

*Conservation Assessment
for
Auricled Twayblade (*Listera auriculata*)*



Photo: Wisconsin Herbarium

USDA Forest Service, Eastern Region

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This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee, Wisconsin 53203.

Table of Contents

EXECUTIVE SUMMARY	4
INTRODUCTION/OBJECTIVES	5
DESCRIPTION OF SPECIES	5
NOMENCLATURE AND TAXONOMY	6
SPECIES BIOLOGY.....	6
HABITAT/ECOLOGY	8
POTENTIAL THREATS AND MONITORING	9
DISTRIBUTION, ABUNDANCE, AND STATUS.....	10
STATUS OF ALL NEW ENGLAND OCCURRENCES—CURRENT AND HISTORIC.....	11
LONG-TERM PROTECTION	25
SEARCHING FOR NEW OCCURRENCES	25
HABITAT AND SPECIES BIOLOGY	26
MONITORING POPULATIONS.....	26
RECOMMENDED CONSERVATION ACTIONS FOR EACH OCCURRENCE.....	27
LITERATURE CITED	45
APPENDICES	49
ACKNOWLEDGMENTS.....	51

EXECUTIVE 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.

INTRODUCTION/OBJECTIVES

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 OF SPECIES

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).

NOMENCLATURE AND TAXONOMY

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*).

POTENTIAL THREATS AND MONITORING

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, ABUNDANCE, 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 <i>Listera auriculata</i> 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)	OCCURRENC E 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.

S t a t e	EO #	County	Town	Site Ownership	First Observed	Last Observed	Description	EO Rank	Population Size (date)	Comments	Threats
M E	.001	Aroostook	Chapman	Unknown	1942	1942	Stream bank	H	No data	U. Maine at Presque Isle Herbarium	Urban encroach ment and water pollution
M E	.002	Aroostook	Fort Fairfield	Unknown	1893	1893	Mossy woods	H	No data	NEBC Herbarium	
M E	.003	Aroostook	Fort Kent	Unknown	1881	1908	Alder thicket and alluvium on river shore	H	No data	Gray, NEBC Herbaria	
M E	.004	Aroostook	Fort Kent	Private	1904	1914	Boggy alluvial woods	H	No data	NEBC Herbarium; not found in 1977 or 1982	
M E	.005	Aroostook	Portage Lake	Unknown	1943	1944	Lake shore under alders	H	No data	U. Maine at Presque Isle Herbarium; not found in 1977	
M E	.006	Aroostook	Presque Isle	Unknown	1902	1902	River shore	H	No data	UNH, NEBC Herbaria	
M E	.007	Aroostook	St. Francis	Unknown	1902	1902	Alluvium on banks and springs in spruce woods	H	No data	NEBC Herbarium; not found in 1977	

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S t a t e	EO #	County	Town	Site Ownership	First Observed	Last Observed	Description	EO Rank	Population Size (date)	Comments	Threats
M E	.008	Aroostook	Van Buren	Unknown	1901	1901		H	No data	NEBC Herbarium	
M E	.009	Aroostook	Wade	Unknown	1920	1920	Alder clump on river shore, with broad-leaved twayblade	H	No data	Orono Herbarium	
M E	.010	Aroostook	T9 R7 WELS	Unknown	1946	1946	Mossy spots under alders on shore	H	No data	NYBG Herbarium	
M E	.011	Aroostook	T18 R10 WELS	Unknown	1908	1908	Alder thicket	H	No data	NYBG Herbarium	
M E	.012	Penobscot	T4 R8 WELS	Private	1900	1986	Alluvial thicket	D	1 (1986)	Lots of potential habitat	Forestr y land
M E	.013	Piscataquis	Dover- Foxcroft	Unknown	1894	1894	Cedar swamp	H	No data	NEBC Herbarium	
M E	.014	Piscataquis	Sangervill e	Unknown	1897	1897		H	No data	NEBC Herbarium	
M E	.015	Piscataquis	Mt. Katahdin Township	Baxter State Park	1xxx	1xxx		H	No data	Not found in 1988	
M E	.016	Franklin	Carrabass ett Valley	Unknown	1896	1896	Mossy bank	H	No data	Gray Herbarium	
M E	.017	Somerset	Sapling Township	Unknown	1888	1888	River shore	H	No data	Gray Herbarium	

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

State	EO #	County	Town	Site Ownership	First Observed	Last Observed	Description	EO Rank	Population Size (date)	Comments	Threats
ME	.018	Oxford	Norway	Unknown	1862	1862		H	No data	NEBC Herbarium	
ME	.019	Oxford	Woodstock	Unknown	1887	1887		H	No data	NEBC Herbarium	
ME	.020	Hancock	Bar Harbor	Unknown (<i>not</i> Acadia NP)	1927	1927	Damp alder thicket	H	No data	NEBC Herbarium	
ME	.021	Hancock	Bar Harbor	Unknown (<i>not</i> Acadia NP)	1891	1891	Woods near meadow	H	No data	Not found in 1987, 1988	
ME	.022	Aroostook	T16 R12 WELS	Private	1984	1986	Alder thicket	CD	3 (1984)	Not found in 1989; station for Furbish's lousewort	
ME	.023	Aroostook	Fort Kent	Private	1984	1990	Alder thicket	C	3 (1984), 10 (1990)	Station for Furbish's lousewort	None
ME	.024	Aroostook	T15 R13 WELS	Private	1985	1985	Riverside seep	A	42 (1985)	Not noted in 1997; station for Furbish's lousewort	Logging
ME	.025	Aroostook	Allagash	Private	1985	1993	Riverside seep	E	77 (1985), 9 (1989)	Not found in 1993; station for Furbish's lousewort	Logging
ME	.026	Aroostook	Allagash	Maine BPL or town of Allagash	1985	1985	Riverbank shrubs	CD	4 (1985)	Station for Furbish's lousewort	Logging

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

S t a t e	EO #	County	Town	Site Ownership	First Observed	Last Observed	Description	EO Rank	Population Size (date)	Comments	Threats
M E	.027	Aroostook	Hamlin	Private	1985	1995	Riverbank	BC	10 (1985), 3 (1995)	Station for Furbish's lousewort	Dam upriver; houses above on bank
M E	.028	Somerset	Bigelow and Dead River Township s	Maine BPL	1978	1978		H	No data	May have been misidentifie d; no voucher	
M E	.029	Aroostook	Westman and	Unknown	No data	No data		H	No data	Not found in 1976	Logging in area
M E	.030	Aroostook	T15 R13 WELS	Private	1993	1997	Seep	B	3 (1993), >100 (1997)	Station for Furbish's lousewort	None
M E	.031	Franklin	Eustis	Private	1994	2000	Riverbank	A	>200 (1994), ~400 (2000)		Nearby rural highway , logging in area
N H	.001	Coos	Atkinson and Gilmanto n Academy Grant	Private	1980	2000	Riverbank	A	159 (1985), 0 (1998), 117 (2000)		On banks of swimmi ng hole, nearby logging

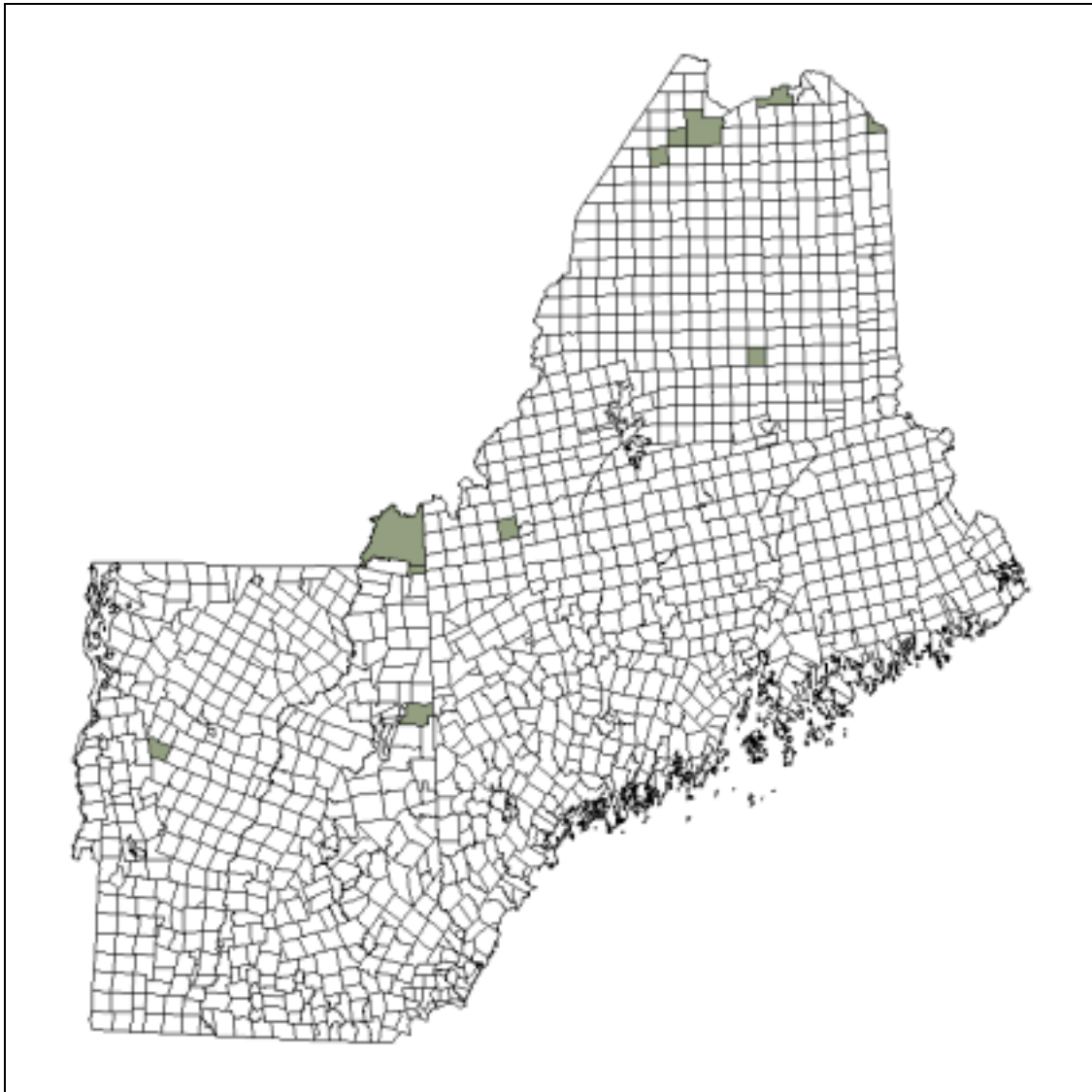
Table 2. New England occurrence records for *Listera auriculata*. Shaded occurrences are considered extant.

S t a t e	EO #	County	Town	Site Ownership	First Observed	Last Observed	Description	EO Rank	Population Size (date)	Comments	Threats
NH	.002	Coos	Pittsburg	Unknown	1955	1955	Alder swamp, serpentine area on border with Canada	H	No data		
NH	.003	Coos	Pittsburg	Private	1984	2000	Stream bank	B	23 (1984), 148 (1987), 45 (1993), 57 (2000)		Fishing along banks; upstream dam
NH	.004	Coos	Bean's Purchase	White Mountain NF	1914	1994	Ephemeral stream into river	E	35 (1992), 0 (2000)	Not found in 1996, 1997, 2000; scoured in 1995 flood	Near active trail
NH	.005	Coos	Colebrook	NH state park	1917	1917	Damp woods	H	No data		
NH	.006	Coos	Gorham	Possibly White Mountain NF and private	1908	1908		H	No data	Not found in 1999, 2000	
NH	.007	Coos	Colebrook	Unknown	1920	1920	Cedar bog	H	No data	In Pease's Flora	
VT	.001	Washington	Warren	Private	1934	1996	Seepy drainage	C	4 (1986), 25 (1996)	Unusual habitat	Logging nearby



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.



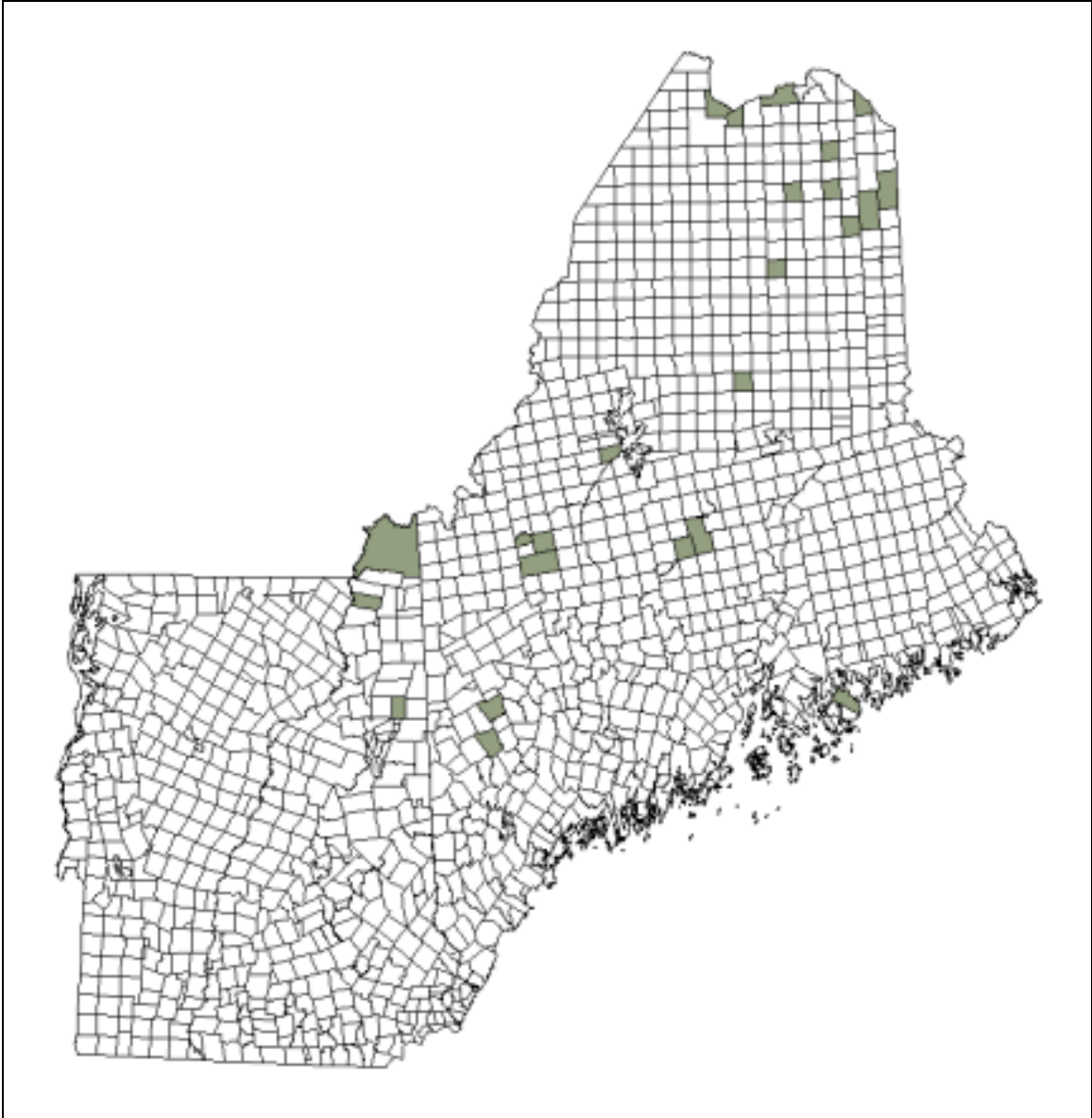


Figure 3. Historic occurrences of *Listera auriculata* in New England. Towns shaded in gray have one to five historic records of the taxon.

Status of Maine Occurrences

ME .001 (Chapman) -- Very little is known about this record from a stream bank in Chapman. The specimen, collected by Norton in 1942, is at the University of Maine at Presque Isle. The EO rank is H.

ME .002 (Fort Fairfield) -- Very little is known about this record from "mossy woods" in Fort Fairfield. The specimen, collected by Fernald in 1893, is in the New England Botanical Club (NEBC) collection at the Gray Herbarium. The EO rank is H.

ME .003 (Fort Kent) -- Four collections place auricled twayblade at Fort Kent along the St. John River. The site(s) were alder thickets and alluvium on the riverbank. Because the latest collection was in 1908, the EO rank is H.

ME .004 (Fort Kent) -- Three collections place auricled twayblade at Fort Kent along the Fish River. The site is variously described as alluvial woods, alluvium near the river, and boggy woods. The plant was not found in 1977, nor in 1982, when other rare plants were noted at the site. Because the latest documentation was in 1914, the EO rank is H.

ME .005 (Portage Lake) -- Norton found the plant on the shore of Portage Lake in 1943 and 1944. The location was under alders, in mossy woods, among wet rocks. The plant was not found in 1977. The EO rank is H.

ME .006 (Presque Isle) -- Very little is known about this record from the banks of the Aroostook River in Presque Isle. Specimens collected by Fernald et al. in 1902 are in the NEBC collection at the Gray Herbarium, the Hodgdon Herbarium at the University of New Hampshire, and the Academy of Natural Sciences, Philadelphia. The EO rank is H.

ME .007 (St. Francis) -- Very little is known about this record from "banks and springs in spruce woods" in St. Francis. A specimen, collected by Eggleston and Fernald in 1902, is in the NEBC collection at the Gray Herbarium. The plant did not turn up in a search in 1977. The EO rank is H.

ME .008 (Van Buren) -- Very little is known about this record from Van Buren. The specimen, collected by E. F. Williams in 1901, is in the NEBC collection at the Gray Herbarium. The EO rank is H.

ME .009 (Wade) -- G. D. Chamberlain collected a specimen in 1920 on the shore of the Aroostook River in Wade. The location was in an alder clump on the riverbank, growing with broad-leaved twayblade (*Listera convallarioides*). The EO rank is H.

ME .010 (T9 R7 WELS) -- Very little is known about this record from mossy spots under alders along the shore of the Aroostook River in T9 R7 WELS. The specimen, collected by Chamberlain and Ogden in 1946, is at the New York Botanical Garden. The EO rank is H.

ME .011 (T18 R10 WELS) -- Very little is known about this record from alder thickets in T18 R10 WELS. It may have been found along the St. John River. The specimen, collected by Mackenzie in 1908, is at the New York Botanical Garden. The EO rank is H.

ME .012 (T4 R8 WELS) -- This site on Wassataquoik Stream in T4 R8 WELS was first reported by Fernald in 1900. One plant was found there in 1986. The site is an alluvial thicket; the plant was in moss under royal fern (*Osmunda regalis*) and speckled alder (*Alnus incana* ssp. *rugosa*) on a sandy substrate. The EO rank is D. The habitat is excellent and is in forestry land.

ME .013 (Foxcroft) -- Very little is known about this record from a cedar swamp in Foxcroft. The specimen, collected by Fernald in 1894, is in the NEBC collection at the Gray Herbarium. The EO rank is H.

ME .014 (Sangerville) -- Very little is known about this record from Sangerville. The specimen, collected by Fernald in 1897, is in the NEBC collection at the Gray Herbarium. The EO rank is H.

ME .015 (Mt. Katahdin) -- Very little is known about this record from Mount Katahdin. The specimen, collected by Chickering, is in the Gray Herbarium. The plant did not turn up in a 1988 search. The EO rank is H.

ME .016 (Carrabassett Valley) -- Very little is known about this record from a mossy bank of the Carrabassett River. The specimen, collected by Fernald in 1896, is in the NEBC collection at the Gray Herbarium. The EO rank is H.

ME .017 (Sapling Township) -- Faxon collected a specimen in 1888 on the shore of the Kennebec River in Sapling Township. The plant has not been reported there since, and so has an EO rank of H.

ME .018 (Norway) -- Very little is known about this record from Norway. The specimen, collected by Mann in 1862, is in the NEBC collection at the Gray Herbarium. The EO rank is H.

ME .019 (Woodstock) -- Very little is known about this record from Woodstock. The specimen, collected by Parlin in 1887, is in the NEBC collection at the Gray Herbarium. The EO rank is H.

ME .020 (Bar Harbor) -- Very little is known about this record from a damp alder thicket on Mount Desert Island (not on National Park land). The specimen, collected by Stebbins in 1927, is in the NEBC collection at the Gray Herbarium. The EO rank is H.

ME .021 (Bar Harbor) -- Rand collected a specimen in 1891 in woods near a brook on Mount Desert Island (not on National Park land). Although suitable habitat still exists, searches in 1987 and 1988 did not find any plants. The EO rank is H.

ME .022 (T16 R12 WELS) -- Three auricled twayblades were found in 1984 during searches for Furbish's lousewort (*Pedicularis furbishiae*, a rare endemic Maine plant) along the banks of the St. John River. They were growing in an alder thicket with Furbish's lousewort. The population was still there in 1986, but was not found in 1989. The property is privately owned and has an EO rank of CD.

ME .023 (Fort Kent) -- Three auricled twayblades were found in 1984 during searches for Furbish's lousewort along the banks of the St. John River. The orchids were growing on sandy loam, in a riverside alder thicket on a steep, mossy bank. An associated species was pink pyrola (*Pyrola asarifolia*). In 1989 the area was scoured, and no plants were seen. In 1990 there were ten plants, some flowering. The area is privately owned and used for logging. The site has an EO rank of C.

ME .024 (T15 R13 WELS) -- A good-sized population of auricled twayblade (42 plants) was found in 1985 during searches for Furbish's lousewort along the banks of the St. John River. The orchids were scattered in moss on a riverbank seep at the bottom of a conifer-covered, steep bank. The substrate is thin gravelly soil over bedrock. Associated species were northeastern paintbrush (*Castilleja septentrionalis*), bunchberry (*Cornus canadensis*), buttercup (*Ranunculus acris*), flat-topped white aster (*Aster umbellatus*), field horsetail (*Equisetum arvense*), alders, rough bedstraw (*Galium asprellum*), and hemlock-parsley (*Conioselinum chinense*).The

location is nearly pristine and privately owned. Logging operations could threaten the hydrology, but the site presently has an EO rank of A.

ME .025 (Allagash) -- This site was discovered in 1985 during searches for Furbish's lousewort along the banks of the St. John River. In 1985, 77 individual orchids were growing in a band of herbs and shrubs at the bottom of a steep gravel riverbank, with a forest above. The area was ice-scoured in 1984, although it is 8 m from low water. The substrate is sandy loam, with some leaf litter. Associated species were speckled alder (*Alnus incana* ssp. *rugosa*), northern white cedar (*Thuja occidentalis*), mountain maple (*Acer spicatum*), round-leaved dogwood (*Cornus rugosa*), dwarf raspberry (*Rubus pubescens*), bead-lily (*Clintonia borealis*), foam-flower (*Tiarella cordifolia*), balsam fir (*Abies balsamea*), and rough bedstraw (*Galium asprellum*). The population disappeared in 1993, when the area was severely scoured; its EO rank was AB before the scouring. The bank is too steep for logging; a woods road is at the top of the bank.

ME .026 (Allagash) -- Four auricled twayblades were found in 1985 during searches for Furbish's lousewort along the banks of the St. John River. The orchids were growing above the scour zone in dense interrupted fern (*Osmunda claytoniana*). Other associates were false hellebore (*Veratrum viride*), rose twisted stalk (*Streptopus roseus*), bristly aster (*Aster puniceus*), dwarf raspberry (*Rubus pubescens*), tall meadow-rue (*Thalictrum pubescens*), and alder. The soil is moist sand and gravel with moss. The land is privately owned and used for logging. The EO rank is CD.

ME .027 (Hamlin) -- Ten auricled twayblades were found in 1985 during searches for Furbish's lousewort along the banks of the St. John River. The small population disappeared in 1989, but was seen again in 1995. The orchids grow on wet to mesic sandy loam, with moss on top. They are between a forested, high, steep riverbank and an alder thicket. Other associated species are willow (*Salix* sp.), red-osier dogwood (*Cornus sericea*), bird-vetch (*Vicia cracca*), red clover (*Trifolium pratense*), hawkweed (*Hieracium* sp.), Furbish's lousewort, and thick-leaved wild strawberry (*Fragaria virginiana*). The hydrology of the site is affected by a nearby dam. At the top of the bank is a highway and some houses. The EO rank is BC.

ME .028 (Bigelow and Dead River Townships) -- This record is unconfirmed; no specimen was collected. The orchid was seen in fruit in atypical habitat.

ME .029 (Westmanland) -- An herbarium specimen from Norway was reported by Eastman. A search in 1976 did not find any plants. The EO rank is H.

ME .030 (T15 R13 WELS) -- Three auricled twayblades were found in 1993 during searches for Furbish's lousewort along the banks of the St. John River. In 1997 the population had grown to more than 100 plants at the rocky base of a steep riverbank, in the shade of alders. The land is privately owned and may be used for logging. The EO rank is B.

ME .031 (Eustis) -- This large population was found on the North Branch of the Dead River in 1994. The original report sampled the population stretching for more than a mile along the river. In 2000 there were hundreds of plants in the surveyed plot, with many others outside the plot, scattered plants across the river, and a medium-sized subpopulation downstream. The plants are on a sandy channel shelf, often growing in moss, with a scattering of other herbaceous plants. Associated species were speckled alder (*Alnus incana* ssp. *rugosa*), sensitive fern (*Onoclea sensibilis*), virgin's bower (*Clematis virginiana*), and dwarf raspberry (*Rubus pubescens*). The forest around the river is largely fir, spruce, and maple. Running along the river is a rural highway; there is occasional dumping from the roadside. The area is used for logging and gravel removal. The EO rank is A.

Status of New Hampshire Occurrences

NH .001 (Atkinson and Gilmanton Academy Grant) -- A sizable but fluctuating population on the Dead Diamond River was first observed in 1980. As many as 159 plants have been seen in an alder thicket, on a seepy bank, not more than 2 m from summer water level. The substrate is sandy alluvial soil, with considerable moss and river debris. Associated plants were speckled alder (*Alnus incana* ssp. *rugosa*) and mosses; other associates varied in different parts of the population, and included bristly aster (*Aster puniceus*), rough bedstraw (*Galium asprellum*), flat-topped white aster (*Aster umbellatus*), violets (*Viola* spp.), whorled aster (*Aster acuminatus*), and bush-honeysuckle (*Diervilla lonicera*). The owners are protecting the site from nearby logging. To maintain woodcock habitat, the manager is considering thinning alders in the large thickets downstream from this site; as far as I know, this area has not been searched for auricled twayblade. The population could suffer from activity at a nearby swimming hole. The EO rank is A.

NH .002 (Pittsburg) -- This site was reported in 1955 by Steele. It is in an alder swamp in a serpentine area. The EO rank is H.

NH .003 (Pittsburg) -- A small population was found in 1984. In 1987, it had 148 plants (most not flowering), in 1993 it had 45 plants, and then it was not seen again until 2000, in spite of intensive searches. In 1999 an upstream dam was partly rebuilt, resulting in a heavier than usual flow that year. The population in 2000 was 57 plants, with very few in flower, and with scattered plants found in a limited search downstream. The orchids were growing on mossy sand among boulders in the ice-scoured and flooded channel shelf. Associated plants were bush-honeysuckle (*Diervilla lonicera*), white lettuce (*Prenanthes* cf. *altissima*), lady fern (*Athyrium filix-femina*), and interrupted fern (*Osmunda claytoniana*). The surrounding community is a mixed forest of hardwoods and softwoods, with speckled alder (*Alnus incana* ssp. *rugosa*) and bush-honeysuckle dominating the stream banks. There are signs of fishing on the banks. The site is partly in a New Hampshire Nature Conservancy site, and partly privately owned and marked "for restrictive land use." The EO rank is B.

NH .004 (Bean's Purchase) -- The Wild River site was first reported in 1914 by Pease. A small population was last seen in 1994, growing in moss on damp sand, next to an intermittent stream. Associated plants included speckled alder (*Alnus incana* ssp. *rugosa*), whorled aster (*Aster acuminatus*), wild sarsaparilla (*Aralia nudicaulis*), and Canada mayflower (*Maianthemum canadense*). The surrounding community is a mixed hardwood forest. In 1995 the area was scoured by fall floods. Searches nearly every year since have not found the orchid. In 2000 the search included likely habitat up- and downstream from the site. The entire upstream watershed is within White Mountain National Forest, so the hydrology is protected from dams and poor logging practices. The site had 35 plants in 1992.

NH .005 (Colebrook) -- This site was reported in 1917 by Pease. It is on Beaver Brook, on public land. Its EO rank is H.

NH .006 (Gorham) -- This site on the Moose River near Gorham was reported in 1908 by Pease. Searches in 1984, 1999, and 2000 did not turn up the plant, although the habitat seems right, including alder stands and interrupted-fern (*Osmunda claytoniana*) glades. Perhaps the same flooding that affected NH.004 in 1995 removed auricled twayblade here as well. The surrounding habitat includes an old railroad track, now a bike path; a highway providing easy access to the river; and housing developments in the watershed. The EO rank is H.

NH .007 (Colebrook) -- Very little is known about this site in Colebrook. The record is from Pease 1964. The EO rank is H.

Status of Vermont Occurrences

VT .001 (Warren) -- This site is a seepy drainage, rather atypical for the plant, in Warren. It was first seen in 1934. It was maintaining a small population of 25 plants as recently as 1996. The orchids are growing next to alders in a mucky area. Part of the population has disappeared, probably because a water impoundment has altered the hydrology of the site. Changes to a nearby road could also affect the drainage. The current owner is aware of the plants and is protecting the area from logging.

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.

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.

General Conservation Actions for the Taxon

1. **Contact landowners** and inform them of the species' status. Get permission to monitor sites and conduct research.
2. **Investigate long-term protection** for high-quality occurrences.
3. **Collect detailed information**, including size, condition, trends, associated species, landscape context, and threats, on extant sites for auricled twayblade. Try to relocate historical sites and search for new populations, especially in areas that are likely candidates for protection.
4. **Study species biology**, such as dispersal mechanisms and germination time.
5. **Institute regular monitoring** of extant sites to collect population data and determine habitat preferences.
6. **Consider feasibility of seed banking and reintroduction** of auricled twayblade where it seems to be permanently extirpated by severe flooding and scouring.

Landowner Communications

Contact (or find) landowners and ask for permission to monitor or search for auricled twayblade. Let them know the habitat needs of the plant (so far as we know them) and encourage them not to interfere with hydrology while logging or clearing land. In many cases, reasonable protection may involve nothing more than formalizing good forestry practices that are already in use.

LONG-TERM PROTECTION

The present flow regimes and watersheds where auricled twayblade is known to grow should be maintained or left alone. Protection could involve easements that would buffer riparian areas from logging, access roads, and other threats to the present hydrology, and discourage recreational use in its favored habitat. Because auricled twayblade populations seem to shift sites, riparian areas that offer apparently suitable, potential habitat should be protected as well as present habitat.

Although major dam building is currently not a threat, other development can affect water quality and hydrology. This is already an issue at some sites, and might be especially difficult to control along the border with Canada. Given that the global rareness of Furbish's lousewort (*Pedicularis furbishiae*), which inhabits some of the same places as auricled twayblade, has not produced formal protection agreements since the beginning of its extensive documentation along the St. John River 17 years ago, it seems unlikely that the presence of auricled twayblade will initiate such agreements. Although New Hampshire has a law that describes a procedure to protect water flow in rivers of natural and cultural significance, none of the sites that support populations of auricled twayblade are on a designated river.

SEARCHING FOR NEW OCCURRENCES

Search for extant populations in historical sites and other likely habitat, emphasizing sites that can be protected and the southernmost occurrences for the species. There are more historical sites than extant sites. Is that largely an artifact of less botanizing going on now than in the late 1800s and early 1900s, or of loss of habitat? The serendipitous sightings of new populations in Maine since 1994—while in pursuit of other objectives -- seems to indicate the former in Maine. Lapin (1996) suggests likely habitat in Vermont would be sandy stream banks with alders, particularly along the Passumpsic and Nulhegan Rivers. Also, look on forested stream

banks, with or without moss, and probably with an herb layer that is not very dense. Interrupted-fern (*Osmunda claytoniana*) glades, especially at seeps, might be worth checking as well.

HABITAT AND SPECIES BIOLOGY

Searching for new populations presupposes an accurate description of auricled twayblade's preferred habitat; there are many alder thickets along streams in northern New England, but not many harbor populations of auricled twayblade. Research is necessary to identify possible habitat; to discover dispersal mechanisms (e.g., tolerance of seeds for water dispersal and effectiveness of wind as a dispersal agent for short-statured plants); to determine how big an area can support a metapopulation (so we can comfortably decide to protect a certain size of preserve); and to develop a template to guide searches for new populations.

MONITORING POPULATIONS

Monitor to ensure the health of extant populations and to gather information on population demography. These data could tell us how long it takes the plant to recover or reestablish in a freshly scoured zone. Because of the shifting populations in this frequently flooded and scoured habitat, it is difficult to track individuals (this was attempted in Michigan in the 1980s; Michael Penskar, Michigan Natural Features Inventory, personal communication). An alternative method, used by Vanhecke (1991) to track southern marsh-orchid (*Dactylorhiza praetermissa*), which also grows in flooded habitat, is to track population fluctuations. He marked a large permanent plot, divided it into grids each year, and noted presence/absence in the squares, as well as microhabitat differences such as flood duration. This kind of data could tell us where to look for auricled twayblade and, if a decision is made to repopulate a site, where to plant, and how long the plants might take to reestablish after a major disturbance. It would probably be useful to follow a population from June/ice out to senescence/first flood in fall, to see how late in the year one could expect to find plants. Herbivory, fall floods, or drought could render the small plants invisible. At other sites, timing visits for the same few weeks each year would help get comparable population figures.

Seed Banking and Reintroduction

Planning to reinstate the plant in historical areas or to establish new populations in appropriate habitats seems premature, since we do not yet have a very thorough survey of this species in New England or sufficient knowledge of its biology. We also do not know how large an area is necessary to allow space for refugia or how long the plant takes to reestablish from seed in a scoured area. Apparently the species can be undetectable for years yet reappear at a site (see NH.003 [Pittsburg]). It is unknown whether auricled twayblade is a good candidate for seed banking and reseeding a site; the few data available indicate poor germination results for seeds collected from heart-leaved twayblade (*Listera cordata*), which has a similar habit but lives in less disturbed habitat (Rasmussen 1995). Rasmussen and Whigham (1993) have described a way to study in situ germination that might be useful for auricled twayblade. Tiny orchid seeds are sown in packets that retain the seeds while allowing access to soil fauna and water. The packets are buried and tethered to a pole for easy retrieval. This method could provide data on dormancy period, seed mortality, germination conditions, and the fungi that associate with seedlings.

RECOMMENDED CONSERVATION ACTIONS FOR EACH OCCURRENCE

Many of the historical occurrences in Maine, and NH.007 (Colebrook), have location descriptions that put them in a search area with about a 5-mile radius. Attempting to relocate these occurrences would essentially be a *de novo* search for the plant, using aerial photos and topographic maps as guides to appropriate habitat. Historical occurrences with more precise descriptions are addressed individually below.

Maine

ME .004 (Fort Kent) -- Auricled twayblade was last seen in this Fort Kent site in 1914. The site was described accurately enough to make searching for an extant population a reasonable option, using topographic maps and local knowledge. Get landowner permission to search. If a population is discovered, collect detailed site information and evaluate its conservation potential.

ME .012 (T4 R8 WELS) -- This site has a lot of potential habitat in an undeveloped area, and the stream is not dammed. With the landowner's permission, survey the area for auricled twayblade and potential habitat. If a population is discovered, collect detailed site information and evaluate its conservation potential.

ME .017 (Sapling Township) -- Auricled twayblade was last seen here in Sapling Township in 1888. The site was described accurately enough to make searching for an extant population a reasonable option, using topographic maps and local knowledge. Get landowner permission to search. If a population is discovered, collect detailed site information and evaluate its conservation potential.

ME .020 (Bar Harbor) -- Auricled twayblade was last seen here in 1927. The Mount Desert Island site was described accurately enough to make searching for an extant population a reasonable option, using topographic maps and local knowledge. Get landowner permission to search. If a population is discovered, collect detailed site information and evaluate its conservation potential.

ME .021 (Bar Harbor) -- Auricled twayblade was last seen here in 1891. The Mount Desert Island site was described accurately enough to make searching for an extant population a reasonable option, using topographic maps and local knowledge. Get landowner permission to search. If a population is discovered, collect detailed site information and evaluate its conservation potential.

ME .022 (T16 R12 WELS) -- Try to make monitoring the auricled twayblade population at this site part of the regular Furbish's lousewort monitoring, which the Maine Natural Areas Program does now. The resulting data would allow assessment of the viability of the population, which was very small in 1986 and had disappeared in 1989. Investigate permanent protection that would encompass both rare plants.

ME .023 (Fort Kent) -- Try to make monitoring the auricled twayblade population at this site part of the regular Furbish's lousewort monitoring, which the Maine Natural Areas Program does now. The resulting data would allow assessment of the viability of the very small population. Investigate permanent protection that would encompass both rare plants.

ME .024 (T15 R13 WELS) -- Try to make monitoring the auricled twayblade population at this site part of the regular Furbish's lousewort monitoring, which the Maine Natural Areas Program does now. Investigate permanent protection that would encompass both rare plants. If the landowner is agreeable, this site would be a good place to gather information on site shifting and microhabitat preferences.

ME .025 (Allagash) -- Try to make monitoring the auricled twayblade population at this site part of the regular Furbish's lousewort monitoring, which the Maine Natural Areas Program does now. Investigate permanent protection that would encompass both rare plants. The habitat was scoured by ice in 1984 and 1993; 77 auricled twayblades reappeared in 1985, but it is unknown how many are there now.

ME .026 (Allagash) -- Try to make monitoring the auricled twayblade population at this site part of the regular Furbish's lousewort monitoring, which the Maine Natural Areas Program does now. The resulting data would allow assessment of the viability of the very small population. Investigate permanent protection that would encompass both rare plants.

ME .027 (Hamlin) -- Try to make monitoring the auricled twayblade population at this Hamlin site part of the regular Furbish's lousewort monitoring, which the Maine Natural Areas Program does now. The resulting data would allow assessment of the viability of the very small population. Consider permanent protection that would encompass both rare plants.

ME .028 (Bigelow and Dead River Townships) -- Search likely habitat in Bigelow and Dead River Townships.

ME .029 (Westmanland) -- Auricled twayblade was last seen here before 1976. The Westmanland site was described accurately enough to make searching for an extant population a reasonable option, using topographic maps and local knowledge. Get landowner permission to search. If a population is discovered, collect detailed site information and evaluate its conservation potential.

ME .030 (T15 R13 WELS) -- Try to make monitoring the auricled twayblade population at this site part of the regular Furbish's lousewort monitoring, which the Maine Natural Areas Program does now. Investigate permanent protection that would encompass both rare plants. If the landowner is agreeable, this site would be a good place to gather information on site shifting and microhabitat preferences.

ME .031 (Eustis) -- Contact landowner to discuss an easement and the possibility of maintaining the present flow regime to conserve a large population at the Eustis site. Determine the full extent of the population. If the landowner is agreeable, this site would be a good place to gather information on site shifting and microhabitat preferences. It also might be a good place to study auricled twayblade germination.

Three new sites (2001) -- Contact landowners for permission to make detailed surveys of the sites in T9 R9 WELS, T9 R10 WELS, and Kibby Township. Assess their viability and conservation potential at that point.

New Hampshire

NH .001 (Atkinson and Gilmanton Academy Grant) -- Continue monitoring the auricled twayblade populations at this site. Search for subpopulations up- and downstream of the swimming hole. Discuss potential alder management for woodcock with the landowner to discover if it could adversely affect auricled

twayblade habitat. If the landowner is agreeable, this site would be a good place to gather information on site shifting and microhabitat preferences. Visit during late summer to see if trampling or erosion caused by swimmers is an issue that needs to be addressed.

NH .002 (Pittsburg) -- Auricled twayblade was last seen here in 1955. The Pittsburg site was described accurately enough to make searching for an extant population a reasonable option, using topographic maps and local knowledge. Get landowner permission to search. If a population is discovered, collect detailed site information and evaluate its conservation potential.

NH .003 (Pittsburg) -- Continue monitoring the fluctuating auricled twayblade population at this site. Search adjacent habitat more thoroughly for other occurrences. This site might be a good place to gather information on site shifting and microhabitat preferences. Are there records that would allow comparison of stream flow before and during rebuilding of the nearby dam? Monitor to see if having few flowering plants relative to vegetative plants is a pattern here, and if so, compare to populations at other sites. If warranted, consider formal protection of habitat, perhaps an extension of the preserve.

NH .004 (Bean's Purchase) -- White Mountain National Forest staff are monitoring this site, which recently (1994) supported a small population on the Wild River in New Hampshire. The 1914 herbarium sheet for this site describes a location upstream from the 1990s population. We conducted the 2000 search before discovering the details of the older site. Continue to monitor the site for a reappearance of the population, and conduct a more extensive search for subpopulations along the river. Encourage the White Mountain National Forest to designate auricled twayblade a "sensitive species."

NH .005 (Colebrook) -- Auricled twayblade was last seen here in 1917. The Colebrook site was described accurately enough to make searching for an extant population a reasonable option, using topographic maps and local knowledge. Get landowner permission to search. If a population is discovered, collect detailed site information and evaluate its conservation potential.

NH .006 (Gorham) -- Auricled twayblade was last seen here in 1908. The Gorham site was described accurately enough to make relocation a reasonable option, using topographic maps and local knowledge. It was searched in 1984, 1999, and 2000, without success; perhaps this site was affected by the same fall floods as NH.004 was in 1995.

Vermont

VT .001 (Warren) -- Continue monitoring the auricled twayblade population at this Warren site. Investigate permanent protection that would ensure that roadwork does not affect the drainage.

One new site (2001) -- Get details on the population and habitat and investigate any measures needed to ensure the population's viability.

Prioritized Implementation Table

The prioritized implementation table (Table 3) lists and ranks actions that should be undertaken in order to implement the conservation plan for *Listera auriculata*. The schedule is subject to revision based on annual review of conservation objectives. Conservation actions are arranged in priority order based on the following definitions:

Priority 1 – An action that should be taken to prevent irreversible declines in the species' status in New England.

Priority 2 – An action that should be taken to prevent or reverse significant declines in the species' status in New England.

Priority 3 and 4 – All other actions necessary to meet the conservation objectives.

As landowner contact is required for each site to gain site access and permission to perform other research activities, it is considered a priority action and is not listed separately for each occurrence unless special circumstances exist. Conservation activities will take place only with landowner permission.

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
New England general actions					Look for likely habitat; identify landowners; get permission to search	Rank new populations; assign priorities for conservation plan
ME	.001	Chapman				Look for likely habitat; identify landowners; get permission to search
ME	.002	Fort Fairfield				Look for likely habitat; identify landowners; get permission to search
ME	.003	Fort Kent				Look for likely habitat; identify landowners; get permission to search
ME	.004	Fort Kent			Get permission to relocate population; make detailed survey	
ME	.005	Portage Lake			Look for likely habitat; identify landowners; get permission to search	
ME	.006	Presque Isle			Look for likely habitat; identify landowners; get permission to search	
ME	.007	St. Francis			Look for likely habitat; identify landowners; get permission to search	

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
ME	.008	Van Buren			Look for likely habitat; identify landowners; get permission to search	
ME	.009	Wade			Look for likely habitat; identify landowners; get permission to search	
ME	.010	T9 R7 WELS			Look for likely habitat; identify landowners; get permission to search	
ME	.011	T18 R10 WELS				Look for likely habitat; identify landowners; get permission to search
ME	.012	T4 R8 WELS		Get permission to relocate population; make detailed survey		
ME	.013	Dover- Foxcroft				Look for likely habitat; identify landowners; get permission to search
ME	.014	Sangerville				Look for likely habitat; identify landowners; get permission to search
ME	.015	Mt. Katahdin Township			Look for likely habitat; identify landowners; get permission to search	

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
ME	.016	Carrabassett Valley			Look for likely habitat; identify landowners; get permission to search	
ME	.017	Sapling Township		Identify landowners; get permission to relocate population; make detailed survey		
ME	.018	Norway				Look for likely habitat; identify landowners; get permission to search
ME	.019	Woodstock				Look for likely habitat; identify landowners; get permission to search
ME	.020	Bar Harbor			Identify landowners; get permission to relocate population; make detailed survey	
ME	.021	Bar Harbor			Identify landowners; get permission to relocate population; make detailed survey	
ME	.022	T16 R12 WELS	Collect demographic data	Assess viability of population	Investigate protection if warranted	
ME	.023	Fort Kent	Collect demographic data	Assess viability of population	Investigate protection if warranted	

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
ME	.024	T15 R13 WELS	Collect demographic data	Investigate long-term protection; study habitat preferences and site shifts		
ME	.025	Allagash	Collect demographic data	Investigate long-term protection		
ME	.026	Allagash	Collect demographic data	Assess viability of population	Investigate protection if warranted	
ME	.027	Hamlin	Collect demographic data	Assess viability of population	Consider long-term protection	
ME	.028	Bigelow and Dead River Townships			Search likely habitat	
ME	.029	Westmanland		Identify landowners; get permission to relocate population; make detailed survey		
ME	.030	T15 R13 WELS	Collect demographic data	Investigate long-term protection; study habitat preferences and site shifts		

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
ME	.031	Eustis	Collect demographic data; establish full extent of population	Investigate long-term protection; study habitat preferences and site shifts; pursue germination studies		
ME new site		Kibby Township		Identify landowners; get permission to relocate population; make detailed survey	Assess viability and conservation options	
ME new site		T9 R9 WELS		Identify landowners; get permission to relocate population; make detailed survey	Assess viability and conservation options	
ME new site		T9 R10 WELS		Identify landowners; get permission to relocate population; make detailed survey	Assess viability and conservation options	
NH	.001	Atkinson and Gilmanon Academy Grant	Collect demographic data; search for subpopulations; discuss plans for alder management	Study habitat preferences and site shifts; determine if habitat is damaged by swimmers		
NH	.002	Pittsburg			Identify landowners; get permission to relocate population; make detailed survey	

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
NH	.003	Pittsburg	Collect demographic data; search for subpopulations	Study habitat preferences and site shifts	Discuss protection options if find new subpopulations	
NH	.004	Bean's Purchase	Monitor for reappearance of population; search for subpopulations	Encourage designation as sensitive species		Consider reintroduction
NH	.005	Colebrook		Identify landowners; get permission to relocate population; make detailed survey		
NH	.006	Gorham			Search likely habitat	
NH	.007	Colebrook				Look for likely habitat; identify landowners; get permission to search
VT	.001	Warren	Collect demographic data	Investigate long-term protection		
VT new site		Lewis		Collect detailed data on population	Assess viability and need for conservation measures	

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
New England general actions					Look for likely habitat; identify landowners; get permission to search	Rank new populations; assign priorities for conservation plan
ME	.001	Chapman				Look for likely habitat; identify landowners; get permission to search
ME	.002	Fort Fairfield				Look for likely habitat; identify landowners; get permission to search
ME	.003	Fort Kent				Look for likely habitat; identify landowners; get permission to search
ME	.004	Fort Kent			Get permission to relocate population; make detailed survey	
ME	.005	Portage Lake			Look for likely habitat; identify landowners; get permission to search	

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
ME	.006	Presque Isle			Look for likely habitat; identify landowners; get permission to search	
ME	.007	St. Francis			Look for likely habitat; identify landowners; get permission to search	
ME	.008	Van Buren			Look for likely habitat; identify landowners; get permission to search	
ME	.009	Wade			Look for likely habitat; identify landowners; get permission to search	
ME	.010	T9 R7 WELS			Look for likely habitat; identify landowners; get permission to search	
ME	.011	T18 R10 WELS				Look for likely habitat; identify landowners; get permission to search

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
ME	.012	T4 R8 WELS		Get permission to relocate population; make detailed survey		
ME	.013	Dover-Foxcroft				Look for likely habitat; identify landowners; get permission to search
ME	.014	Sangerville				Look for likely habitat; identify landowners; get permission to search
ME	.015	Mt. Katahdin Township			Look for likely habitat; identify landowners; get permission to search	
ME	.016	Carrabassett Valley			Look for likely habitat; identify landowners; get permission to search	
ME	.017	Sapling Township		Identify landowners; get permission to relocate population; make detailed survey		

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
ME	.018	Norway				Look for likely habitat; identify landowners; get permission to search
ME	.019	Woodstock				Look for likely habitat; identify landowners; get permission to search
ME	.020	Bar Harbor			Identify landowners; get permission to relocate population; make detailed survey	
ME	.021	Bar Harbor			Identify landowners; get permission to relocate population; make detailed survey	
ME	.022	T16 R12 WELS	Collect demographic data	Assess viability of population	Investigate protection if warranted	
ME	.023	Fort Kent	Collect demographic data	Assess viability of population	Investigate protection if warranted	

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
ME	.024	T15 R13 WELS	Collect demographic data	Investigate long-term protection; study habitat preferences and site shifts		
ME	.025	Allagash	Collect demographic data	Investigate long-term protection		
ME	.026	Allagash	Collect demographic data	Assess viability of population	Investigate protection if warranted	
ME	.027	Hamlin	Collect demographic data	Assess viability of population	Consider long-term protection	
ME	.028	Bigelow and Dead River Townships			Search likely habitat	
ME	.029	Westmanland		Identify landowners; get permission to relocate population; make detailed survey		
ME	.030	T15 R13 WELS	Collect demographic data	Investigate long-term protection; study habitat preferences and site shifts		

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
ME	.031	Eustis	Collect demographic data; establish full extent of population	Investigate long-term protection; study habitat preferences and site shifts; pursue germination studies		
ME new site		Kibby Township		Identify landowners; get permission to relocate population; make detailed survey	Assess viability and conservation options	
ME new site		T9 R9 WELS		Identify landowners; get permission to relocate population; make detailed survey	Assess viability and conservation options	
ME new site		T9 R10 WELS		Identify landowners; get permission to relocate population; make detailed survey	Assess viability and conservation options	
NH	.001	Atkinson and Gilmanon Academy Grant	Collect demographic data; search for subpopulations; discuss plans for alder management	Study habitat preferences and site shifts; determine if habitat is damaged by swimmers		

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
NH	.002	Pittsburg			Identify landowners; get permission to relocate population; make detailed survey	
NH	.003	Pittsburg	Collect demographic data; search for subpopulations	Study habitat preferences and site shifts	Discuss protection options if find new subpopulations	
NH	.004	Bean's Purchase	Monitor for reappearance of population; search for subpopulations	Encourage designation as sensitive species		Consider reintroduction
NH	.005	Colebrook		Identify landowners; get permission to relocate population; make detailed survey		
NH	.006	Gorham			Search likely habitat	
NH	.007	Colebrook				Look for likely habitat; identify landowners; get permission to search
VT	.001	Warren	Collect demographic data	Investigate long-term protection		

Table 3. Prioritized implementation table for <i>Listera auriculata</i>. Landowner permission is pre-requisite to these actions.						
State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
VT new site		Lewis		Collect detailed data on population	Assess viability and need for conservation measures	

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APPENDICES

1. Personal communication references

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

Personal communication references

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Lisa R. St. Hilaire, Bryological Advisory Committee, 14 Prospect Street, Augusta, ME 04330, USA.

David Werier, Botanical Consultant, 30 Banks Road, Brooktondale, NY 14817, USA.

2. 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.

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