

New England Plant Conservation Program
Conservation and Research Plan

Listera auriculata Wieg.
Auricled Twayblade

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SUMMARY

A conservation plan for auricled twayblade (*Listera auriculata* Wieg.) is necessary because the orchid's patchy, ephemeral populations grow on stream and river banks -- habitat that is under pressure from human interference. Another objective of the conservation efforts is to protect potential genetic diversity in the southeastern limits of the species' range.

In New England auricled twayblade occurs in temporarily flooded riparian areas in northern forests, on sandy alluvial deposits that may be bare or mossy. It is often in or near alder thickets. It is also found on sandy banks and outwash along streams and in swamps adjacent to large lakes (such as Lake Superior). Changes to hydrology, as a result of intensive logging in the watershed or damming of rivers, may destroy auricled twayblade habitat.

Auricled twayblade is a North American endemic, with a global rank of G3. It apparently was never plentiful (at least since the 19th century), as it was not recognized as a species until 1899. It is most common in Quebec and Ontario. New Hampshire, Maine, and Vermont all list it as S1. It is probably more frequent than the 17 occurrences known to be extant in the past 20 years in New England, but its populations are usually small and hard to find. In the best-known sites population size seems cyclical, swinging widely up and down over a few years.

Auricled twayblade has been reported in 43 sites in New England, most historical and without much detail on the site. Fifteen sites have been described in detail. Four new sites have been reported for Maine and Vermont in the past five years; these sites need to be confirmed and field forms submitted.

The conservation objectives for auricled twayblade in New England are to conserve hydrology and habitat for ten viable populations (50+ plants) scattered over the region. That number is an estimate based on Heritage Program reports on the species and the way the population size fluctuates and shifts sites. Priority conservation actions should focus on protection of flow regimes and watersheds where auricled twayblade is known to be, probably through easements that would buffer it from logging and other threats to the present hydrology, and discouraging recreational use in its favored habitat. Because populations seem to shift sites, possible habitat should be protected as well as present habitat. Therefore, research is necessary to identify possible habitat and dispersal mechanisms, to learn how large an area is necessary to maintain a metapopulation. Searching for extant populations in likely habitat, perhaps in historical sites, is another priority, with the emphasis on sites that can be protected.

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

Auricled twayblade (*Listera auriculata* Wieg.) is a North American endemic, with a global rank of G3. A conservation plan for auricled twayblade in New England is necessary because the orchid's patchy, ephemeral populations grow in habitat that is under pressure from human interference. Changes to hydrology, as a result of intensive logging in the watershed or damming of rivers, may destroy auricled twayblade habitat, that is, stream and river banks.

The conservation objectives for auricled twayblade in New England are to conserve hydrology and habitat for the viable populations scattered over the region, thereby protecting the species in the most southern part of its range. Little is known of auricled twayblade biology, and consequently, it is not obvious how to define a viable population; this plan includes steps to learn that. Also important, for this elusive species, is searching for new populations in appropriate habitat in the northern New England states.

DESCRIPTION

Auricled twayblade was first described by Wiegand (1899). The description below is based on Coleman and Magrath (in preparation) and Case (1987).

Auricled twayblade is a terrestrial orchid with slender, fibrous roots and a slender, glabrous, pale green stem. Its height ranges from 5 cm to 25 cm. Its two sessile, subopposite leaves are pale green and glabrous, sub-orbicular to ovate-elliptic, 25–60 mm long, and 15–42 mm wide. It has an open terminal raceme, 20–100 mm long, with floral bracts that are broadly elliptic to oblong-lanceolate, obtuse, and 2–7 mm by 1–2 mm. Below the leaves, the stem is glabrous; the peduncle and rachis are densely glandular-puberulent. The bracts, pedicels, and ovaries are usually glabrous. A plant may have 5–20 flowers that are pale green to blue-green, fading to whitish. The sepals and petals are reflexed away from the column and lip. The dorsal sepal is elliptic-obovate, subobtuse, and 3–3.5 mm by 1.5–2 mm, and the lateral sepals are elliptic to oblong to ovate-lanceolate, subobtuse to acute, strongly falcate, and 3–4 mm by 1–1.5 mm. The petals are linear-oblong to linear, obtuse, falcate, and 3–3.7 mm by 0.8 mm. The lip is obovate to oblong, with a slightly expanded apex. The lip is cleft approximately one-fifth to one-third of its length, forming two broadly rounded lobes, with ciliate margins. The auricles at the base of the lip curve around and clasp the base of the column. The disk has three veins, with branched lateral veins and a central ridge at the base. The column is curved, 2.5–3.3 mm by 1 mm, and dilated at the summit. Seed capsules are ellipsoid, 8 mm by 4 mm, horizontal to semi-erect.

There are eight North American species in the genus *Listera*. Auricled twayblade may overlap in habitat and distribution with southern twayblade (*L. australis*), northern twayblade (*L. borealis*), heart-leaved twayblade (*L. cordata*), and broad-leaved twayblade (*L. convallarioides*). All but northern twayblade are found in New England. Northern twayblade has auricles that diverge and are pointed or truncated, not hugging the column and rounded like those of auricled twayblade. Southern twayblade and heart-leaved twayblade have more deeply cleft lips with pointed tips, and shorter columns (<1.0 mm) than auricled twayblade. Broad-leaved twayblade has a lip that is attached at the base by a narrow claw and that is widest and merely notched at its distal end; auricled twayblade has no visible claw, and its lip is clearly cleft.

Auricled twayblade hybridizes with broad-leaved twayblade. The parent plants have distinctly different flower morphology and habitat preferences. Auricled twayblade prefers (or tolerates) acidic soils on frequently disturbed riverbanks and lake shores. Broad-leaved twayblade grows on soils with higher nutrient availability, usually in forest seeps or conifer swamps. The rare hybrid, *Listera* × *veltmanii*, has been found growing with one or the other of its parents. It is intermediate between the two in pubescence and shape of its lip. Like the broad-leaved twayblade, it has a claw, but it is shorter; the lip broadens at the distal end, but not as much. It has a shallower cleft in its lip than auricled twayblade, but more than a notch like broad-leaved twayblade. It has small, uncurved auricles. It is taller than either parent, appears to have a longer flowering season, and is found in different, more disturbed habitat than its nearby parent (Catling 1976). The parents and hybrid could be easily distinguished from each other in the collections Catling examined. In two cases he found evidence of backcrossing with broad-leaved twayblade. The hybrid is known from New Brunswick, Newfoundland, Quebec, Ontario, Michigan, Wisconsin, and New Hampshire (Cody and Munro 1980, Coleman and Magrath in preparation).

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

The auricled twayblade orchid was first recognized as a species in 1899, based on specimens from Quebec, Maine, and New Hampshire (Wiegand 1899). Synonyms that have been published, *Ophrys auriculata* (House 1905) and *Bifolium auriculatum* (Nieuwland 1913), were based on publication priority of those genus names. *Listera* has since been conserved as the correct genus name (Gleason and Cronquist 1991). It is part of the Neottieae tribe (Dressler 1993), which has several genera, including one other North American genus, *Epipactis*.

SPECIES BIOLOGY

Little is known specifically of auricled twayblade biology; however, results from studies of other members of the genus may be applicable to auricled twayblade. Rasmussen (1995) reviews the research done, mostly on common twayblade (*L. ovata*), a widespread, weedy European species, including seed storage and culture. Details from that review that may be pertinent to auricled twayblade are mentioned below.

The few auricled twayblade populations that have been watched recently in New England seem cyclical, with wide swings in the number of individuals over a few years. Reddoch and Reddoch (1997) also report population fluctuations in Ontario. These fluctuations may be an artifact of surveying rather ephemeral plants too late in the summer; however, they may well be the product of periodic floods that naturally occur in the riparian habitat. It is not clear how patches reestablish. A disturbance may leave a few plants that can reseed the site, a possible explanation for a site in Maine where the population seemed to have been wiped out in 1989, and ten plants appeared in 1990. Or the site may have to be reseeded from refugia, a possible explanation for the continuing absence of the Wild River population, which has not been seen since a flood scoured the area in 1995. It seems unlikely that the roots survive, lying dormant for some years, to eventually reemerge. Auricled twayblade roots are small and cannot provide much food for a dormant plant; however, the plants could feed saprophytically through fungi. To the best of my knowledge, no one has discovered whether auricled twayblade shares the typical orchid reliance on fungi for germination and growth. Its habitat is shaded and disturbed -- two characteristics that often accompany fungal-plant interaction (Rasmussen 1995). Fungal infection of heart-leaved twayblade (*L. cordata*) sprouts persists in mature plants. Common twayblade (*L. ovata*) roots harbor fungi, but its rhizomes do not (Rasmussen 1995).

Herbivory was common at three sites visited in 2000. The damage was mostly small holes in the leaves, probably inflicted by invertebrates, in up to 90% of the plants. Similar holes appear in specimens at the Gray Herbarium (personal observation).

Auricled twayblade flowers from late June to August (Coleman and Magrath in preparation); in New England it is mostly finished flowering by mid-July. The capsules start to fatten up even as lower flowers are still blooming. Fred Case (Cranbrook Institute of Science, personal communication) has observed the capsules splitting open while they are still green, early in the summer. Estimates for how old common twayblade is before producing flowers are 7 to 15 years (Rasmussen 1995); it seems likely that, in its disturbed habitat, auricled twayblade matures more quickly.

Twayblades have a small nectary that attracts nonspecific small flying insects, and all have a common pollination mechanism. Ackerman and Mesler (1979) describe pollination in heart-leaved twayblade. A nectary runs down the middle of the lip, and another lies at the base of the column. An insect that visits the flower touches trigger hairs on the column. A dab of glue squirts on the insect, and the pollinia are immediately dropped on the glue. The stigma is

covered for about a day, and then is exposed for pollination. This mechanism helps prevent self-pollination. Many species of *Listera* have fetid-smelling nectar (Brackley 1985), but this scent has not been noted in auricled twayblade.

Because twayblade nectaries and columns are quite accessible, pollination requires no specific insect body shape (Ackerman and Mesler 1979). Heart-leaved twayblade visitors in California were often fungus gnats (Mycetophilidae), and other Diptera and some Hymenoptera (Ackerman and Mesler 1979). Hapeman (2000) shows a photograph of auricled twayblade being visited by a small dipterid, perhaps a fungus gnat.

The dust-sized seeds are produced early in the summer. It is not known whether they germinate the same year or are dormant for a time. Also unknown is whether they disperse other than by wind; water dispersal is also possible. Common twayblade seeds probably germinate in spring; leafy shoots appear in the fourth spring (Rasmussen 1995). Auricled twayblade adults overwinter by a shoot at the base of the current year's stem. The new shoot is present when the plant is flowering (Reddoch and Reddoch 1997), and grows 1–2 cm high while the capsules mature (personal observation of herbarium specimens).

Out of more than 100 auricled twayblade herbarium specimens that had roots, several produced two stems in a year, both rising close together from a small root system (personal observation). On some plants the two stems were so close that they seemed to be from the same node; perhaps the renewal bud and the reserve bud occasionally both develop (see Rasmussen 1986). Other "twins" were up to 1 cm apart (personal observation). Studies of vegetative reproduction in other species in the genus may apply to auricled twayblade. Heart-leaved twayblade did not reproduce vegetatively in California populations studied by Ackerman and Mesler (1979) in redwood forests. Pieces of its roots can produce shoots (Rasmussen 1995).

HABITAT/ECOLOGY

In New England, auricled twayblade occurs on temporarily flooded and ice-scoured riverbanks in northern forests, above bankfull level on sandy alluvial deposits that may be bare or mossy (NatureServe 2000). Elsewhere, it is also found on sandy banks and outwash along streams and in swamps adjacent to large lakes (such as Lake Superior) (Case 1964, 1987). In New England it most often grows in sandy, acid soils, but it has also been reported growing in muck (Whiting and Catling 1977, Lapin 1996), sphagnum bogs (MacKenzie and Greenwood 1969), and calcareous soils (Marie-Victorin 1995). It is often in or near riverside thickets of speckled alder (*Alnus incana* ssp. *rugosa*), and tolerates shade. It prefers moist, cool microclimates (Whiting and Catling 1977, and personal observation).

In its typical association with alders, auricled twayblade probably benefits from the shrubs' ability to hold litter in place, to prevent substrate movement in mild flooding, and to provide shelter from ice scouring and drying sun. Auricled twayblade may also benefit from

alder's symbiotic association with nitrogen-fixing actinomycetes (e.g., *Frankia*) (Withgott 2000). Frequently associated mosses may act as nurses for auricled twayblade seeds, perhaps holding them in place during winds or floods, anchoring the substrate surface, harboring compatible fungi, and maintaining moisture (Lisa St. Hilaire, personal communication; St. Hilaire and Leopold 1995).

In New England, auricled twayblade's most common associates (as reported on field forms) are alders (when identified to species, most often speckled alder), mosses, violet (*Viola* species), dwarf raspberry (*Rubus pubescens*), Canada mayflower (*Maianthemum canadense*), tall meadow-rue (*Thalictrum pubescens*), and inflated sedge (*Carex intumescens*). As is typical of riparian areas (Nichols et al. 2001), dozens of other herbaceous species may share habitat with auricled twayblade, including the rare Furbish's lousewort (*Pedicularis furbishiae*). A few reports give interrupted fern (*Osmunda claytoniana*) as the dominant species in seepy habitats. Platt et al. (1982) also report this habitat.

Catling (1976) lists similar associates for auricled twayblade on the shores of Lake Superior, Ontario: speckled alder, mosses (*Atrichum oerstedianum*, *Hypnum lindbergii*), liverworts (*Pellia epiphylla*), inflated sedge, wood horsetail (*Equisetum sylvaticum*), dwarf raspberry, violet (*Viola* cf. *nephrophylla*), sensitive fern (*Onoclea sensibilis*), little shinleaf (*Pyrola minor*), mad-dog skullcap (*Scutellaria lateriflora*), calico aster (*Aster lateriflorus*), and twisted stalk (*Streptopus amplexifolius* var. *denticulatus*).

THREATS TO THE TAXON

Changes to hydrology affect riparian sediment deposition and erosion, flood duration and strength of flow, and ice-scour reach (Malanson 1993). Mixing and churning floodwaters can create a mosaic of different soil conditions and microtopography within a single site (Hupp and Osterkamp 1985, Hupp 1986, Bornette and Amoros 1996), as well as a mosaic of different sites along a single river (Shankman 1993). This shifting mosaic reflects disturbance that is frequent enough to prevent successional patterns of plant communities (White 1979, Shankman 1993, Bornette et al. 1994, Naiman and Décamps 1997). In some cases, this means setting the clock back to bare soil, which is revegetated from the seed bank, from refuges that were not destroyed by that particular flood, from uplands, and by hydrochory (water travel of seeds and clonal plant parts) (Hupp and Osterkamp 1996). Without a natural level of ecological disturbance, the community composition will change (Malanson 1993) because of changes to nutrients, moisture availability, and ambient light.

Because auricled twayblade is most often found in these frequently disturbed natural communities, changes in disturbance frequency or severity will alter or destroy its habitat. In northern New England, the most frequent disturbers of auricled twayblade-related hydrology are logging and dams for flood control and electricity (beaver dams do not appear to be a threat in these flashy systems).

Damming that results in modified timing, duration, location, and elevation of peak flood intensity; changes in sedimentation rate; and alteration of vegetation structure due to reduced or increased flooding and scouring can affect native species (Sparks 1992, Poff et al. 1997, Richter et al. 1997). Less frequent flooding of a site permits successional species to crowd out those that exist in disturbed areas, such as auricled twayblade. More frequent scouring or deeper erosion could also wipe out a population and make it impossible to recover (Pautou and Arens 1994, Hughes and Cass 1997, Jansson et al. 2000).

When the timing, scale, and intensity of logging are sufficient to alter the natural watershed, runoff, nutrient supply, and erosion may also be profoundly affected. The impact of logging roads on hydrology can be greater than logging itself, because they alter the sheet flow of water to streams (Lockaby et al. 1997). The reforestation of New England in the last hundred years has undoubtedly affected the hydrology of streams that support auricled twayblade populations, but not enough is known of its present status to say whether this has been detrimental.

Disturbance per se makes some habitats hospitable to invasive plants, such as Japanese knotweed (*Polygonum cuspidatum*) (Hobbs and Huenneke 1992). None of the New England sites for auricled twayblade have reported knotweed. Auricled twayblade seems to be more shade tolerant than Japanese knotweed (Simon 1998), and the alder that the orchid so often associates with may help exclude knotweed (Diane Burbank, U. S. Forest Service, personal communication).

Some populations are likely threatened by trampling by fishermen and other recreational users and by collecting. In many sites, however, alder thickets may shelter auricled twayblade from trampling. I have seen no reports of these problems in New England or any evidence of them at the sites I have visited.

DISTRIBUTION AND STATUS

General Status

Auricled twayblade is a North American endemic, with a global rank of G3 (vulnerable to extinction). It inhabits cool, moist banks of streams and rivers above 44° north (NatureServe 2000). Auricled twayblade apparently was not plentiful in the 19th century, as it was not identified as a species until 1899. About 130 occurrences have been recorded; however, it may well be more common, as it is easily overlooked. Maine, New Hampshire, and Vermont all list it as S1; its national rank in the United States is N2N3. It is most common in Quebec and Ontario; New Brunswick may change its status from S2 to S3 (Hinds 2000). Its national rank in Canada is N3.

Table 1. Occurrence and status of *Listera auriculata* 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)
Maine: S1	Ontario: S3	Newfoundland Island: SR	Not applicable
Michigan: S2S3	Quebec: S3		
Minnesota: S1			
New Hampshire: S1			
New York: S1			
Vermont: S1			
Wisconsin: S1			
Labrador: S1?			
Manitoba: S1			
New Brunswick: S2?			

Status of All New England Occurrences—Current and Historic

Auricled twayblade has been reported in 43 sites in New England. Twenty-six of those have not been seen for more than 20 years, and most of those give insufficient details to narrow the search to a radius of less than 5 miles. Three new sites have been reported for western Maine in the past five years (David Werier, Consulting Botanist, personal communication); these sites need to have their owners identified and asked for permission to return to gather detailed descriptions. A new site for Vermont was located in 2000 (Marc Lapin, Champlain Valley Project Coordinator, personal communication).

Auricled twayblade probably occurs in New England more frequently than the 17 occurrences seen in the past 20 years. The small plants are hard to find and usually appear in populations of less than 50 plants.

Element occurrence (EO) quality ranks are based on the size, condition, and landscape context of a rare species population. These terms collectively refer to the integrity of natural processes or the degree of human disturbances that may sustain or threaten long-term survival. They range from A (excellent) to D (poor). A rank of E applies to element occurrences that are extant but unranked because of a lack of information. A rank of H applies to sites for which no observations have been made for more than 20 years and are considered historical. A rank of X applies to sites that are known to be extirpated.

Table 2. New England occurrence records for *Listera auriculata*. Shaded occurrences are considered extant.

State	Element Occurrence Number	County	Town
ME	.001	Aroostook	Chapman
ME	.002	Aroostook	Fort Fairfield
ME	.003	Aroostook	Fort Kent
ME	.004	Aroostook	Fort Kent
ME	.005	Aroostook	Portage Lake
ME	.006	Aroostook	Presque Isle
ME	.007	Aroostook	St. Francis
ME	.008	Aroostook	Van Buren
ME	.009	Aroostook	Wade
ME	.010	Aroostook	T9 R7 WELS
ME	.011	Aroostook	T18 R10 WELS
ME	.012	Penobscot	T4 R8 WELS
ME	.013	Piscataquis	Dover-Foxcroft
ME	.014	Piscataquis	Sangerville
ME	.015	Piscataquis	Mt. Katahdin Township
ME	.016	Franklin	Carrabassett Valley
ME	.017	Somerset	Sapling Township
ME	.018	Oxford	Norway
ME	.019	Oxford	Woodstock
ME	.020	Hancock	Bar Harbor
ME	.021	Hancock	Bar Harbor
ME	.022	Aroostook	T16 R12 WELS
ME	.023	Aroostook	Fort Kent
ME	.024	Aroostook	T15 R13 WELS
ME	.025	Aroostook	Allagash
ME	.026	Aroostook	Allagash
ME	.027	Aroostook	Hamlin
ME	.028	Somerset	Bigelow and Dead River Townships
ME	.029	Aroostook	Westmanland
ME	.030	Aroostook	T15 R13 WELS
ME	.031	Franklin	Eustis
NH	.001	Coos	Atkinson and Gilmanton Academy Grant
NH	.002	Coos	Pittsburg

Table 2. New England occurrence records for *Listera auriculata*. Shaded occurrences are considered extant.

State	Element Occurrence Number	County	Town
NH	.003	Coos	Pittsburg
NH	.004	Coos	Bean's Purchase
NH	.005	Coos	Colebrook
NH	.006	Coos	Gorham
NH	.007	Coos	Colebrook
VT	.001	Washington	Warren



Figure 1. Occurrences of *Listera auriculata* in North America. States and provinces shaded in gray have at least one extant occurrence of the taxon. The state (Maine) shaded in black has five or more confirmed occurrences.

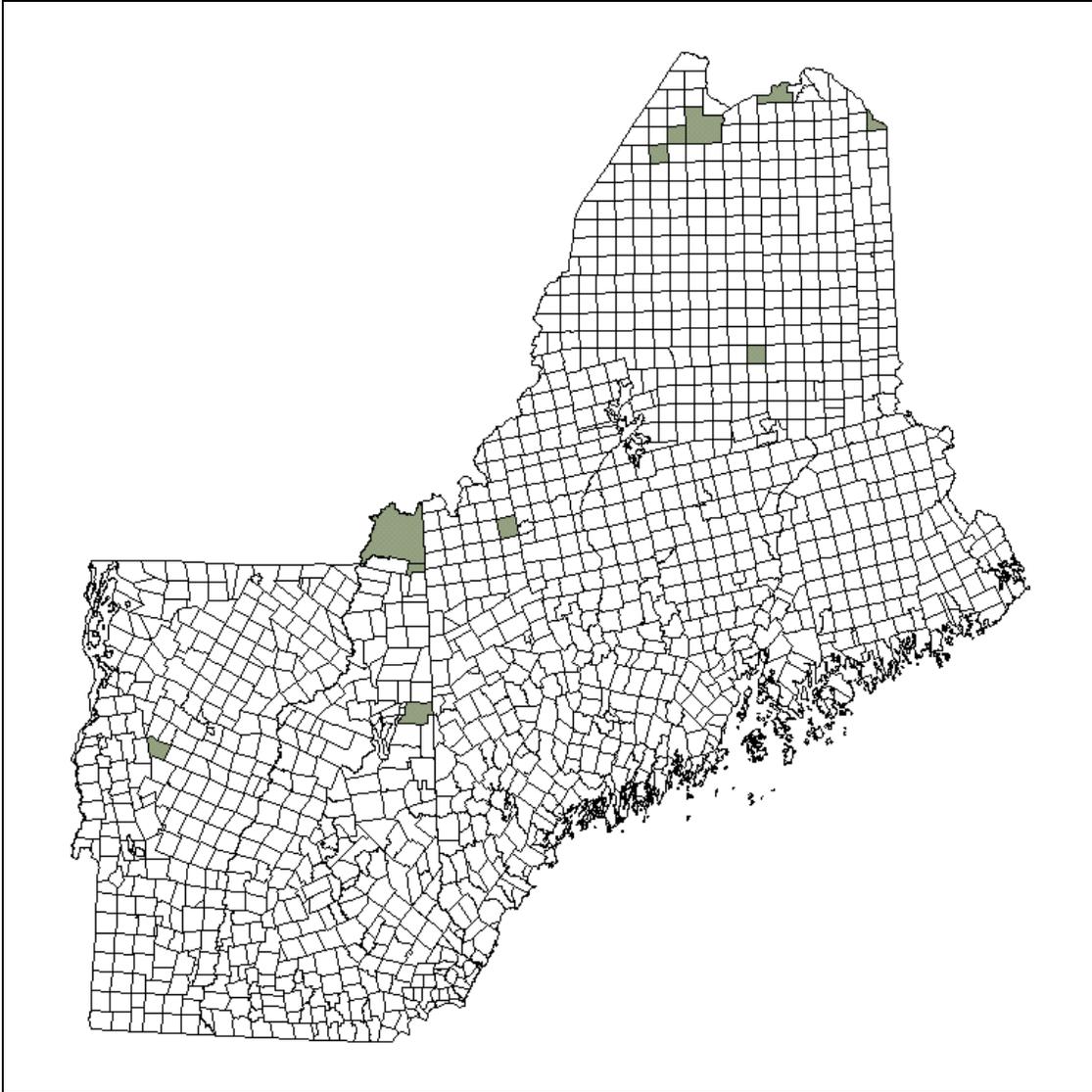


Figure 2. Extant occurrences of *Listera auriculata* in New England. Town boundaries for Maine, New Hampshire, and Vermont (the only New England states with the taxon) are shown. Towns shaded in gray have one to five confirmed, extant occurrences.

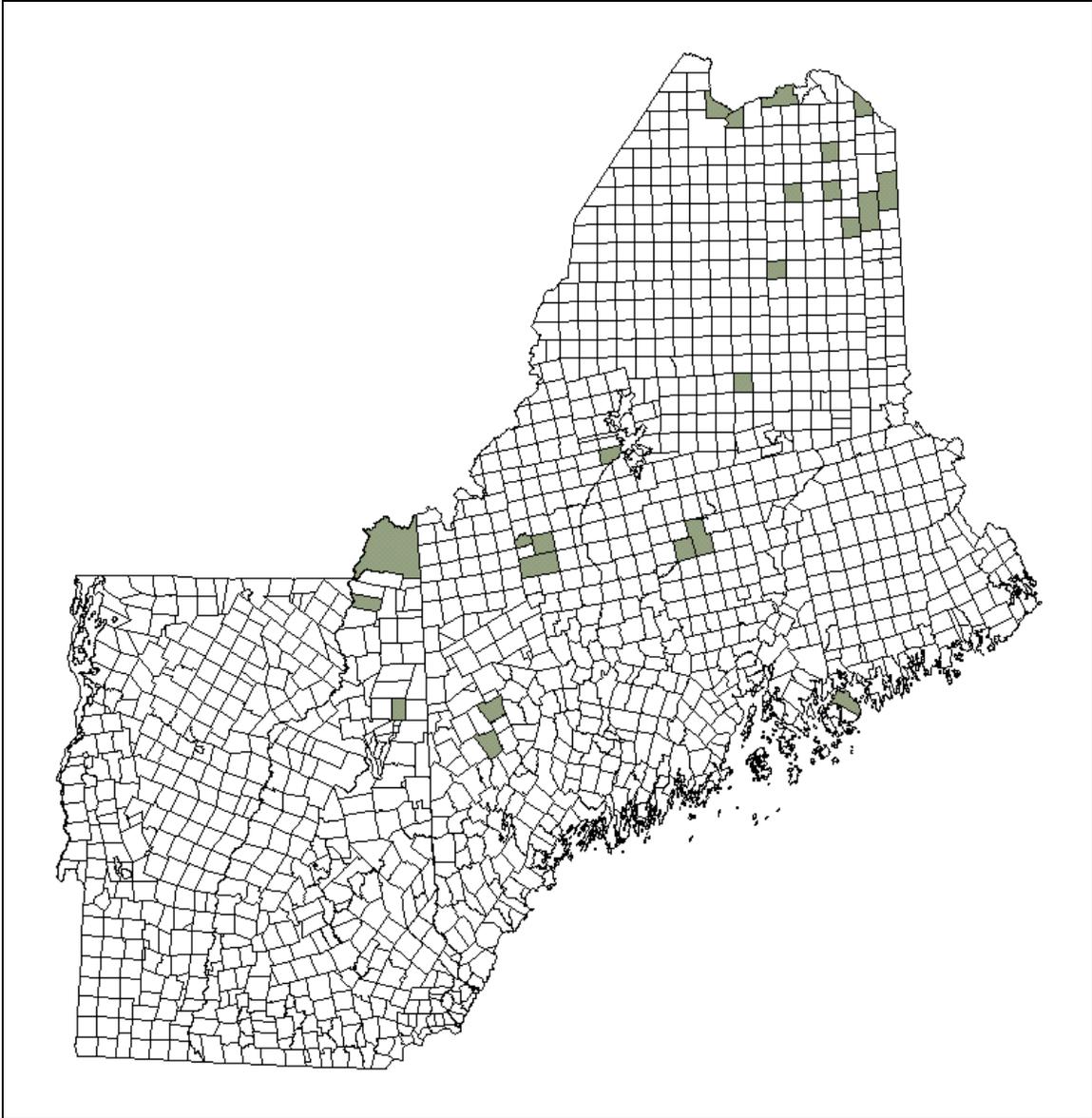


Figure 3. Historic occurrences of *Listera auriculata* in New England. Towns shaded in gray have one to five historic records of the taxon.

CURRENT CONSERVATION MEASURES IN NEW ENGLAND

In Maine, only one extant site is on state land; the land manager is aware of the sensitivity of the riparian areas (Susan Gawler, Maine Natural Areas Program, personal communication). The rest are on private lands and are not formally protected, except by shoreline zoning. Sites along the upper St. John River may benefit from an existing agreement to refrain from logging and development on uplands near the river. However, the hydrology of the river is not formally protected, and heavy timber harvesting in the watershed could affect the river's flow.

All of New Hampshire's three extant sites are protected: one is privately owned and managed as a registered natural area; part of one is in a Nature Conservancy preserve (more plants are nearby, on privately owned, unprotected land), and so is protected from development and monitored; however, the watershed is not protected by the Nature Conservancy. The site in the White Mountain National Forest is protected from human activities that might adversely affect the habitat, as long as the auricled twayblade population there is considered viable.

One of Vermont's populations is on private land; the present owner is protecting it by not logging near it. The other is protected in a national wildlife refuge.

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

Auricled twayblade in its entire range is widespread but vulnerable to extirpation, especially by human alteration of stream and river hydrology. The only place it is protected by law is in Minnesota. In New England it reaches the southern limit of its range, with none reported below 44° north. It fits the profile for threatened species described in Reznicek (1989): northern distribution; scattered, small pockets of habitat; and scarcity of nearby populations that could produce propagules for repopulation.

The conservation objectives for auricled twayblade in New England are to conduct a more thorough search for the plant, to protect habitat on moderate-energy riverbanks by conserving natural hydrology, and to study the plant's life history and habitat preferences. The goal is to protect hydrology and habitat for ten viable populations (of 50+ plants each) scattered over the region. Those numbers are estimates based on the Heritage Program reports on the species and the way the population size fluctuates and shifts sites. Populations of more than 50 plants may shrink dramatically and even disappear at times, but seem to persist in the few sites that have been observed over several years.

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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 -- that is, 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 to 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 (EO) ranks. 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 EOs 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 been made for more than 20 years. An X rank is utilized for sites that are known to be extirpated. Not all EOs have received such ranks in all states, and ranks are not necessarily consistent among states as yet.