New England Plant Conservation Program

Listera convallarioides (Sw.) Nutt.
Broad-Leaved Twayblade

Conservation and Research Plan

for U.S. Forest Service Region 9

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SUMMARY

A conservation plan for *Listera convallarioides* (Swartz) Nuttall (broad-leaved twayblade) was set in motion by the White Mountain National Forest (WMNF) because the orchid has been given sensitive-species status. That status prescribes a site-specific conservation plan for each occurrence and investigation of potential sites before initiating ground-disturbing activities. This plan is for U.S. Forest Service Region 9, which extends from the East Coast through Minnesota and down to Missouri, Illinois, Indiana, Ohio, West Virginia, and Maryland.

Listera convallarioides is a North American endemic, with a global rank of G5 (widespread and secure). *Listera convallarioides* most often grows in circumneutral to somewhat acidic muck in forest seeps and northern white cedar swamps in the eastern part of its range. Some populations grow in moist sand along streams under cedars, and it is abundant in moist interdunal woods near the northern Great Lakes. In mountainous regions of western North America, it can be found growing with moss and grasses, in damp, often shady spots. It apparently requires cool, moist growing conditions, and is found in exceptionally cool ravines and at moderately high elevations (2,000–3,200 feet [600–975 m]) in its southernmost range in New Hampshire.

Listera convallarioides can be locally abundant, even where it is uncommon. Large colonies of several hundred plants are not uncommon, forming dense groundcover. Most sites visited in New Hampshire in 2001 had hundreds of plants, ranging from densely gathered to scattered. Timber harvesting, road building, and other human disturbance to habitat and hydrology are probably the biggest threats to *L. convallarioides* persistence.

The conservation objectives for *L. convallarioides* in Region 9 are to buffer northern white cedar swamps that harbor *L. convallarioides* and forest seeps from logging and recreational use, to discover what the orchid prefers in its habitat, and to search for extant populations in likely habitat, and perhaps in historical sites. The goal is to protect wetlands where *L. convallarioides* is known to be, to conserve the four good-quality populations (800+ plants) in New Hampshire and to search for four or five more good-quality populations. The population size is based on Natural Heritage rankings and reports of stable populations in provinces and states where the orchid is not rare. The number of populations is an estimate of what it will take to maintain the orchid's presence in this part of its range, based on the number of historical and present occurrences.

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) of the New England Wild Flower Society 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

Listera convallarioides is a North American endemic, with a global rank of G5 (widespread and secure). At the edges of its range, it can be locally rare (e.g., New Hampshire and Wisconsin).

Recently the U.S. Forest Service in Region 9 added *Listera auriculata, L. cordata,* and *L. convallarioides* to its list of sensitive species. Although these twayblades are not listed under the Endangered Species Act, they are locally rare, and the National Forests will use this plan and those for *L. auriculata* and *L. cordata* (Hoy 2001, 2002) to develop management strategies to protect and enhance populations and habitat.

The conservation objectives for *L. convallarioides* in U.S. Forest Service Region 9 are to preserve potential genetic diversity at the southeast fringe of its range and to maintain its range across eastern North America.

DESCRIPTION

Swartz (1800) first described *Listera convallarioides*, based on a collection identified only as from North America. He called it *Epipactis convallarioides*. The description below is based on Coleman and Magrath (in preparation) and Case (1987).

Listera convallarioides is a terrestrial orchid with slender, fibrous roots that are somewhat stoloniferous. It is between 5 and 37 cm tall. Its two sessile, subopposite leaves are glabrous; broadly ovate to elliptic, oval, or suborbicular; obtuse to (rarely) acute or apiculate; 20–70 mm long and 15–58 mm wide. It has a loosely flowered, terminal raceme, 20–120 mm long, with floral bracts that are rhombic-ovate to lanceolate, semitranslucent, and 3–5 mm by 1–2.5 mm. Below the leaves the stem is glabrous; the peduncle and rachis are densely whitish glandular-pubescent. The pedicels and ovaries are glandular-pubescent, with the ovaries becoming glabrate. A plant may have 5–20 flowers that are yellowish-green, sometimes with a tinge of purple. The sepals and petals are reflexed away from the column and lip. The dorsal sepal is ovate-lanceolate to elliptic and 4.5–5 mm by 1.5–2 mm, and the lateral sepals are lanceolate, acute to obtuse, falcate, and 4.5–5.5 mm by 1.5–1.8 mm. The petals are linear, falcate, and 4–5 mm by 0.8–1 mm. The lip is cuneate, tapering to a slender claw. The lip apex is dilated and has a shallow notch with rounded lateral lobes and a tiny tooth in the sinus between the lobes. The base of the lip has an inconspicuous triangular tooth on either side. The

column is slender, slightly curved, and slightly expanded at the apex, 2.5–4 mm by 1 mm. Seed capsules are ellipsoid, 8 mm by 5 mm, and glabrous.

There are eight North American species in the genus *Listera*. *Listera convallarioides* may overlap in habitat and distribution with *L. australis* (southern twayblade), *L. borealis* (northern twayblade), *L. cordata* (heart-leaved twayblade), and *L. auriculata* (auricled twayblade). All but *L. borealis* are found in Region 9. *Listera convallarioides* has a lip that is attached at the base by a narrow claw and that is widest and merely notched at its distal end. All the other twayblades in Region 9 have cleft lips and are clawless. See the key in Appendix 1.

Listera convallarioides hybridizes with *L. auriculata*. The parent plants have distinctly different flower morphology and habitat preferences. *Listera auriculata* prefers (or tolerates) acidic soils on frequently disturbed riverbanks and lake shores. *Listera convallarioides* 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 *L. convallarioides*, it has a claw, but it is shorter; the lip broadens at the distal end, but not as much. The hybrid has a shallower cleft in its lip than *L. auriculata*, but more than a notch like *L. convallarioides*. It has small, uncurved auricles. It is taller than either parent, appears to have a longer flowering season, and is found in more disturbed habitat than its nearby parents (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 *L. convallarioides*. 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

Listera convallarioides was first identified in 1800 by Swartz, who put it into *Epipactis*. Elliott (1824) classified it as *Listera*. Chamisso (1828) apparently misidentified Alaskan *L. convallarioides*, giving it a new name: *Listera eschscholziana*. The synonym *Diphryllum convallarioides* (Swartz) O. Kuntze can be dismissed; *Diphryllum*, proposed in 1808, was never clearly connected to *Listera* Brown. Two synonyms that were published after 1823, *Ophrys convallarioides* (Wright ex House 1905) and *Bifolium convallarioides* (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 another North American genus, *Epipactis*.

SPECIES BIOLOGY

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

Listera convallarioides can be locally abundant, even where it is uncommon. Brown (1997) reports that large colonies of several hundred plants are not uncommon, forming dense groundcover in Vermont and Maine. Nylander (1921) also found them abundant in Maine in some years. Most sites visited in New Hampshire in 2001 had hundreds of plants, densely clustered to scattered (personal observation). Fred Case (Cranbrook Institute of Science, personal communication) reports acres of *L. convallarioides* in Minnesota. Extensive colonies form in the upper Great Lakes region where freshets wet the forest floor during heavy rains (Case 1987). In California, large, dense colonies grow in water along stream banks (Coleman 1995).

I could find no studies of *L. convallarioides*' mycorrhizal partners. Fungi that infect *L. cordata* (heart-leaved twayblade) sprouts persist in mature plants. *Listera ovata* roots harbor fungi, but its rhizomes do not (Rasmussen 1995). Fungal parasites, however, appear to be common; Correll (1950) notes that *L. convallarioides* is exceptionally susceptible to fungal attacks. Case (1987) reported many blackened stems in populations that grow in intermittent freshets in forests near the Great Lakes.

Slight invertebrate herbivory was apparent at New Hampshire sites in 2001. I have found one report of herbivory (possibly rodent) as a notable problem.

Listera convallarioides flowers from June to September (Coleman and Magrath in preparation); in Region 9, it has mostly finished flowering by mid-August (Brackley 1985, Case 1987, Brown 1997). The leaves appear well before the flowering spike elongates (Brackley 1985). It is not known how long it takes for *L. convallarioides* to mature. Estimates for the age of *L. ovata* at first flowering range from 7 to 15 years (Rasmussen 1995).

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 *L. cordata*. 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 *L. convallarioides*.

Because twayblade nectaries and columns are quite accessible, pollination requires no specific insect body shape (Ackerman and Mesler 1979). *Listera cordata* visitors in California were often fungus gnats (Mycetophilidae), and other Diptera and some Hymenoptera (Ackerman and Mesler 1979). Hapeman (2000) shows a photograph of *L. auriculata* being visited by a small dipterid, perhaps a fungus gnat. It is possible that *L. convallarioides* is also pollinated by fungus gnats.

The dust-sized seeds are produced in the summer and most likely disperse by wind. It is not known whether they germinate the same year or are dormant for a time. Vinogradova (1996) reports for *L. cordata* that the first green leaf appears after 2–3 years of development underground. *Listera cordata* and *L. auriculata* adults overwinter by a shoot at the base of the current year's stem (Reddoch and Reddoch 1997). *Listera convallarioides* also does, with the shoot developing gradually through the summer (personal observation of herbarium specimens).

Studies of vegetative reproduction in other species in the genus may apply to *L. convallarioides*. *Listera cordata* did not reproduce vegetatively in California populations studied by Ackerman and Mesler (1979) in redwood forests. Disconnected *L. cordata* roots contain some starch and can produce shoots. The root-tip meristem transforms directly into a shoot meristem. It sheds the root cap after a shoot meristem with leaf primordia forms beneath. New roots arise at nodes of the shoot (Rasmussen 1995).

HABITAT/ECOLOGY

Listera convallarioides most often grows in circumneutral to somewhat acidic muck in forest seeps, northern white cedar swamps, boreal forests, and other wet-mesic forests in the eastern part of its range (Case 1964, Catling 1976, Cody and Munro 1980, Case 1987, Marie-Victorin 1995, Thompson and Sorenson 2000, unpublished data from New Hampshire field forms, personal observations). Some populations grow in moist sand along streams under cedars (Case 1964, Voss 1972). Case (1987) reports it as abundant in moist interdunal woods near the northern Great Lakes. Cody and Munro (1980) report it from forested floodplains and bottomlands. In mountainous regions of western North America, it can be found growing with moss and grasses, in damp, often shady spots (Correll 1950, Coleman 1995). It apparently requires cool, moist growing conditions, and is found in exceptionally cool ravines and at moderately high elevations (2,000–3,200 feet [600–975 meters) in its southernmost range in New Hampshire.

Typical associates of *L. convallarioides* in Region 9 are *Mnium* and other mosses, rough sedge *(Carex scabrata)*, dwarf enchanter's nightshade *(Circaea alpina)*, golden saxifrage *(Chrysosplenum americanum)*, asters, and violets. It apparently rarely grows in peat moss (*Sphagnum* spp.; e.g., Case 1964, and personal observation), but is often near it (Cody and Munro 1980). Characteristic species in the seeps and headwaters that harbor *L.*

convallarioides are lady-fern *(Athyrium filix-femina),* intermediate wood fern *(Dryopteris intermedia),* twisted stalk *(Streptopus amplexifolius),* false hellebore *(Veratrum viride),* bedstraw (*Galium* spp.), and long beech fern *(Phegopteris connectilis).* Common trees in the surrounding forest are northern white cedar *(Thuja occidentalis),* balsam fir *(Abies balsamea),* red maple *(Acer rubrum),* mountain maple *(Acer spicatum),* sugar maple *(Acer saccharum),* yellow birch *(Betula alleghaniensis),* and paper birch *(Betula papyrifera).*

THREATS TO THE TAXON

Harvesting the canopy over a seep or in a northern white cedar *(Thuja occidentalis)* swamp affects *Listera convallarioides* habitat in several ways. Increased light might encourage other plants to outcompete *L. convallarioides,* dry out the habitat, or make it too warm. Moving logging equipment through a seep or swamp may seriously alter water flow and drainage by creating microdams and channels and by compacting the substrate. Because many seeps never freeze and so remain softer than the surrounding soil, they are vulnerable to vehicles even in winter (Thompson and Sorenson 2000). The farther apart populations of plant species that grow in scattered seeps are, the less likely that they could recover from local extinctions. This may be because seeds cannot disperse very far or because pollination is disrupted (Harrison et al. 2000). Although logging northern white cedar continues in the region, affecting habitat for *L. convallarioides,* it is presently an issue at only one site tracked in this plan (NH .018 [Stark]).

Hydrological changes in the forested swamps that *L. convallarioides* often inhabits could eliminate the plant. Roads can obstruct water flow. Road salt and artificial impoundments also affect the habitat: northern white cedar is salt-sensitive and cannot stand long impoundment (Johnston 1990, Thompson and Sorenson 2000). Any major activity upslope from a swamp or seep is likely to significantly affect the water quality and quantity below. Beavers also alter hydrology. Groundwater that feeds the swamps can also be altered, primarily by humans using it. In the ravine settings that *L. convallarioides* inhabits in the White Mountain National Forest, hikers, trail maintainers, and plant researchers can trample the plants or affect drainage by increasing erosion or building water bars.

Global climate change is ongoing and is likely to affect temperature, precipitation, and storm severity and frequency in Region 9 (Hansen et al. 2001). These changes will affect different plants in different ways, leading to changes in range and in community species composition (Halpin 1997, McCarty 2001). Climate change is likely to affect *L. convallarioides* through the arrival of new competitors, loss of northern white cedar habitat (or its movement north), warming groundwater and thus microclimate in seeps, change in size of the subalpine area (it is not yet clear whether that will increase, decrease, or stay about the same [Halpin 1997]), change in number and type of pollinators and herbivores, and change in timing of leaf-out for the canopy. Change of climate might also make *L. convallarioides* more susceptible to its fungal parasites (reported in Correll 1950 and Case 1987). Because of land

use that leads to forest fragmentation, *L. convallarioides* at the edges of its range may not be able to migrate to accommodate these changes. Hunter (1993), which gives reasons for preserving fringe populations of even common species, points out that plants and animals adapted to conditions at the edge of their range may be well-adapted to a climate change.

Disruption of pollinators by changes in habitat, either nearby logging or climatic effects, cannot be evaluated without knowing more about *L. convallarioides* pollinators. Invasive plants are not a problem in the reports I have seen or sites I have visited, but could be introduced by logging equipment, recreational vehicles, railways, and hikers. McCarty (2001) suggests that invasive plants in general could become more and more troublesome as the climate warms. Another influence on community structure of forested swamps, especially northern white cedar, is excessive deer browse, which can prevent regeneration and change the character of the forest (Johnston 1990).

DISTRIBUTION AND STATUS

General Status in Region 9

Listera convallarioides is a North American endemic, with a global rank of G5 (widespread and secure; NatureServe 2001). Because it prefers cool, moist forests, it spreads in a northern band across most of the continent, with a gap across the drier climates in Minnesota and South Dakota and areas to the north. In the west, it is restricted to mountainous areas, from British Columbia to Arizona and Nevada. Table 1 (below) summarizes the distribution and status of the species in North America.

States in U.S. Forest Service Region 9 that list *L. convallarioides* as Endangered or Threatened are New Hampshire and Wisconsin. Wisconsin has five extant sites, none in a National Forest. In New Hampshire, the White Mountain National Forest holds three of the eight extant sites.

In other Region 9 states, *L. convallarioides* populations are not tracked, because it is either common or at least not rare. In northern Michigan and the Upper Peninsula, it is frequently found, so the Hiawatha and Huron-Manistee National Forests probably have populations. In the northern half of Vermont, *L. convallarioides* is occasional to locally abundant (Thompson and Sorenson 2000; Everett Marshall, Vermont Nongame and Natural Heritage Program, personal communication). The Green Mountains in Vermont may have *L. convallarioides* populations in forest seeps; however, northern white cedar swamps are not found there (Thompson and Sorenson 2000). In Maine, *L. convallarioides* appears in most counties (except for the coast), in rich moist woods, in northern white cedar swamps, and among alders along riverbanks (Josselyn Botanical Society 1995, herbarium labels from the herbarium at University of Maine, Orono).

Table 1. Occurrence and status of *Listera convallarioides* 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[1]**	**HISTORICAL (LIKELY EXTIRPATED)**
Alaska: S1	Nova Scotia: S3S4	California: SR	Minnesota: SH?
Arizona: S1	Ontario: S4	Idaho: SR	New York: SH
Colorado: S2		Maine: SR	
New Hampshire: S2		Michigan: SR	
South Dakota: S1		Montana: SR	
Wisconsin: S1		Nevada: SR	
Wyoming: S1		Oregon: SR	
Alberta: S2		Utah: SR	
Prince Edward Island: S1?		Vermont: SR	
		Washington: SR	
		British Columbia: SR	
		New Brunswick: SR	
		Newfoundland: SR	
		Quebec: SR	

[1]*SR* means "status reported." For *L. convallarioides* in some cases (e.g., Maine and Michigan), *SR* indicates that the orchid is rather common and widespread.

Listera convallarioides is not tracked in three of the five states in which it occurs in Region 9: Maine, Michigan, and Vermont. New York has five historical records for the plant, four from Lewis County (1881 and 1927) and one from Jefferson County (1927). These two counties are near the east end of Lake Ontario. Minnesota has one record, from 1924 in Cook County. It seems odd that *L. convallarioides* has been reported only once in Minnesota, as it has abundant seemingly appropriate habitat in northern white cedar swamps (Minnesota Department of Natural Resources 1993, Smith 1993).

In New Hampshire and Wisconsin, *L. convallarioides* has been reported in 27 sites. Eleven of those occurrences have not been seen for more than 20 years. Two new sites for New Hampshire were located in 2001 (personal observation). Wisconsin has six extant sites and three historical records (pre-1970) in Bayfield, Iron, and Ashland Counties. I was not allowed to see details for the Wisconsin sites. Table 2 shows occurrences for Region 9 National Forests and New England states where *L. convallarioides* is tracked.

Element Occurrence (EO) quality ranks are based on the size, condition, and landscape context of a rare species population. They range from A (excellent) to D (poor). The rank E applies to element occurrences that are extant but unranked because of a lack of information. The rank H applies to sites for which no observations have been made for more than 20 years and are considered historical. The rank X applies to sites that are known to be extirpated. See Appendix 2 for more details.

For *L. convallarioides,* EO rank specifications have been published in Chase 2001, which is quoted here:

> A = 1,000+ genets with evidence of reproduction in excellent habitats of large size and high natural integrity. . .
>
> B = 100–999 genets in habitat of good to excellent condition and landscape context and with minimal threats to viability. . .
>
> C = 10–99 genets in habitat of fair to excellent condition and landscape context. . .
>
> D = 1–9 genets in habitat of poor to excellent condition and landscape context. . .

Table 2. Region 9 occurrence records for *Listera convallarioides.* Shaded occurrences are considered extant.

State	EO #	County	Town
NH	.001	Coos	Dixville Notch
NH	.002	Coos	Dummer
NH	.003	Coos	Pittsburg
NH	.004	Grafton	Franconia
NH	**.005**	**Grafton**	**Bethlehem**
NH	**.006**	**Coos**	**Randolph**
NH	**.009**	**Coos**	**Stark**
NH	**.010**	**Coos**	**Stratford**
NH	**.011**	**Coos**	**Stratford**
NH	.012	Coos	Pittsburg
NH	.013	Coos	Pittsburg
NH	.014	Coos	Colebrook
NH	.015	Coos	Colebrook
NH	.016	Coos	Carroll
NH	**.017**	**Coos**	**Sargent's Purchase**
NH	**.018**	**Coos**	**Stark**
NH	**new**	**Coos**	**Colebrook**

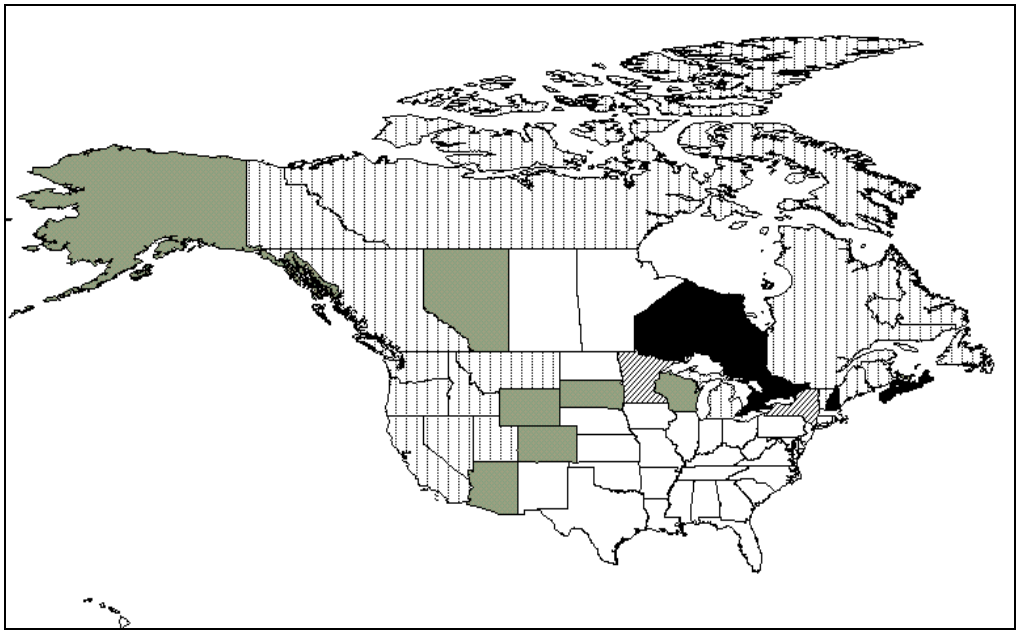

Figure 1. Distribution of *Listera convallarioides* in North America. States and provinces shaded in gray have one to five (or an unspecified number of) current occurrences. Areas shaded in black have more than five extant occurrences. Stippling indicates states and provinces in which the taxon is ranked SR ("status reported") with no further information. See Appendix 2 for an explanation of NatureServe ranks. Diagonal hatching indicates states in which the taxon is considered historical.

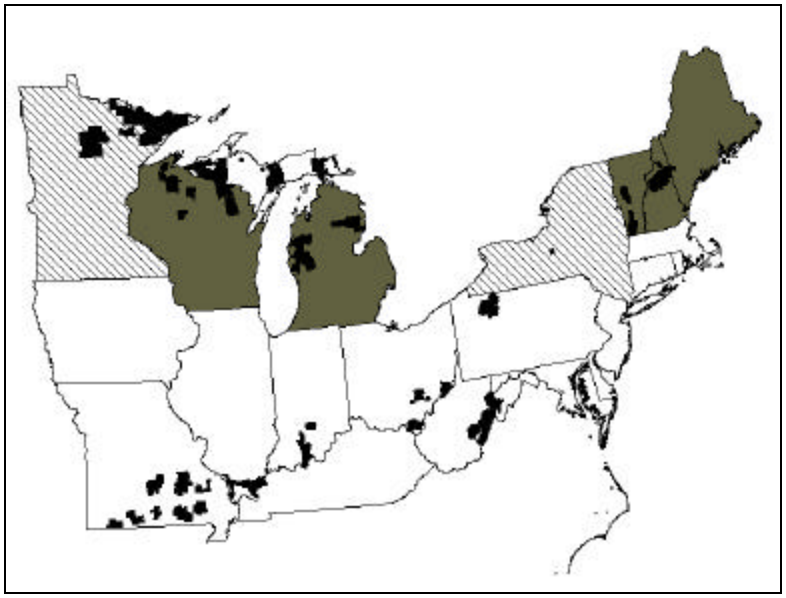

Figure 2. States in Region 9 from which *Listera convallarioides* has been recorded. Shading indicates that the taxon is extant; diagonal hatching indicates a rank of "historical" or "extirpated." Black polygons indicate National Forest boundaries.

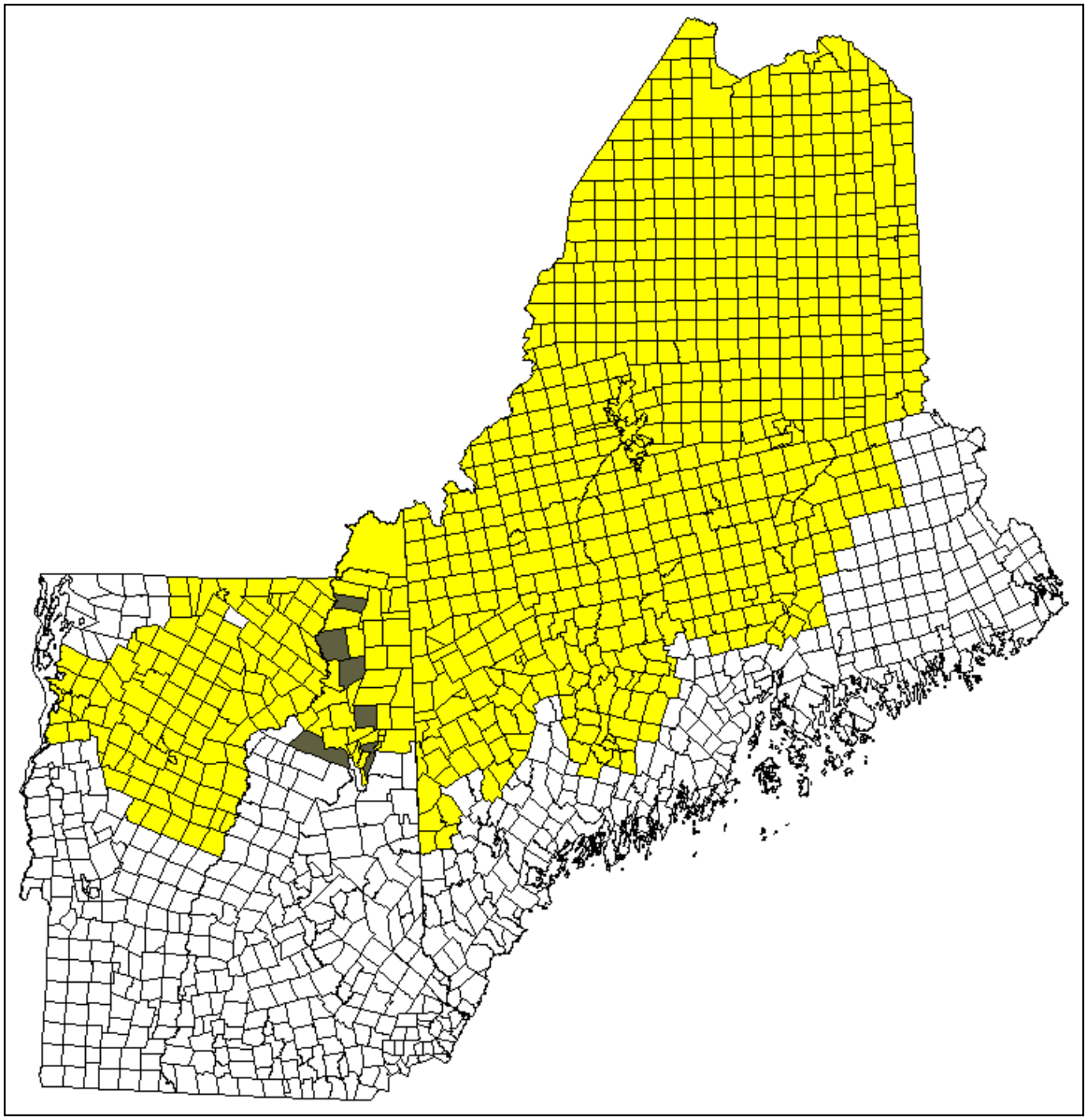

Figure 3. Extant occurrences of *Listera convallarioides* in New England. Town boundaries for New Hampshire, Maine, and Vermont are shown. Towns shaded in dark gray have one to five confirmed, current occurrences of the taxon. Yellow shading shows reported distribution in Maine, New Hampshire, and Vermont counties.

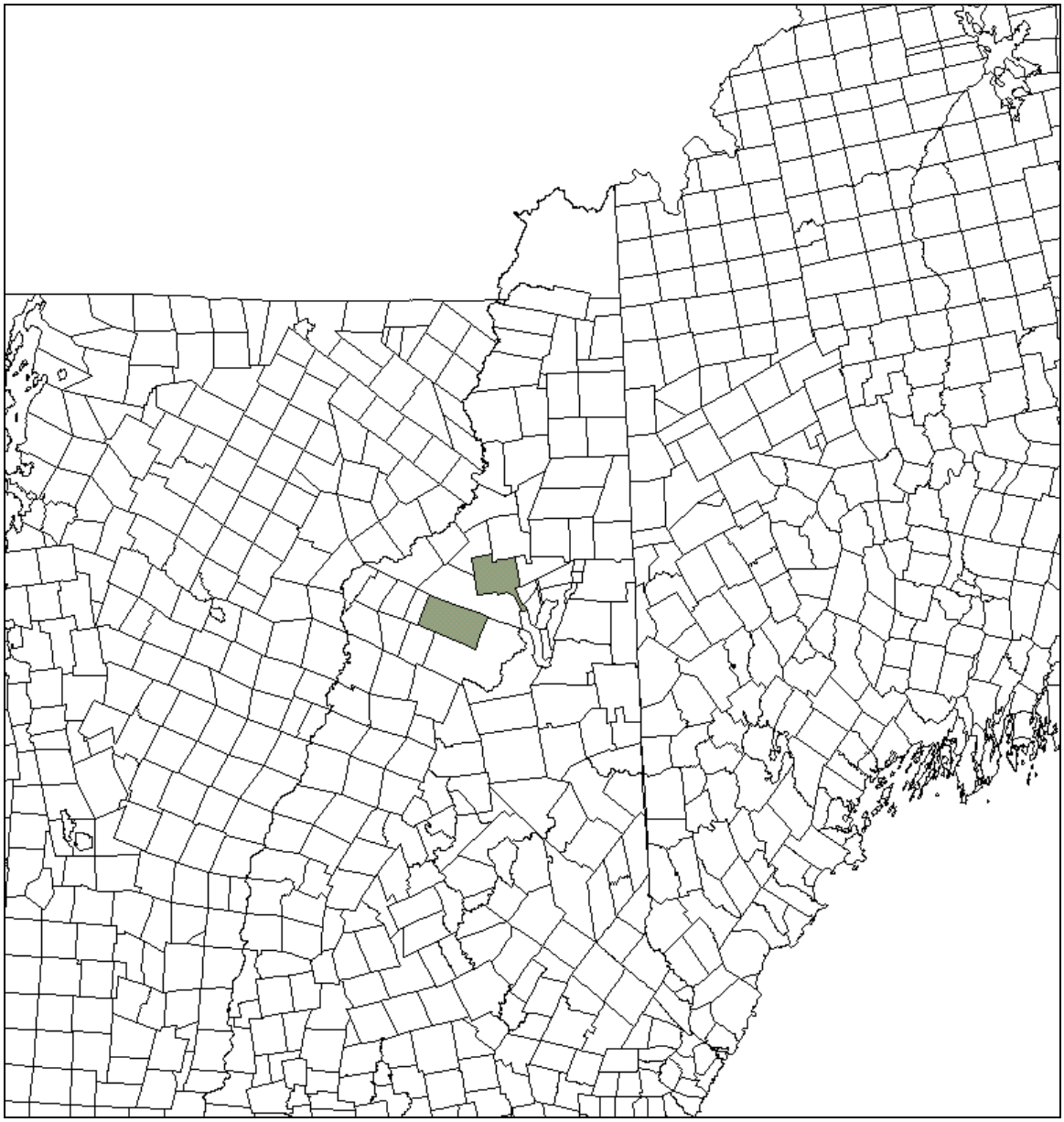

Figure 4. Historical occurrences of *Listera convallarioides* in New England. Town boundaries for New Hampshire and adjacent states are shown. Towns shaded in gray have one to five historical records of the taxon. Data on county-level historical distributions are not available.

II. CONSERVATION

CONSERVATION OBJECTIVES FOR *LISTERA CONVALLARIOIDES* IN REGION 9

In its entire range, *Listera convallarioides* is widespread and secure. At the limits of its range in U.S. Forest Service Region 9, however, pressure on *L. convallarioides* habitat threatens its persistence.

The conservation objectives for *L. convallarioides* in Region 9 are to buffer habitats that harbor *L. convallarioides* (mostly northern white cedar swamps and forest seeps) from logging and recreational use, to discover what the orchid prefers in its habitat, and to search for extant populations in likely habitat, and perhaps in historical sites. The goal is to protect wetlands where *L. convallarioides* is known to be, to conserve the four good-quality populations (800+ plants) in New Hampshire and to search for and protect four or five more good-quality populations. The population size is based on Natural Heritage rankings (Chase 2001) and reports of stable populations in provinces and states where the orchid is not rare. The number of populations is an estimate of what it will take to maintain the orchid's presence in this part of its range, based on the number of historical and present occurrences.

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IV. APPENDICES

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1. Key to *Listera* Species in U.S. Forest Service Region 9

2. An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe

1. Key to *Listera* Species in U.S. Forest Service Region 9

Adapted from Coleman and Magrath (in preparation) and Case (1987). Habitats are for Region 9.

1. Lip deeply cleft into pointed, linear lobes.....2.

1. Lip expanded at apex, or, if cleft, with rounded lobes.....3.

2. Lip with basal lobes (auricles) rounded and curved back, partly surrounding the column; moist woods, peatlands .....*L. australis*

2. Lip with basal lobes pointed and projecting outward like horns, away from the column; wet woods, northern white cedar swamps .....*L. cordata*

3. Lip about as broad at the apex as at the base; banks of streams and rivers, shores of large lakes.....*L. auriculata*

3. Lip broader at the apex than at the base.....4.

4. Lip with a short claw (lip appearing stalked).....5.

4. Lip with no claw (lip sessile) .....6.

5. Base of lip with inconspicuous triangular tooth on each side; lip slightly notched; rich humus in open woods, forest seeps.....*L. convallarioides*

5. Base of lip with distinct lobe on each side; lip deeply notched.....*L.* × *veltmanii*

6. Lip angled downward; base of lip without lobe; moist, rich areas, disturbed sites.....*L. ovata*

6. Lip not angled downward; base of lip with two lobes; shady, moist Appalachian forests.....*L. smallii*

2. An Explanation of Conservation Ranks Used by the Nature Conservancy and NatureServe

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

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

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

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

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

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

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