1913; Ertter and Reveal 2020; PNHP 2019; Weakley et al. 2024; Werier et al. 2024). In Alberta, Canada *S. tridentata* is reported from pine woods and dry sandy soil (Smreciu et al. 2013) and in Ontario, Canada it is found in fields and open areas (Muma 2012). Somewhat tolerant of thin, dry soil, it can survive in anthropogenic or disturbed habitats (Native Plant Trust 2024) in areas with little competition (LBJWC 2023).

Three-toothed Cinquefoil has been found growing in soils over mafic and felsic metamorphic rocks (Virginia Botanical Associates 2024) and sedimentary quartzite conglomerate rock (Niering 1953), and range wide at elevations ranging from 0 to 1900 m (6233 feet) (Ertter and Reveal 2020), although along the central and southern Appalachian Mountains south to Georgia it is found growing mainly above 1158 to1219 m (3800 to 4000 ft) on exposed outcrops (Strausbaugh and Core 1978; LeGrand et al. 2024). With a heliophily ranking of 9, Three-toothed Cinquefoil requires full sun and an open canopy (> 50%) (Weakley et al. 2024). The New Jersey population of Three-toothed Cinquefoil is growing in full sun on a mountain summit in the rocky soil that has accumulated between rock outcrops (Niering 1953). The surrounding habitat was described as dry, exposed rock outcrops and scrub thickets mixed with grass in open non-rock areas (NJNHP 2024).

Widespread in northern boreal habitat, Three-toothed Cinquefoil is confined to higher elevation rocky outcrops south along the spine of the Appalachian Mountain Range. This distribution

pattern in the east is thought to be an artifact of past glacial periods, with glacial retreat isolating those higher elevation populations (Niering 1953). Genetic analysis by Bresowar and Walker (2011) showed that *S. tridentata* populations along the Appalachian Mountains exhibit genetic similarities throughout. In contrast, there is a genetic discontinuity with populations west of the Appalachians as they are separated by the Valley and Ridge Province, an important barrier to gene flow.

In a literature survey of mycorrhizal occurrence among land plants, thirteen species of *Potentilla* were found to have an association with arbuscular mycorrhizal (AM) fungi (Wang and Qiu 2006). In addition, the closely related *Sibbaldia procumbens* has both AM-associated populations and others that are nonmycorrhizal. Although *Sibbaldiopsis tridentata* was not included in the survey, the species likely exhibits a similar association with arbuscular mycorrhizal fungi.

## Wetland Indicator Status

*Sibbaldiopsis tridentata* is a facultative upland species, meaning that it usually occurs in nonwetlands but may occur in wetlands (U. S. Army Corps of Engineers 2020).

## USDA Plants Code (USDA, NRCS 2024b)

SITR3

## Coefficient of Conservancy (Walz et al. 2020)

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 native range of *Sibbaldiopsis tridentata* extends from the eastern United States north to Greenland (POWO 2024). The map in Figure 1 depicts the extent of the species throughout its range.

The USDA PLANTS Database (2024b) shows records of *Sibbaldiopsis tridentata* in one New Jersey county: Sussex County (Figure 2). The map reflects the known state distribution of the species.

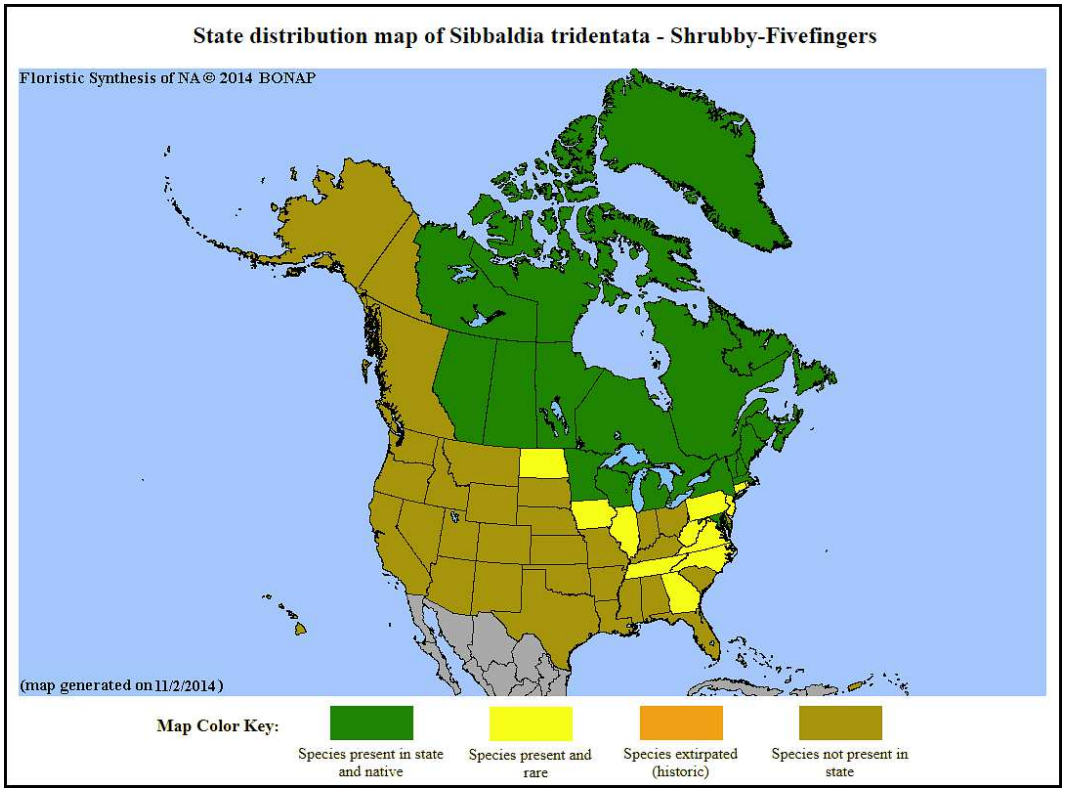



*Figure 1. Distribution of S. tridentata in North America, adapted from BONAP (Kartesz 2015).*

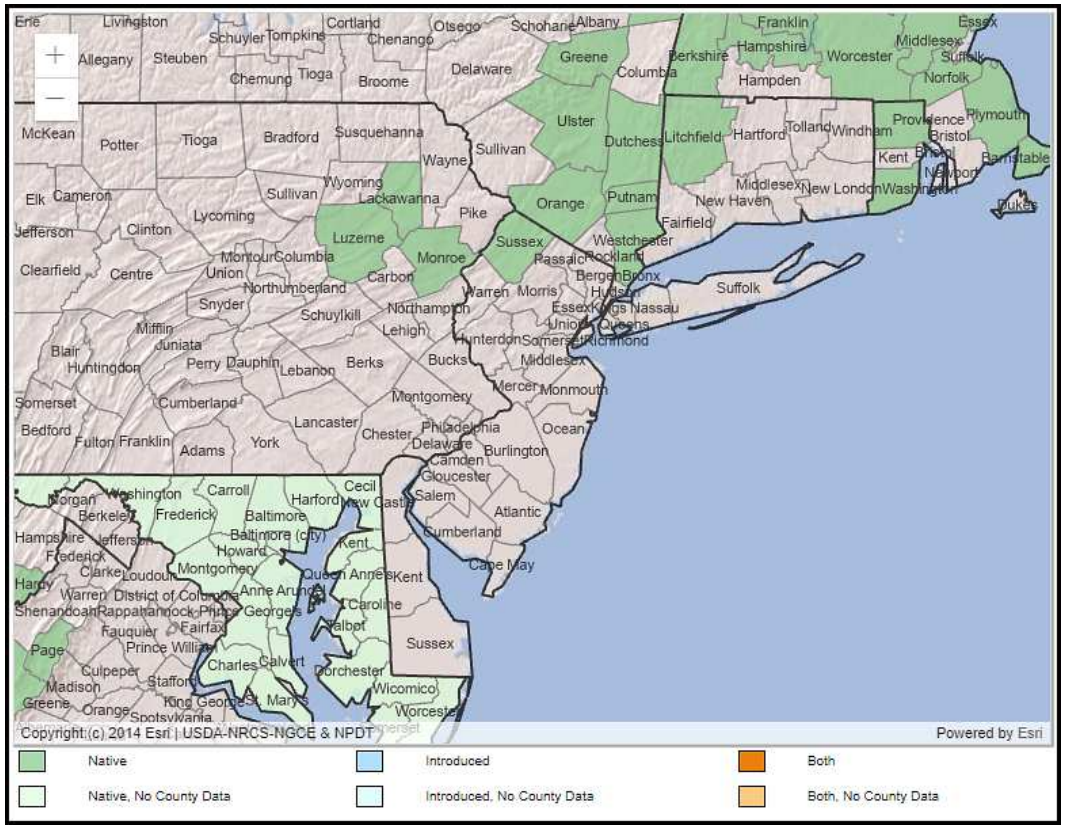



*Figure 2. County records of S. tridentata in New Jersey and vicinity (USDA NRCS 2024b).*

## Conservation Status

*Sibbaldiopsis tridentata* 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 *Sibbaldiopsis tridentata* in Canada and the United States. Three-toothed Cinquefoil is considered secure or apparently so throughout much of central and eastern Canada, and it has not been ranked in a number of states where it occurs. However, the species is vulnerable (moderate risk of extinction) in one state and three provinces, imperiled (high risk of extinction) in three states, critically imperiled (very high risk of extinction) in six states, and possibly extirpated in Rhode Island.

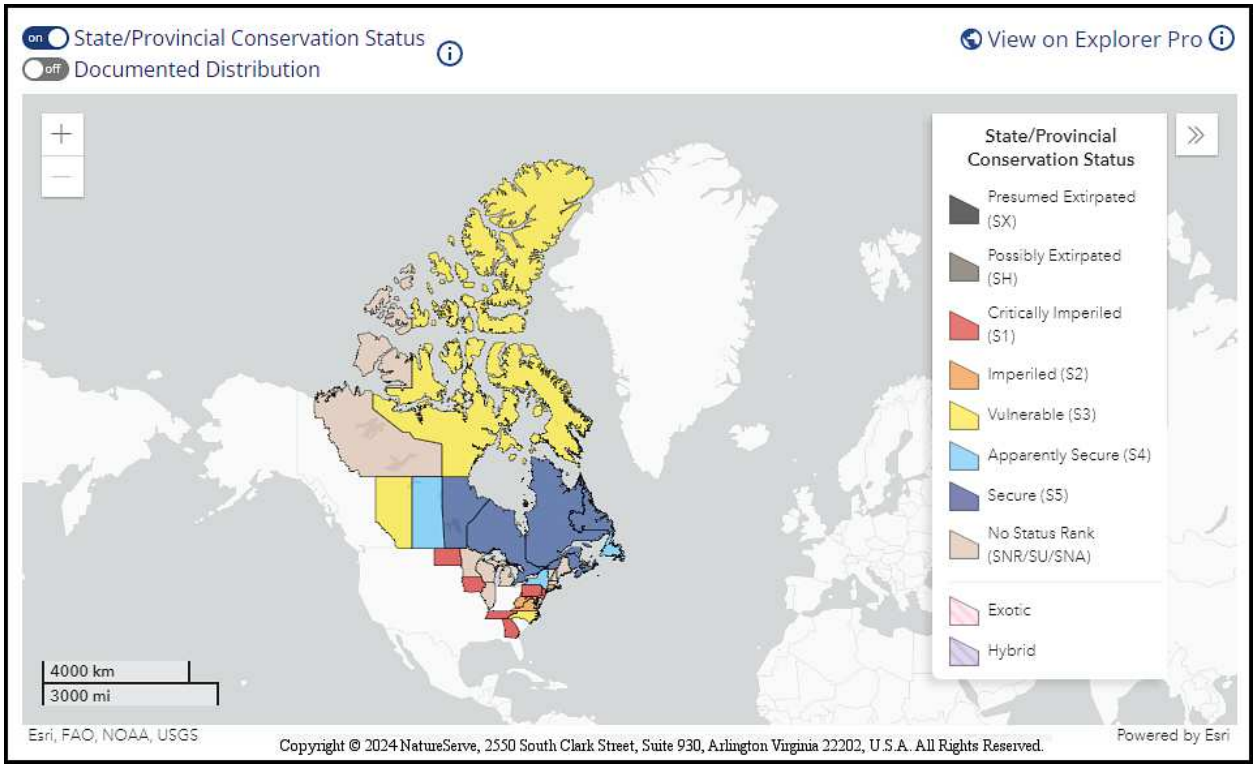



*Figure 3. Conservation status of S. tridentata in the United States and Canada (NatureServe 2024).*

*Sibbaldiopsis tridentata* 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. *S. tridentata* 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, being listed does not currently provide broad statewide protection for the plants. Additional regional status codes assigned to *S. tridentata* 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).

New Jersey records of *Sibbaldiopsis tridentata* date back to 1858 when a population was discovered by Austin in Sussex County (Britton 1889). Nearly a century after *S. tridentata* was documented it was still only known from the original location (Fables 1956), and it was among the first species in the state to be identified as endangered (Fairbrothers and Hough 1973). Despite the fact that its habitat at the site was thought to be fragile due to fairly heavy foot traffic (Fables 1956; Fairbrothers and Hough 1973), the original population of *S. tridentata* continues to persist and it remains the sole known New Jersey occurrence (NHNHP 2024).

## Threats

In New Jersey, the main threat to the persistence of the single population of *S. tridentata* is heavy trampling by foot traffic, as noted during the three most recent site visits (2021–2023). In addition, the placement of a park bench over top of plants in the New Jersey population, as observed during the 2021 site visit, increased the likelihood of trampling. Invasive species are a second threat with the presence of two species observed in 2021 in the vicinity of the Three-Toothed Cinquefoil population—a non-native *Sedum* sp. and Morrow's Honeysuckle (*Lonicera morrowii*) (NJNHP 2024).

Although *S. tridentata* populations in some locations have been found to be somewhat tolerant of disturbance (via survival of underground rhizomes [Marchand and Roach 1980]) and the species has been used for cliff and cliff-edge restoration in Minnesota (Olfelt et al. 2009), small, isolated populations at the periphery of the range remain vulnerable. As in New Jersey, trampling has been identified as a threat to higher elevation *S. tridentata* populations in other areas (NatureServe 2024). For example, Chafin (2020) mentioned rock climbing and other recreational activity as threats to Georgia's high elevation populations, with those activities also serving as a conduit for invasive plant seed dispersal via the boots of hikers.

Habitat succession and related shading are other threats affecting populations in some areas (NatureServe 2024). The New Jersey population is located mainly among rock outcrops in an open summit area and succession per se has not been identified as a challenge to date. However, the encroachment of non-native shrubs may have the potential to shade and outcompete Three-Toothed Cinquefoil plants in portions of the population. Habitat loss to development, particularly of high-altitude vistas, and the placement of cell phone towers in areas that also support *S. tridentata* populations are considered threats in Georgia (Chafin 2020). The presence of the New Jersey population on protected park land limits the likelihood of future development pressure.

Herbivory has not been identified as a major threat in the literature. Related cinquefoils have relatively low wildlife value, with Ruffed Grouse (*Bonasa umbellus*) mentioned as occasionally consuming seeds and plants infrequently browsed by Eastern Cottontails (*Sylvilagus floridanus*) and White-tailed Deer (*Odocoileus virginianus*) primarily during late winter and early spring (Miller and Miller 2005). No signs of herbivory of Three-toothed Cinquefoil have been observed yet at the New Jersey population.

New Jersey's only population of *S. tridentata* has persisted at this site since 1858, and though genetically isolated, the isolation does not appear to have affected its longevity. Site visits since

1980 continue to indicate the population's abundance and stability, with observations from 1993 and 2001estimating 10% flowering and confirmed fruiting in other years (NJNHP 2024), although the germination rate of those seeds is unknown. While vegetative reproduction may be more common in this species, with sexual reproduction only occurring under optimal conditions (Marchand and Roach 1980), it is still important—especially for a population as small and isolated as this one. Disease has not been observed in the New Jersey population or mentioned in the literature as a significant threat elsewhere in the range of the species.

## Climate Change Vulnerability

Information from the references cited in this profile was used to evaluate the vulnerability of New Jersey's *Sibbaldiopsis tridentata* 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 *S. tridentata* was assessed as Extremely Vulnerable, meaning that climate change is expected to have a notable detrimental impact on its extent in New Jersey by 2050. This conclusion was reached with high confidence, based information regarding the species' ecological requirements, its limited dispersal capacity, and the fact that only a single population remains in the state.

As Hilty (2020) plainly stated, "Because this [*Sibbaldiopsis tridentata*] is a boreal species, it dislikes excessive heat during the summer" and this temperature sensitivity restricts southern populations to high elevation sites (Chafin 2020). New Jersey is the fastest warming state in the Northeast and third fastest in the country (Howard 2024) and even its higher elevations (where *S. tridentata* is found) are not immune from the effects of rising temperatures. *S. tridentata* populations in more northern regions are responding to warming temperatures. For example, research on populations on Cadillac Mountain, Acadia National Park, ME found that leaf out in populations of Three-toothed Cinquefoil is responding to yearly temperature changes as well as microclimate conditions at different elevations (MacKenzie et al. 2018).

Nadeau et al. (2017) posit that plant species living in places with high spatial climatic variation such as mountainous regions should be less vulnerable to climate change. However, they suggest that "small populations currently restricted to isolated mountaintops are likely to be an exception." Given that, New Jersey's isolated mountain top population may be more vulnerable than others to a warming climate.

Climate change in New Jersey is projected to lead to warmer temperatures and altered precipitation patterns with summer droughts becoming more common (Hill et al. 2020). Those changes may negatively affect reproduction in *S. tridentata* as the seeds require cold stratification to break dormancy. Seed production and germination rates under natural conditions are already low (Marchand and Roach 1980) such that any changes that might cause further reductions could affect population viability in New Jersey regardless of how much vegetative spread is possible. Additionally, while *S. tridentata* is adapted to living on exposed rocky outcrop summits that can be droughty, there may be a limit to that tolerance as the extent and/or timing of droughty periods shifts.

Changes in future climatic conditions may also increase the threat of new invasive plant species encroachment into the state (Bellard et al. 2013; Coville et al. 2021; Salva and Bradley 2023; O'Uhuru 2022) as plant ranges shift in response to altered abiotic conditions. This could further reduce habitat suitability if any of those species become established in the vicinity of the *S. tridentata* population.

## Management Summary and Recommendations

The New Jersey population has been regularly monitored over the years due to its rarity, and as the only extant population in the state, continued monitoring is highly recommended. Although the population of *S. tridentata* is found on protected land, its location in a heavily trafficked area is challenging population persistence. A recent (2023) site visit confirms that trampling is ongoing and worsening (NJNHP 2024). It would be important to work with park managers to better protect the plants from trampling or other human activities that damage plants, and perhaps encourage park visitors to rest or explore elsewhere away from the population.

The encroachment of invasive species should be closely monitored, with control or removal implemented early, before they become too difficult to remove. Three-toothed Cinquefoil grows in the soil-filled cracks between outcrops and colonization of aggressive invasive plants would severely reduce the amount of available soil for *S. tridentata* germination, growth, and spread. In some locations, habitat succession is a challenge to the persistence of *S. tridentata* populations. The Pennsylvania Natural Heritage Program (2019) has recommended active management, including the use of prescribed fire to maintain or create habitat for this species, although that may not be applicable to New Jersey given the outcrop location of the population.

Additional research on optimal conditions for pollination and seed set at this location, and the genetics of New Jersey's population would be important. More details about seed viability and dispersal capacity generally, confirming whether plants are self-compatible as found in related *Sabbatia procumbens*, and whether *S. tridentata* does have any mycorrhizal associations would all be useful. A better understanding about the species generally and this population in particular will help to determine how best to ensure the continued persistence this population of Three-toothed Cinquefoil, particularly in light of climate change.

## Synonyms

The accepted botanical name of the species is *Sibbaldiopsis tridentata* (Aiton) Rydb. Some orthographic variants, synonyms, and common names are listed below (Clemants and Gracie 2006; ITIS 2024; POWO 2024; USDA NRCS 2024b). The name *Sibbaldia tridentata* is used by some current sources (eg., Kartesz 2015; POWO 2024).

| **Botanical Synonyms** | **Common Names** |
|---|---|
| *Potentilla tridentata* Aiton | Three-toothed Cinquefoil |
| *Sibbaldia tridentata* (Aiton) Paule & Soják | Shrubby Fivefingers |

| | |
|---|---|
| *Potentilla retusa* O. F. Müll. | Mountain Cinquefoil |
| *Sibbaldia retusa* (O. F. Müll.) T. Erikss. | Mountain White Cinquefoil |
| *Trichothalamus tridentatus* (Aiton) Spreng. | Wine-leaf Cinquefoil |
| | Wineleaf Potentilla |
| | White Sibbaldia |

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