New England Plant Conservation Program

Conservation and Research Plan

Triphora trianthophora (Swartz) Rydb.
Three-birds Orchid

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SUMMARY

Triphora trianthophora (Swartz) Rydberg (Ochidaceae), three-birds orchid or nodding pogonia, is represented by 24 current occurrences in New England. *Triphora trianthophora* is protected as a threatened (T) or endangered (E) species in Maine (T), Vermont (T), New Hampshire (T), and Massachusetts (E); it is thought to be extirpated in Connecticut. It is a Division 2a plant species according to the *Flora Conservanda:* New England of the New England Plant Conservation Program. There are also several undocumented occurrences in New Hampshire. Recent fieldwork indicates that three of the occurrences may be extirpated, and only ten occurrences had greater than 100 stems at the most recent survey. Current occurrences represent about half of all known current and historic occurrences. The orchid is also rare and threatened in much of its range in North America; it is an S1 or S2 species in 19 of the 30 states in which it occurs and in Ontario.

In New England, the orchid typically occurs in moist hardwood forests dominated by beech in conditions of filtered light. Plants frequently grow in hollows filled with deep leaf litter with few or no other herbaceous plant species co-occurring. *Triphora trianthophora* is thought to depend upon mycorrhizal relationships and to act as a semi-saprophyte. The orchid is ephemeral, with stems appearing above ground and flowering during a short period in late summer. Stems do not appear above ground each year; plants may persist as subterranean tuberoids for extended periods. The long-term persistence of the species likely depends upon the presence of appropriate light, moisture, soil, and leaf litter conditions, as well as conditions that are conducive to the development of mycorrhizal and saprophytic relationships. Development, timber harvest, habitat alteration, and changes that disrupt the orchid's biology or habitat are substantial threats to the taxon. In addition, the small size of many populations makes them vulnerable to stochastic events that may destroy populations, and the cryptic nature of the orchid makes it especially vulnerable to inadvertent disturbance. These threats were contributing factors in the extirpation of historic occurrences and continue to affect extant occurrences.

The conservation objectives of this Conservation and Research Plan are to:

1. Maintain, at a minimum, the existing occurrences at their current population levels;
2. Search for previously undocumented occurrences and protect any newly found populations when possible;
3. Identify and protect promising habitat that could support the orchid
4. Evaluate the possibility of augmentation, introduction, and reintroduction of the orchid.

Conservation actions that must be taken to meet these conservation objectives include: land acquisition or protection; regular surveys of occurrences; *de novo* searches for new populations; species biology research; habitat management; *ex-situ* activities; evaluation of reintroduction; and education.

PREFACE

This document is an excerpt of a New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. Full plans with complete and sensitive information are made available to conservation organizations, government agencies, and individuals with responsibility for rare plant conservation. This excerpt contains general information on the species biology, ecology, and distribution of rare plant species in New England.

The New England Plant Conservation Program (NEPCoP) is a voluntary association of private organizations and government agencies in each of the six states of New England, interested in working together to protect from extirpation, and promote the recovery of the endangered flora of the region.

In 1996, NEPCoP published "*Flora Conservanda*: New England," which listed the plants in need of conservation in the region. NEPCoP regional plant Conservation Plans recommend actions that should lead to the conservation of *Flora Conservanda* species. These recommendations derive from a voluntary collaboration of planning partners, and their implementation is contingent on the commitment of federal, state, local, and private conservation organizations.

NEPCoP Conservation Plans do not necessarily represent the official position or approval of all state task forces or NEPCoP member organizations; they do, however, represent a consensus of NEPCoP's Regional Advisory Council. NEPCoP Conservation Plans are subject to modification as dictated by new findings, changes in species status, and the accomplishment of conservation actions.

Completion of the NEPCoP Conservation and Research Plans was made possible by generous funding from an anonymous source, and data were provided by state Natural Heritage Programs. NEPCoP gratefully acknowledges the permission and cooperation of many private and public landowners who granted access to their land for plant monitoring and data collection.

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I. BACKGROUND

INTRODUCTION

Triphora trianthophora (Swartz) Rydb. (Orchidaceae) –Three-birds orchid, (also known as Nodding pogonia) – is an elusive orchid occurring in hardwood forests often dominated by beech (*Fagus grandifolia*). In New England, the orchid grows most commonly in hollows filled with deep leaf litter. Few herbaceous species co-occur immediately adjacent to the plant. Moisture conditions are typically mesic, and light conditions are filtered. Although no specific studies exist, numerous investigators assume that *T. trianthophora* depends upon mycorrhizal relationships and is a semi-saprophyte. The orchid is ephemeral; stems appear aboveground and flowering takes place for a brief period in late summer. Pollination is infrequent. Little is known about seed dispersal or seedling establishment. The plant may rely heavily on vegetative reproduction via tuberoids. Plants may exist for numerous years as subterranean tuberoids and produce aboveground stems only at infrequent intervals.

Triphora trianthophora ranges widely from Ontario, Canada into New England, south to Florida, as far west as Wisconsin, south to Texas, and into Central America (Luer 1975). Despite this relatively broad range, *T. trianthophora* is sparsely distributed throughout much of its range in North America. In the United States, the orchid is rare to very rare at the northern edge of its range and becomes more frequent in the south central United States and Appalachian Mountains (Case 1964). According to Natural Heritage Program ranks, the taxon is an S1 species (critically imperiled in a state, typically with five or fewer occurrences or very few remaining individuals) or an S2 species (imperiled in a state, typically with six to 20 occurrences or few remaining individuals) in 19 of the 30 states and in the one Canadian province from which it is currently known (Association for Biodiversity Information 2000). The species receives protection as an endangered or threatened species in 13 states and in Ontario. In New England, *T. trianthophora* is listed in *Flora Conservanda* as a Division 2a species (greater than 20 current occurrences, but with a substantial number with a small number of individuals) (Brumback and Mehrhoff et al. 1996). The taxon occurs in Maine (S1; T), Vermont (S1; T), New Hampshire (S2; T), and Massachusetts (S1; E), and it is believed to be extirpated from Connecticut.

Threats to *Triphora trianthophora* include: development; timber harvest; habitat alteration due to road maintenance; alteration of appropriate light and moisture regimes; disruption of an adequate leaf litter layer and appropriate soil conditions; disruption of mycorrhizal and saprophytic relationships; competition from understory species; changes in canopy composition; stochastic events affecting small populations; low genetic diversity; inadvertent trampling; herbivory; and collection. Several of these threats likely caused the

demise of historic occurrences, resulted in suspected extirpation from one New England state (Connecticut), and continue to threaten many extant populations.

A Conservation and Research Plan for *Triphora trianthophora* is necessary to encourage the immediate and long-term persistence of the orchid in New England. Although there are technically 24 current occurrences in New England, Natural Heritage Program data indicate that there may be as few as 20 extant occurrences. Only ten of the current occurrences had greater than 100 stems at the most recent survey. Additionally, there are substantial threats facing the orchid, and the taxon appears to require specific habitat conditions. *Triphora trianthphora* is relatively rare in New England and throughout much of the United States. Additionally, *T. trianthophora* is the only member of the genus found in New England. The species' rarity in New England and throughout the United States, threats to the taxon and its habitat, and its taxonomic uniqueness serve as rationale for developing this New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. The goals of the plan are to compile existing information on the taxon and to provide a framework for long-term conservation of *T. trianthophora* in New England. This two-parted plan provides background information on the taxonomy, biology, ecology, distribution, and status of *T. trianthphora* in the first section. The second section uses this information to develop conservation objectives, general conservation actions for the taxon, recommended conservation actions for each occurrence, and a prioritized implementation schedule for the actions.

DESCRIPTION

Triphora trianthophora, a species within the Orchidaceae, is an herbaceous perennial plant of moist woods. The fleshy, delicate stems are glabrous and range in height from 5-30 cm with 3-5 alternate, ovate leaves (1-2 cm in length) that clasp the stem. Shortly before blooming, the stems arise from elongate tuberoids attached to short, slender stolons; tuberoids produce stems sporadically from year to year. The stems are nodding as they emerge, and straighten as they grow. Each stem typically produces from one to three small (1.5-2 cm), axillary flowers in a raceme; each of the white to pinkish flowers is fully open and fresh for a single day. A stem usually produces a single mature flower on a given day, and blooming tends to be synchronous with most stems in a population producing a mature flower on a given day. The sepals and lateral petals are free, ascending, and similar in appearance; the labellum (lip) is obovate and three-lobed with three small, longitudnal green ridges. An ovate bract subtends each flower. The anther is erect at the end of the column and has two pollinia. The anther has red-purple flanges, and the pollen is purple. When a fruit is produced, the capsule contains thousands of minute seeds. Description of *T. trianthophora* is based on information from Fernald (1950), Martin (1983), Gleason and Cronquist (1991), Homoya (1993), Williams (1994), Brown (1997), MDCNAD (1999).

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

Triphora trianthophora (Swartz) Rydberg is one of 10 species in the genus *Triphora* worldwide (Medley 1996). The genus has long posed taxonomic challenges, but Dressler (1986) places the genus within the Tribe Triphorae in the subfamily Epidendroideae. The Tribe Triphorae is likely a relic group with no very close allies (Dressler 1981). The genus is tropical in origin, with species found primarily in Central America and South America. *Triphora trianthophora* is the only member of the genus found in New England, and it is the only species found north of subtropical southern Florida (Homoya 1993). Two subspecies are recognized: *Triphora trianthophora* subsp. *trianthophora* and *Triphora trianthophora* subsp. *mexicana* (Medley 1991). Subspecies *mexicana* does not occur in the United States (Brown 1997). Throughout this document, *Triphora trianthophora* subsp. *trianthophora* will be referred to as *Triphora trianthophora*. A specimen with erect capsules was designated as the variety *schaffneri* Camp (Camp 1940). However, this is not a genuine variety; erect capsules eventually develop on all stems producing fruits (Homoya 1993), and it is considered a synonym by Kartesz and Kartesz (1980). An albino form, forma *albidoflava* Keenan, has been described from one locality in New Hampshire (Keenan 1992).

Luer (1975) provides a comprehensive overview of the synonomy of *T. trianthophora*. The orchid was originally described as *Arethusa trianthophoros* Swartz in 1800. Subsequent taxonomic revisions were: *Arethusa parviflora* Michaux in 1803; *Arethusa pendula* Muhlenberg ex Willdenow in 1805; *Triphora pendula* (Muhlenberg ex Willdenow) Nuttall in 1818; *Pogonia pendula* (Muhlenberg ex Willdenow) Lindley in 1825; *Pogonia trianthophorus* (Swartz) Britton, Sterns & Poggenberg in 1888; and the current specific epithet, *Triphora trianthophora* (Swartz) Rydberg in 1901. The genus *Triphora* differs from the genus *Pogonia* in column morphology, features of the pollinia, and by producing stolons, which *Pogonia* does not (Homoya 1993). In a systematic study of 210 orchid genera, the genus *Triphora*, along with *Goodyera* and *Elythranthera*, exhibited endothecial cell thickenings in anthers (a useful taxonomic character) that were intermediate between the recognized types characteristic of other orchid genera (Freudenstein 1991). Based on an examination of the literature, Brackley (1985) indicates that *T. trianthophora* has a diploid chromosome number of $2n=18$. However, Dressler (1981) states that members of the Tribe Triphorae have 44 rather small chromosomes.

SPECIES BIOLOGY

Triphora trianthophora appears aboveground from fleshy, belowground structures, referred to most accurately as tuberoids (Williams 1994), for a short period in late summer during flowering and into the fall if a fruit develops. In addition to its ephemeral aboveground existence of approximately one month from flowering to fruiting within a year, substantial fluctuations in aboveground population size occur from year to year (Williams 1994). Periodic dormancy may result in a site containing hundreds of aboveground stems in some years and few

or no stems in other years (Porcher 1977, Keenan 1986, Homoya 1993, Williams 1994). During an intensive six-year study of 25 sites at one Massachusetts population, total population size fluctuated from approximately 50 plants to 300 plants (Williams 1994). In addition, tuberoids were located in the litter in potential sites where plants had never been observed before, and, subsequently, plants appeared aboveground. Sporadic shoot production makes accurate assessment of population size extremely difficult (Williams 1994).

Individuals within a population may persist for years underground as tuberoids. In fact, most plants appear not to produce a shoot in any given year and instead remain underground (Williams 1994). One occurrence in a well-botanized location in South Carolina was last observed in about 1850 and then seen again in 1975; this rediscovery may be the result of the successful subterranean existence of the orchid via its tuberoids (Porcher 1977). These tuberoids are thickened underground storage structures resembling tubers, but with structural differences (Williams 1994); true tubers do not exist within the Orchidaceae (Dressler 1981). The primary tuberoid contains the apical bud that has the ability to form a new shoot each year. Axillary buds form secondary tuberoids at the end of slender stolons (Williams 1994). The species reproduces asexually by the production of new, secondary tuberoids arising from the plant's primary tuberoid. The secondary tuberoids can separate from the primary tuberoid and produce new, independent stems. Stolons are fragile and near the litter surface and are likely to break as a result of physical forces (Williams 1994). The longevity of colonies of the orchid is not known, but Case (1987) reports a colony in Michigan that has persisted for a minimum of 30 years, and Keenan (1998) notes that one colony in New Hampshire has persisted for at least 70 years.

Flowering in *Triphora trianthophora* occurs from late July until mid-September throughout the United States (Homoya 1993), and typically in August in New England (Brown 1997). There is general consensus that each flower remains open and viable for pollination for a single day (Keenan 1986, Homoya 1993, Williams 1994,). Lownes (1920), however, suggests that blossoms last for three or four days if not fertilized. As with many orchids, pollination does not appear to occur frequently. Each plant tends to have one flower open at a time in synchrony with other plants in the population (Homoya 1993). Acccording to Luer (1975), all mature buds open simultaneously on a given day. The order of opening appears to be erratic, with the top, middle, or bottom buds opening in any order (Keenan 1990). A drop in night-time temperatures often precipitates mass flowering in a population approximately two days later; however, flowering may occur without a drop in night-time temperatures (Luer 1975). Because of synchronous flowering, a single day of flowering for each flower, and the relatively small number of buds per stem, there may be only a few days of mass flowering during the approximately month-long blooming period (Keenan 1998). Triggers for flowering in *T. trianthophora* are likely complex and may involve thermoperiodicity (Luer 1975). A six-year study at a Massachusetts site revealed that the majority of stems produce either one or two flowers, less than 10% of the stems produce no flowers or three flowers, and about 1% of the stems produce four flowers. There is a significant positive relationship between primary tuberoid size and flowering in *T. trianthophora*. At a Massachusetts site, tuberoids producing

flowering stems ranged from about 0.4 cm to 2.8 cm; tuberoids producing stems with no flowers, hyaline stems (underground stems), or no stems at all were significantly shorter than those tuberoids producing flowering stems (Williams 1994). Although the relationship between primary tuberoid size and flowering is potentially useful in understanding patterns of aboveground stem density and in conservation efforts, Williams (1994) restricted the examination of tuberoids due to the likely detrimental effects of such disturbance on plants.

Little is known about potential pollinators of *Triphora trianthophora* (Williams 1994). Lownes (1920) identified the bee *Halictus quadrimaculatus* as a pollinator of the orchid. Floral visitors were observed on only two occasions in six years at a Massachusetts site. One visitor was likely a small species of bumblebee (*Bombus*) that entered the flower and exited with a pollinium attached. The other visitor was a smaller bee possibly of the genus *Hylaeus*; pollinium removal did not occur in this visit (Williams 1994). Low pollination levels are likely partially the result of the short duration (one day) of floral longevity (Williams 1994). However, the gregarious flowering habit within a population may increase the likelihood of pollination (Luer 1975).

When pollination and fertilization do occur, capsule development and seed dispersal occur within approximately one month (Keenan 1998). Capsule production, as a percentage of bud production, was less than five percent in each of five years at a site in Massachusetts. Maturation of capsules was 95%; those capsules that did not mature were lost to herbivory (Williams 1994). The minute seeds are likely wind-dispersed; however, no published information is available on patterns of seed dispersal for the orchid. Dressler (1981) notes that most orchids have seeds well suited for wind dispersal. While the majority of seeds are likely to fall close to the parent plant, some seeds may occasionally be dispersed over long distances. *Triphora trianthophora* has typical tiny, dustlike seeds that could be wind dispersed. Although there is no published information available on seedling establishment, it does not seem likely that seedling establishment rates are high. For any orchid, seeds must be dispersed to locations with appropriate physical conditions and then encounter appropriate fungi to form mycorrhizae (Dressler 1981). Because pollination, seed production, and seedling establishment do not appear to occur frequently, asexual reproduction via secondary tuberoids is likely to be the primary means of reproduction in *T. trianthophora*. Emphasis on vegetative reproduction rather than sexual reproduction may result in decreased genetic variability in *T. trianthophora* (Williams 1994).

Mycorrhizal associations are likely important in various phases of the lifecycle of *Triphora trianthophora* and may enable the plant to act as a saprophyte (Keenan 1986, Homoya 1993, Williams 1994), although there are no known published studies documenting this aspect of its biology. Dressler (1981) indicates that all orchids typically have a saprophytic stage during seedling development. The largely subterranean existence of *T. triphora* and its small photosynthetic surface during its brief aboveground appearance suggest that non-photosynthetic sources of carbon are critical to the species. For this reason, Case (1964) refers to *T. trianthophora* as a semi-saprophyte. Williams (1994) provides an integrated view of

several aspects of the life history, biology, and habitat of *T. trianthophora*. She notes that the orchid initiates shoot growth and flowers in the late summer under a full canopy characterized by low light levels, high soil temperatures, and low nutrient and water availability. Unlike spring ephemerals in the deciduous forest that grow and reproduce primarily prior to canopy closure, shade-tolerant species such as *T. trianthophora* carry out most growth under a closed canopy. The plant may be successful in this seasonally stressful environment in part because its mycorrhizal associations may enable it to meet its energy and nutrient requirements. Its reduced leaves may indicate diminished photosynthetic capacity, and much of its existence is spent underground. *Triphora trianthophora* is closely associated with *Fagus grandifolia,* and the orchid may be receiving nutrients and photosynthates from beech trees via mycorrhizal fungi connected both to the beech tree and the orchid. Williams (1994) cites several examples of three-way associations among orchids, mycorrhizal fungi, and adjacent trees. Several associated species are saprophytic or parasitic as well: *Epifagus virginiana, Corallorhiza maculata,* and *Monotropa uniflora*.

Herbivory by slugs, insects, rodents, and deer can completely destroy aboveground portions of the plant (Keenan 1986, Williams 1994). Entire plants are consumed occasionally by chipmunks; their tunnels occur under former clumps of *Triphora,* with no trace of stems or tuberoids remaining. Slugs chew through stems and sometimes consume buds and also occur on the tuberoids. The impact of herbivory on a population level is unknown.

HABITAT/ECOLOGY

In New England, *Triphora trianthophora* grows most commonly in moist, beech-dominated woods in hollows filled with substantial leaf litter. The species occurs in mixed northern hardwood forests and central New England mesic transitional forests. Williams (1994) contends that *Triphora trianthophora* is always associated *with Fagus grandifolia* in New England. There are typically few or no co-occurring herbaceous species growing immediately adjacent to the plants. Elevation at extant New England sites typically ranges from approximately 200 to 900 feet (61-274 meters); three sites occur from 1250 to 1420 feet (381-433 meters) in elevation. Soil is usually acidic at New England sites, but can be calcareous. The species is noted from rich woods in some regions of the United States. Light conditions are typically filtered. Appropriate light, moisture, soil temperature, and mycorrhizal and saprophytic relationships are likely to be especially critical to the persistence of the species.

Elsewhere in the United States, *Triphora trianthophora* occurs from sea level in Florida to 6,000 feet (1829 meters) in North Carolina. It grows on rich humus in moist woods; it can be found on decaying logs, along streams, in floodplain forests, and on steep mountain slopes (Porcher 1977). In South Carolina, *T. trianthophora* occurs in the coastal plain in mixed mesophytic hardwood forests, where dominant tree species include *Fagus grandifolia, Liriodendron tulipifera, Quercus alba, Q. falcata, Q. michauxii, Liquidambar styraciflua,* and *Carpinus caroliniana*. Co-occurring herbaceous species include *Corallorhiza*

wisteriana, C. odontorhiza, Goodyera pubescens, Sanguinaria canadensis, Asarum canadense, Podophyllum peltatum, Obolaria virginiana, Amsonia tabernaemontana var. salicifolia, Thaspium barbinode, Thalictrum thalictroides, and *Uvularia perfoliata.* In Indiana, *T. trianthophora* grows in rich mesophytic woodlands with dominants such as *Fagus grandifolia, Quercus rubra, Liriodendron tulipifera, Acer saccharum*, and *Juglans nigra*. Co-occurring herbaceous species include *Actaea alba, Amphicarpaea bracteata, Brachyelytrum erectum, Carex hirtifolia, Desmodium nudiflorum, Dryopteris marginalis, Epifagus virginiana, Galium triflorum, Hydrophyllum appendiculatum, Osmorhiza pumila, Podophyllum peltatum,* and *Polystichum acrostichoides.* Soils typically have a high organic matter content, and adequate moisture and shade are necessary. The species tends to occur on gentle slopes. However, plants grow also in mesic floodplain forests, borders of swamps, and one colony grows on a bare, sandy flat in a wooded ravine (Sheviak 1974, Homoya 1993). In the western Great Lakes region, the orchid grows in *Fagus grandifolia* and *Acer saccharum* woodlands or mixed deciduous forests in pockets of deep humus. The orchid is never found on predominantly mineral soil. It is occasionally reported from sphagnum bogs or mixed forest borders of bogs (Case 1964).

THREATS TO TAXON

There are a number of threats identified in Natural Heritage Program data bases that confront *Triphora trianthophora* in New England. Threats to the taxon include: development; timber harvest; habitat alteration due to road maintenance; alteration of appropriate light and moisture regimes; disruption of an adequate leaf litter layer; disruption of mycorrhizal and saprophytic relationships; competition from understory species; changes in canopy composition; stochastic events that may eliminate small populations; low genetic diversity as a result of small populations and vegetative reproduction; inadvertent trampling; herbivory; and collection. Some of these threats are largely self-explanatory, while others require elaboration. Additionally, while adverse impacts of a number of threats have been suggested, lack of biological information about the taxon and lack of experimental data make it difficult to confirm the severity and prevalence of several of these threats. An evaluation of the importance of each of the threats would require both an understanding of how severe an impact the threat would have and how likely it is that the threat will occur. In terms of severity of impact, it is likely that development, timber harvest, alteration of physical and biological aspects of the habitat, and stochastic events affecting small populations are the most serious threats. Development, timber harvest (and its attendant impacts), small population size, and changes in canopy and understory composition are present at five or more occurrences each. The following section elaborates further on each threat. The threats discussed below are often interrelated and some may be thought of as primary causes which then have secondary impacts that can affect the orchids; for purposes of thoroughness, however, each is described individually.

- **Development** has eliminated a number of *T. trianthophora* occurrences and continues to threaten several extant sites. Many of the extant occurrences are in sites attractive for development.

- **Timber harvest** may damage or destroy individual plants or colonies, alter light and moisture regimes, and alter important soil characteristics. Most of the large and extensive *T. trianthophora* populations are in relatively undisturbed woods with mature beech. Conversely, it has been suggested that selective harvesting at appropriate times of the year and logging in general may benefit the species by allowing more light to reach the plants. Plants may respond favorably to canopy openings in the short-term. Although the orchid is relatively shade tolerant, it is not typically found in full shade. The orchid seems to have survived logging historically. The interactions between timber harvest, changes in light availability, changes in leaf litter and soil characteristics, growth of a dense understory, and the long-term well-being of *T. trianthophora* are undoubtedly highly complex. Therefore, timber harvest should generally be viewed as a threat unless there is long-term evidence to the contrary.

- **Habitat alteration due to road maintenance** may adversely impact populations through culvert maintenance, plowing and sanding, roadside cutting, and general maintenance.

- **Alteration of appropriate light and moisture regimes** may occur through timber harvest, as mentioned above, development, or a number of other activities. Precise physical requirements are not known, so it is difficult to establish guidelines for various activities that may affect light and moisture.

- **Disruption of an adequate leaf litter layer and appropriate soil conditions** may be highly detrimental to the species; the plant is almost always found in relatively deep leaf litter.

- **Disruption of mycorrhizal and saprophytic relationships** that are likely crucial in the lifecycle of the taxon could eliminate populations.

- **Competition from other understory plants** may result in the decline and extirpation of *Triphora* populations. The taxon tends to occur with very few other species immediately adjacent, and any factor that increases the density of the understory may adversely affect the taxon.

- **Changes in canopy composition** can alter light availability and leaf litter and may not be favorable to the persistence of the orchid. For example, beech-dominated forests can shift to hemlock-dominated forests. Such changes appear to have occurred at several sites, and the orchid is less prevalent than at beech-dominated sites. Any factors that result in beech decline are especially problematic. Both global warming (Iverson et al. 1999) and diseases affecting beech may result in the decline of beech in New England and the consequent decline of *T. trianthophora*. Diseases such as beech bark disease, caused by the combined

attack of the woolly beech scale (*Cryptococcus fagisuga*) and a fungus (*Nectria coccinea*) (Pirone 1978) can result in beech decline. The distribution of beech may change significantly as a result of global warming with increased temperatures causing the extirpation of beech from southern New England and much of New York (Iverson et al. 1999).

- **Stochastic events** may adversely affect or eliminate the small populations present at many sites. Examples include inadvertent disturbances caused by road maintenance and changes in soil and leaf litter conditions or vegetation caused by unpredictable tree falls or storms.

- **Low genetic diversity** may threaten the long-term viability of populations and the species. Although no information exists on genetic diversity in the taxon, diversity may be low due to the small size of many populations and the potentially high reliance on vegetative rather than sexual reproduction. Genetic problems resulting from low genetic diversity such as inbreeding depression may not be a serious threat if the orchid reproduces primarily vegetatively. However, low genetic diversity may still compromise the evolutionary potential of plant species in the face of environmental change.

- **Inadvertent trampling** may occur during recreational use, timber harvest, monitoring, scientific research, and other activities.

- **Herbivory** appears to be common at many *Triphora* sites. It is unknown what impact herbivory has on the populations.

- **Collection** of the orchid would be detrimental to populations; it is unknown if collection is currently a serious problem for the taxon.

DISTRIBUTION AND STATUS

General Status

Triphora trianthophora occurs in Ontario, Canada, in New England (except Connecticut (H) and Rhode Island (SRF)), south to Florida and west to Nebraska (except Pennsylvania (H), Minnesota, North Dakota, and South Dakota) and south to Texas. It occurs in 30 states, but it is rare throughout much of its range in the United States. *Triphora trianthophora* is an S1 or S2 species in 19 states and in Ontario (Association for Biodiversity Information 2000, Association for Biodiversity Information 2001, and personal communications with Natural Heritage Program botanists and data managers). The taxon occurs as well in some localities in Central America including Mexico, Guatemala, and Panama (Correll 1950, Case 1964, Medley 1996). Globally, the orchid is ranked as a G3/G4 species (Association for Biodiversity Information 2000). In New England, *T. trianthophora* is an S1 or S2 species in Maine (T), New Hampshire (T), Vermont (T), and Massachusetts (E). The taxon is historic in Connecticut. *Triphora trianthophora* is a Division 2a species (potentially greater than 20

occurrences, but with a substantial number of occurrences consisting of small numbers of individuals) according to *Flora Conservanda* (Brumback and Mehrhoff et al. 1996). Table 1 summarizes the distribution and status of *T. trianthophora* in the United States and Canada. The table reflects what is believed to be the most accurate information derived from multiple sources (Fernald 1950, Gleason and Cronquist 1991, Association for Biodiversity Information 2000, Association for Biodiversity Information 2001, and personal communications with Natural Heritage Program botanists and data managers). Figures 1 through 3 show the North American and New England distributions of current and historic occurrences.

Table 1. Occurrence and status of *Triphora trianthophora* in the United States and Canada based on Information from Natural Heritage Programs.			
OCCURS & LISTED (AS S1, S2, OR T &E)	**OCCURS & NOT LISTED (AS S1, S2, OR T & E)**	**OCCURRENCE REPORTED OR UNVERIFIED**	**HISTORIC (LIKELY EXTIRPATED)**
Delaware (S1; E)	Florida (S3)	Alabama (SR): relatively frequent throughout state	Connecticut (SC*; believed extirpated)
Kansas (S2; T)	Georgia (S3?): occurs in at least 4 counties)	Arkansas (SR)	Pennsylvania (SH)
Louisiana (S1; T)	Illinois (S3?)	Missouri (occurs in 20-25 counties)	District of Columbia (SH)
Maine (S1; T)	Indiana (S?)	Tennessee (occurs in about 15 counties)	Maryland (SH; X)
Massachusetts (S1; E)	Iowa (S3)	Texas (SR)	
Michigan (S1; T)	Kentucky (S?)		
Mississippi (S2S3)			
Nebraska (S1; E)			
New Hampshire (S2; T)			
New Jersey (S1; E)			
New York (S1S2; E)			
North Carolina (S2)			
Ohio (S2; T)			
Oklahoma (S2S3)			
Ontario, Canada (S1; E)			
South Carolina (S2; SC)			
Vermont (S1; T)			
Virginia (S1; E)			
West Virginia (S2)			
Wisconsin (S2; SC)			

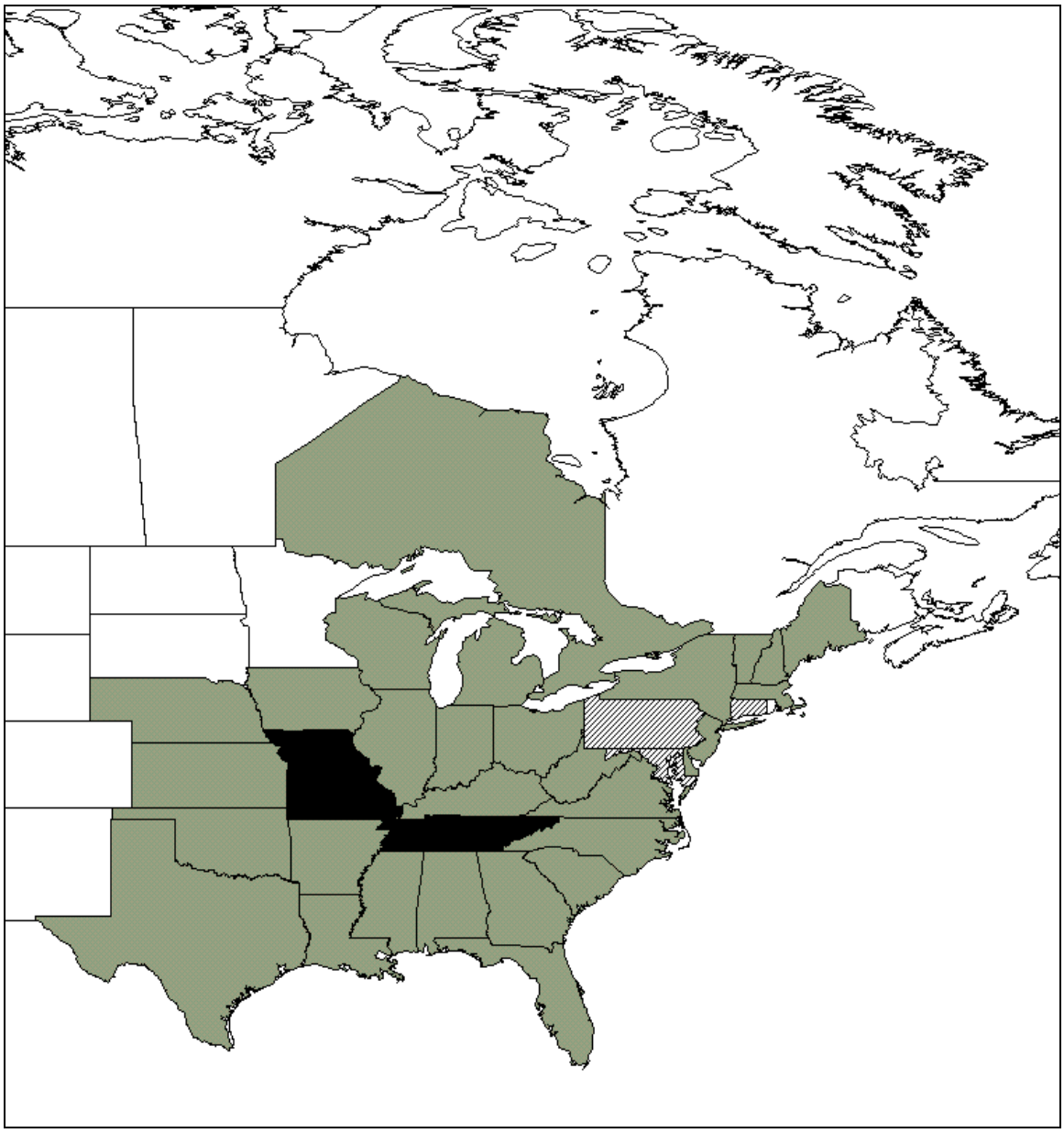

Figure 1. Occurrences of *Triphora trianthophora* in North America. States and provinces shaded in gray have confirmed, extant occurrences of the taxon. Diagonal hatching indicates states where the taxon is historic or presumed to be extirpated (see Appendix for explanation of ranks).

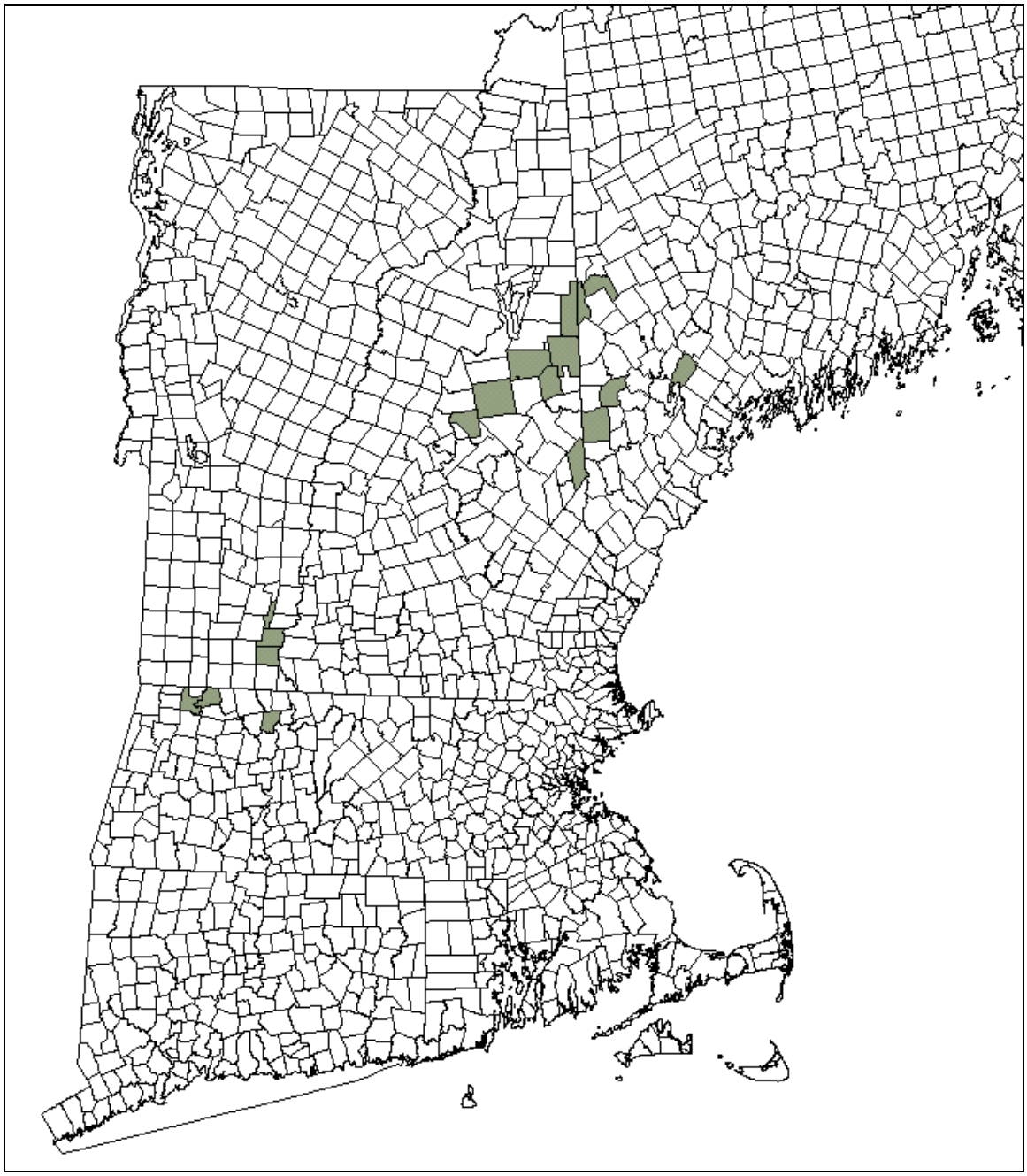

Figure 2. Extant occurrences of *Triphora trianthophora* in New England. Town boundaries for New England are shown. Towns with shading have 1-5 current occurrences of the taxon.

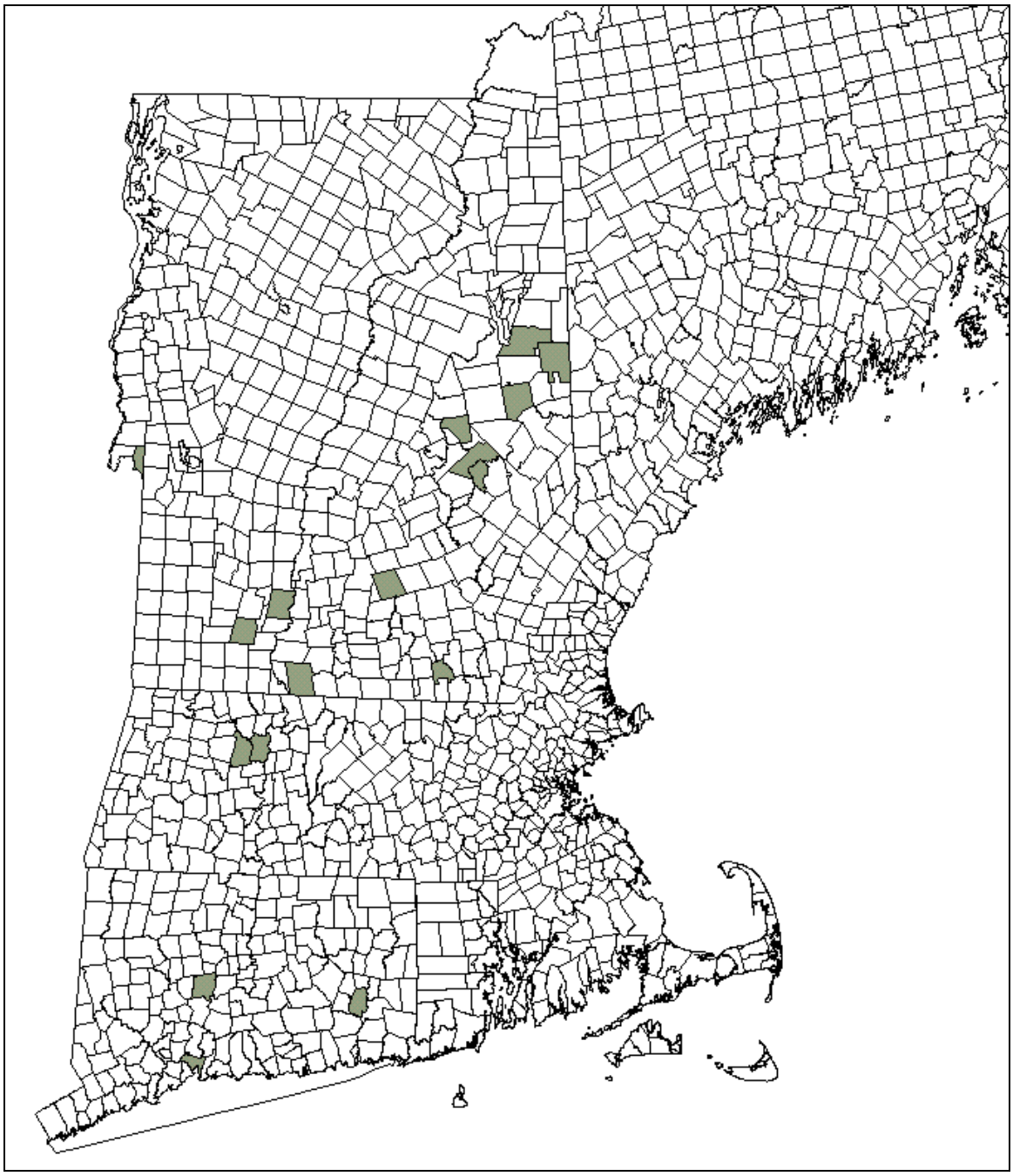

Figure 3. Historic occurrences of *Triphora trinathophora* in New England. Town boundaries for New England are shown. Towns with shading have 1-5 historic records for the taxon.

Status of all New England Occurrences--Current and Historic

Triphora trianthophora occurs in southwestern Maine, central-eastern New Hampshire, southeastern Vermont, and northwestern Massachusetts. The taxon is historic in Connecticut. Twenty-four current occurrences (seen after 1970) are found in New England. The majority of the current occurrences (17 of 24) are in Maine and New Hampshire. Nineteen current occurrences have been documented recently. Three current occurrences are still listed by Natural Heritage Programs as extant, but are possibly extirpated. There are two additional New Hampshire occurrences that have been seen but were not documented in the Heritage Program data base as of 2000 (Sara Cairns, New Hampshire Natural Heritage Program, personal communication) and perhaps a third population not listed in the data base (Frankie Brackley Tolman, consulting botanist, personal communication). There are 19 documented historic occurrences of the taxon.

Occurrences of *Triphora trianthophora* in Maine, New Hampshire, Vermont, and Massachusetts exhibit similarities in terms of habitat and threats to the occurrences. *Triphora trianthophora* occurs in mesic northern hardwood forests with beech typically a dominant species. At the Vermont site, hemlock dominates, although a few beech are present. Plants occur most frequently in substantial leaf litter in shallow depressions. Sites are often rocky. The moisture regime is usually mesic but may be dry-mesic, and light conditions are usually filtered and less commonly shaded. Most of the New England sites range in elevation from 200 to 900 feet (61-274 meters); three sites range from 1250-1420 feet (381-433 meters). Slope of the sites ranges from 0-35%; about two-thirds of the sites are S, SE, or E-facing. There are typically few herbaceous or shrub species in the immediate vicinity of *T. trianthophora* plants, but *Epifagus virginiana*, *Monotropa uniflora*, *Uvularia sessilifolia*, *Gaultheria procumbens*, *Mitchella repens*, and *Medeola virginiana* often occur nearby. The following threats have the potential to occur at the majority of sites: timber harvest; development; habitat alteration; competition from understory plants; changes in canopy composition; stochastic events affecting small populations; herbivory; recreation; ice storms; proximity to roads; inadvertent trampling; collection; and canopy closure.

Table 2 presents information on each of the New England occurrences of *Triphora trianthophora*. Data from state Natural Heritage programs is the primary source for the information as well as site visits by the author in 2000. The table includes information on location, type of ownership, first and last observation dates, site description, element occurrence rank, population size and trend, general comments, and threats. The element occurrence ranking should be considered subjective as the ranking is assigned by different investigators who may or may not have visited more than one occurrence. Several occurrences have no ranking information available. The section following the table provides a more detailed discussion of each occurrence in narrative form.

Table 2. New England Occurrence Records for *Triphora trianthophora*. Shaded occurrences are considered extant.

State	Element Occurrence Number	County	Town
ME	**.001**	**Oxford**	**Stow**
ME	**.002**	**Oxford**	**Stow**
ME	**.003**	**Oxford**	**Stoneham**
ME	**.004**	**Oxford**	**Hiram**
ME	**.005**	**Cumberland**	**Raymond**
ME	**.006**	**Oxford**	**Stow**
ME	**.007**	**York**	**Parsonfield**
NH	**.001**	**Carroll**	**Madison**
NH	**.002**	**Carroll**	**Conway**
NH	**.003**	**Carroll**	**Madison**
NH	**.004**	**Carroll**	**Wakefield**
NH	**.005**	**Carroll**	**Albany**
NH	**.006**	**Grafton**	**Holderness**
NH	.007	Carroll	Tamworth
NH	.008	Belknap	Laconia
NH	.009	Belknap	Meredith
NH	.010	Carroll	Tamworth
NH	**.011**	**Carroll**	**Chatham**
NH	.012	Grafton	Holderness
NH	.013	Chesire	Winchester
NH	.014	Hillsborough	Milford
NH	**.015**	**Carroll**	**Chatham**
NH	.016	Carroll	Conway
NH	.017	Hillsborough	Hillsborough
NH	.018	Carroll	Bartlett
NH	.019	Grafton	Holderness
NH	**.020**	**Carroll**	**Sandwich**
NH	**.021**	**Carroll**	**Albany**
VT	**.001**	**Windham**	**Dummerston**
VT	**.002**	**Windham**	**Brattleboro**
VT	**.003**	**Windham**	**Brookline**
VT	.004	Rutland	Fair Haven
VT	.005	Windham	Newfane

Table 2. New England Occurrence Records for *Triphora trianthophora.* Shaded occurrences are considered extant.

State	Element Occurrence Number	County	Town
VT	.007	Windham	Westminster
VT	**New**	**Windham**	**Dummerston**
MA	**.001**	**Franklin**	**Greenfield**
MA	.003	Franklin	Deerfield
MA	**.004**	**Franklin**	**Rowe**
MA	.005	Franklin	Conway
MA	**.006**	**Berkshire**	**Florida**
CT	.001	New Haven	New Haven
CT	.002	Hartford	Southington
CT	.003	New London	Norwich

CURRENT CONSERVATION MEASURES IN NEW ENGLAND

Current conservation measures that potentially protect *Triphora trianthophora* in New England include protection under state endangered species legislation, site ownership by entities that may act to protect the species, management to protect a portion of a population from the impacts of timber harvest, and regular monitoring of a number of occurrences.

State Endangered Species Legislation

In Maine, *Triphora trianthophora* is listed as a threatened species and is protected under Maine Revised Statutes Annotated 5 MSRA C, 383, sub C. III, articles 1-A. In New Hampshire, *T. trianthophora* is listed as a threatened species and is protected under the 1987 State law RSA 217-A:3, III. In Vermont, *T. trianthophora* is listed as a threatened species and is protected under the 1981 Vermont Endangered Species Law 10 V.S.A. Chapter 123. In Massachusetts, *T. trianthophora* is listed as an endangered species and is protected under the 1992 Massachusetts Endangered Species Act, MGL c. 131A and its regulations, 321 CMR 10.00. In Connecticut, *T. trianthophora* is listed as a species of special concern that is extirpated from the state, and is protected under Public Act 89-224. While *T. trianthophora* receives legal protection in these New England states, the scope of protection provided by the legislation is limited. State endangered species acts typically prohibit the direct taking of listed species but do not prohibit taking that is incidental to and not the purpose of carrying out an otherwise lawful act. For example, in Vermont the legislation does not address threats such as land use that are incompatible with the well being of the plant unless the plant itself is taken. Also, permitting processes exist that can allow for the taking of individuals of listed taxa under certain circumstances.

Site Ownership

Conservation of *Triphora trianthophora* occurrences may result from site ownership by private or public entities that act to protect the plant. There are six occurrences in Maine and New Hampshire found on White Mountain National Forest land. The Forest Service is aware of these occurrences, and endeavors to protect listed species such as *T. trianthophora*. Several occurrences are on land owned by private individuals. One is owned by corporation with interests in the conservation of the species and its habitat, and another by a town potentially willing to accommodate the species. One site in Vermont is owned by a private conservation organization. Approximately half of the current occurrences of *T. trianthophora* in New England are on privately owned land with no formal or informal conservation measures in place.

Management

One portion of an occurrence in the White Mountain National Forest was protected from a timber harvest conducted at the site. Data will be collected over several years to assess impacts of timber harvest on *Triphora trianthophora*. No other management activities are known for *T. trianthophora* in New England. Various management suggestions have included canopy thinning, preventing timber harvest, rerouting trails and woods roads, preventing development, and modifying roadside maintenance activities.

Monitoring

Although monitoring of populations is not a conservation measure in itself, it is essential for establishing the current status of populations and to assess population trends. It is also a prerequisite to implementation of management activities. In the past 20 years, approximately one-third of the current New England occurrences have been monitored for Natural Heritage Programs as many as four times, but the monitoring intervals are not consistent.

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

Four conservation objectives are proposed for *Triphora trianthophora* to ensure its persistence in New England during the next 20 years. The first objective is to maintain, at a minimum, the existing number of occurrences at their current population levels. The second objective is to search for previously undocumented occurrences and to protect newly found populations when possible. The third objective is to identify and protect promising habitat that is apparently unoccupied by the orchid currently. The fourth objective is to evaluate the possibility of augmentation, reintroduction, and introduction of the orchid. Specifically, the result of achieving the above objectives should be the presence of 20 protected occurrences. At least half of the occurrences should have greater than 100 stems present aboveground in any given year (or another similar threshold value that is established). Although 100 stems is perhaps an arbitrary and conservative threshold for extreme concern for populations, the four current populations that may now be extirpated (ME .006, VT .001, VT .002, and MA .001) had fewer than 20 stems present at their most recent survey. It is prudent maintain populations above thresholds from which populations may not recover.

A discussion of the rationale for developing these four conservation objectives for *Triphora trianthophora* follows. First, the most effective way to ensure the long-term viability of plant species is to protect large numbers of healthy populations in natural habitat; protecting the remaining *T. trianthophora* occurrences through the first objective is essential to this effort. Second, *T. trianthophora* is represented in New England by 24 occurrences, a relatively low number. Furthermore, three of these occurrences are possibly extirpated based on recent field observations (ME .006 [Stow], VT .001 [Dummerston], and MA .001 [Greenfield]). Five additional occurrences had fewer than 50 stems found at the most recent surveys (ME .004 [Hiram], NH .001 [Madison], NH .002 [Conway], VT .002 [Brattleboro], and VT .003 [Brookline]). Only ten occurrences had greater than 100 stems present at the most recent surveys (ME .001 [Stow], ME .005 [Raymond], ME .007 [Parsonfield], NH .003 [[Madison], NH .004 [Wakefield], NH .005 [Albany], NH .006 [Holderness], NH .021 [Albany], VT .008 [Dummerston], and MA .004 [Rowe]). The number of known and protected occurrences should include a minimum of 20 protected occurrences.

The second objective of searching for previously unknown populations will help to increase the number of known occurrences. Twenty occurrences would be approximately half of the combined total of 42 historic and current occurrences reported, and this figure represents the threshold number of occurrences for a NEPCoP Division 2 plant species (Brumback and Mehrhoff *et al*. 1996). Small populations of *T. trianthophora* are more susceptible to

extirpation than are larger populations; as mentioned previously, several smaller current populations are probably extirpated. Thus, it is important to conserve a significant number of populations (approximately half of the occurrences) with at least 100 stems present in any given year. Long-term conservation of *T. trianthophora* in New England will likely require the persistence of a minimum of 20 occurrences and the presence of a minimum of 10 with greater than 100 stems present.

Third, although protection of apparently unoccupied habitat might be viewed as a low priority compared with the substantial protection needs of known populations, it is a high priority for this taxon because plants may actually be present in the form of underground tuberoids.

Fourth, while augmentation, introduction, or reintroduction of *T. trianthophora* are not presently recommended, it is prudent to explore the desirability and feasibility of such actions now so that information will be available to inform future decisions.

Determination of the number of populations, their size, and their distribution required for successful conservation of any taxon is clearly a subjective and dynamic endeavor. The conservation objectives and actions presented here should be viewed as initial recommendations that will be modified as a new information becomes available and is evaluated.

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Appendix 1. An explanation of conservation ranks used by The Nature Conservancy and the Association for Biodiversity Information

The conservation rank of an element known or assumed to exist within a jurisdiction is designated by a whole number from 1 to 5, preceded by a G (Global), N (National), or S (Subnational) as appropriate. The numbers have the following meaning:

1 = critically imperiled
2 = imperiled
3 = vulnerable to extirpation or extinction
4 = apparently secure
5 = demonstrably widespread, abundant, and secure.

G1, for example, indicates critical imperilment on a range-wide basis—that is, a great risk of extinction. S1 indicates critical imperilment within a particular state, province, or other subnational jurisdiction—i.e., a great risk of extirpation of the element from that subnation, regardless of its status elsewhere. Species known in an area only from historical records are ranked as either H (possibly extirpated/possibly extinct) or X (presumed extirpated/presumed extinct). Certain other codes, rank variants, and qualifiers are also allowed in order to add information about the element or indicate uncertainty.

Elements that are imperiled or vulnerable everywhere they occur will have a global rank of G1, G2, or G3 and equally high or higher national and subnational ranks. (The lower the number, the "higher" the rank, and therefore the conservation priority.) On the other hand, it is possible for an element to be rarer or more vulnerable in a given nation or subnation than it is range-wide. In that case, it might be ranked N1, N2, or N3, or S1, S2, or S3 even though its global rank is G4 or G5. The three levels of the ranking system give a more complete picture of the conservation status of a species or community than either a range-wide or local rank by itself. They also make it easier to set appropriate conservation priorities in different places and at different geographic levels. In an effort to balance global and local conservation concerns, global as well as national and subnational (provincial or state) ranks are used to select the elements that should receive priority for research and conservation in a jurisdiction.

Use of standard ranking criteria and definitions makes Natural Heritage ranks comparable across element groups—thus G1 has the same basic meaning whether applied to a salamander, a moss, or a forest community. Standardization also makes ranks comparable across jurisdictions, which in turn allows scientists to use the national and subnational ranks assigned by local data centers to determine and refine or reaffirm global ranks.

Ranking is a qualitative process: it takes into account several factors, including total number, range, and condition of element occurrences, population size, range extent and area of occupancy, short- and long-term trends in the foregoing factors, threats, environmental specificity, and fragility. These factors function as guidelines rather than arithmetic rules, and the relative weight given to the factors may differ among taxa. In some states, the taxon may receive a rank of SR (where the element is reported but has not yet been reviewed locally) or SRF (where a false, erroneous report exists and persists in the literature). A rank of S? denotes an uncertain or inexact numeric rank for the taxon at the state level.

Within states, individual occurrences of a taxon are sometimes assigned element occurrence ranks. Element occurrence (EO) ranks, which are an average of four separate evaluations of quality (size and productivity), condition, viability, and defensibility, are included in site descriptions to provide a general indication of site quality. Ranks range from: A (excellent) to D (poor); a rank of E is provided for element occurrences that are extant, but for which information is inadequate to provide a qualitative score. An EO rank of H is provided for sites for which no observations have made for more than 20 years. An X rank is utilized for sites that are known to be extirpated. Not all EO's have received such ranks in all states, and ranks are not necessarily consistent among states as yet.