

New England Plant Conservation Program

*Liparis liliifolia* (L.) L. C. Rich. ex Lindley  
Lily-leaved twayblade

Conservation and Research Plan  
for New England

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## TABLE OF CONTENTS

SUMMARY .....	i
PREFACE .....	ii
ACKNOWLEDGMENTS .....	iii
<b>I. BACKGROUND .....</b>	<b>1</b>
Introduction .....	1
Description .....	2
Taxonomic Relationships, History, and Synonymy .....	3
Species Biology .....	5
Habitat/Ecology .....	10
Threats to Taxon .....	14
Distribution and Status .....	16
General Status .....	16
Status of All New England Occurrences — Current and Historical .....	21
Current Conservation Measures in New England .....	44
<b>II. CONSERVATION .....</b>	<b>58</b>
Conservation Objectives for the Taxon in New England .....	58
General Conservation Actions for the Taxon .....	59
Recommended Conservation Actions for Each Occurrence .....	65
<b>III. LITERATURE CITED .....</b>	<b>86</b>
<b>IV. APPENDICES .....</b>	<b>90</b>
1. Personal Communication References .....	91
2. Herbarium Specimens for <i>Liparis liliifolia</i> .....	94
3. An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe .....	106
<b>TABLES AND FIGURES</b>	
Table 1. Rangewide Habitat Types for <i>Liparis liliifolia</i> .....	11
Table 2. North American Occurrence Summary .....	17
Figure 1. North American occurrences of <i>Liparis liliifolia</i> .....	20
Figure 2. Extant New England occurrences of <i>Liparis liliifolia</i> .....	45
Figure 3. Historic New England occurrences of <i>Liparis liliifolia</i> .....	46
Table 3. Current and Historical New England Occurrences .....	49
Table 4: Prioritized Implementation Table .....	78

## SUMMARY

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Lily-leaved twayblade, *Liparis liliifolia* (L.) L.C. Rich. ex Lindley, is a perennial member of the Orchid family (Orchidaceae). It is placed in the subfamily Epidendroideae and tribe Malaxideae. The taxon was first described by Linnaeus in 1753 as *Ophrys liliifolia* based on a specimen collected by Clayton from Virginia. *Liparis liliifolia* is endemic to North America. It blooms in late spring to early summer. Flowering times vary from May in the southern areas of its range to July in northern regions. In the northeast, Seymour lists the flowering for New England as June 8 to July 6.

Similar to many orchids, *Liparis liliifolia* has a very specific fungal associate. The fungus is same over the entire range of species and has virtually no genetic variation. The specificity of this association and the lack of the genetic variation within the fungus are surprising and not found among most orchids. Throughout its range, *Liparis liliifolia* occupies a variety of habitats. The *Flora of North America* makes the following statement concerning the habitats of this species: "Mature mesic to moist deciduous forests, pine woods, rich moist humus, often colonizing previously open disturbed habitats during the early to middle stages of reforestation." In New England, the taxon is currently restricted largely to a single habitat type: open, glade-like woodlands dominated by oak, ash, hickory, and/or cedar.

The taxon is reported from 26 states and one Canadian province, and is apparently common throughout much of its range. It is ranked G5 (globally secure). Based on herbarium specimens, it appears to have been quite common in parts of southern New England at the turn of the last century. Herbarium specimens documenting over 100 populations exist in regional herbaria. Over the past 100 years, changes to the landscape of New England have seemingly eliminated most populations. The New England Plant Conservation Program lists *Liparis liliifolia* as Division 2 or Regionally Rare in "*Flora Conservanda: New England*, a status ranking reserved for taxa with fewer than 20 current occurrences (seen since 1970) within New England. Although there are apparently 27 current populations in New England, a tally of populations documented extant since 1993 reveals only 12 occurrences, one of which has not been relocated despite repeated searches. Although a number of lesser potential threats exist, forest succession, browse, genetic suppression, and invasive species are of greatest concern to *Liparis liliifolia* in New England.

The primary objective is to ensure the long-term survival of the 11 populations that are currently known to be extant. This will involve increasing plant numbers at most sites and enhancing the reproductive ability at each site. A secondary objective is to increase the number of known populations. An overall target objective for the number of extant populations in New England is 20 to 25.

## PREFACE

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

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

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

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

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## I. BACKGROUND

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### INTRODUCTION

Lily-leaved twayblade, *Liparis liliifolia* (L.) L.C. Rich. ex Lindley, is a perennial member of the Orchid family (Orchidaceae). It is placed in the subfamily Epidendriodeae and tribe Malaxideae. The genus *Malaxis* is the only other member of this tribe (Magrath 2002). The taxon was first described by Linneaus in 1753 as *Ophrys liliifolia* based on a specimen collected by Clayton from Virginia (USDA NRCS 2003). *Liparis liliifolia* is endemic to North America, but four very similar species are described from Japan (*L. japonica* and *L. makinoana*) and China (*L. pauliana* and *L. cathcartii*) (Magrath 2002). *Liparis liliifolia* is well distributed in the eastern half of the continental United States occurring in 26 states and one Canadian province. The range of the species is described as from Vermont west to Ontario and Minnesota and south to Oklahoma, Alabama and Georgia (Gleason and Cronquist 1991).

The global and national ranks for the taxon are G5 and N5 respectively, indicating that the species is secure throughout its range both globally and in the United States. The Canadian national rank is N2, indicating the taxon is imperiled throughout its range in that country. Ontario is the only Canadian province reporting the species, assigning it a rank of S2 (NatureServe 2003). Throughout much of its range in the United States, the species is relatively common. The Indiana Natural Heritage Program reports that it is one of the most common forest and edge orchids in the state (Homoya, Indiana Natural Heritage Program, personal communication). Only nine out of 31 states or provinces, primarily on the periphery of its range, list the species as S1 or S2: Vermont (S1), Massachusetts (S2), Rhode Island (S1), Connecticut (S1), New York (S1), Ontario (S2), Delaware (S2), Oklahoma (S1), and Alabama (S1) (personal communications with state Natural Heritage programs).

In New England, *Liparis liliifolia* is ranked as Division 2, or Regionally Rare in *Flora Conservanda*: New England: The New England Plant Conservation Program (NEPCoP) list of plant in need of conservation (Brumback and Mehrhoff et al 1996). This status ranking is reserved for taxa with fewer than 20 current occurrences (reported since 1970) within New England. There are 27 current populations in New England, reported since 1970 and not known to be extirpated. However, if slightly different criteria are applied, the number of extant populations drops dramatically. A count of populations documented as extant since 1993, reveals 12 occurrences: two in Vermont, four in Massachusetts, and six in Connecticut; however, one Massachusetts occurrence has not been relocated despite repeated searches. The remaining 15 have not been located in the past 10 years despite searches at most locations.

Over the entire range of the species, it occupies a variety of habitats including moist forest slopes, dry rocky road banks, dry oak forests, dense red cedar stand, young successional forests. Observations and research of populations throughout the range indicate that the species prefers early- to mid-successional forest habitats (Homoya

1993). Populations tend to decline dramatically and rapidly with increasing shade (Sheviak 1974). In New England, herbarium specimens collected up to approximately 1939 reference habitats similar to those known rangewide. Most extant occurrences are restricted to a single habitat type: rich, open glade-like woodlands in the Mount Holyoke Range of Massachusetts and the Metacomet Ridge area of Connecticut.

Most threats currently affecting the taxon in New England are naturally occurring and have some impact on most extant occurrences. The primary threats are shading by a maturing forest, inbreeding, browse by deer, and the presence and continued spread of invasive species. There are also a number of lesser potential threats, trampling, collection, and logging that impact individual occurrences.

This conservation and research plan summarizes the available information on the ecology, taxonomy, biology, distribution, and status of *Liparis liliifolia*. It also assesses threats, evaluates current conservation measures, and sets forth conservation actions designed to protect the taxon on the landscape of New England over the next 20 years.

## **DESCRIPTION**

*Liparis liliifolia* (L.) L. C. Richard ex Lindley is a small herbaceous perennial species in the Orchidaceae. The following description is compiled from the following sources: Fernald (1950), Seymour (1969), Gleason and Cronquist (1991), Homoya (1993), Magee and Ahles (1999), Magrath (2002), Species at Risk (2003), and personal observations.

*Liparis liliifolia* is a small orchid with a maximum height of 9-25 cm; in New England, observed plants are typically small, 10-12 cm tall with some reproductive individuals as small as 5 cm. Individuals arise from two connected pseudobulbs from which spread fine fibrous root systems. The previous years' leaf bases and stalk are typically persistent on the parent pseudobulb. The parent pseudobulb is connected to the daughter by a short rhizome, while the daughter pseudobulb gives rise to the current years' plant. The two pseudobulbs are connected by a short rhizome. Each pseudobulb is encased in several sheathing scales. One (on sterile plants) to two basal leaves arise from the daughter pseudobulb in late spring. The resulting leaves and flowering stalk are glabrous and greasy in appearance. The leaves are medium to dark green, elliptic to ovate with an acute to obtuse apex, somewhat succulent in appearance, strongly keeled abaxially, and measure 4-18 cm long and 2-8.5 cm wide. The leaves are held in an upright, but somewhat reflexed position typically rising 6-8 cm above ground level.

The scape measures 10-30 cm. It is leafless, bright green, sometimes tinged with purple or brown, and often angled or winged. The inflorescence is a loose raceme of 5 to 30 widely spreading, pale purple flowers. The pedicels are long and purplish. Pedicels and the ovary together measure approximately 8-15 mm. A small bract subtends each odorless flower. Petals are tubular and curved, narrowly linear to filiform, measuring 8.5-12 mm long to 0.2-0.3 mm wide. The petal margins are strongly revolute. The lip of

each flower is purple with a fine network of reddish to purple veins and large in comparison to the rest of the plant measuring 8-12 mm long by 6-10 mm wide. It resembles a translucent, purple helicopter landing pad. The obovate lip is nearly flat with its margins minutely erose. The base is slightly auriculate and the tip apiculate. The petals are purple and filliform, 10-13 mm long but only 0.25-0.5 mm wide. The light green sepals are 8-12 mm long and 1-1.5 mm wide, lanceolate, with revolute margins. The single dorsal sepal projects upward while the two lateral sepals project forward under the lip, often cross, and can be seen through the lip. The column (the fused pistils and stamens) is winged and elongated, measuring 3-4 mm long by 1-1.5 mm wide with two blunt tubercles on the inner surface near the base. It is exposed and arches above the lip. The anthers and pollinia are yellow.

Fruiting capsules are persistent and measure approximately 15 mm in length. The fruiting capsule is produced on a stipe that is as long or longer than the body of the capsule itself. The seeds measure 0.35 mm in length by 0.12 mm in width.

Only one other species of *Liparis* occurs in New England: *Liparis loeselii*. Unlike *L. liliifolia*, *L. loeselii* has greenish-yellow flowers, is typically smaller in stature and occupies wetland or moist habitats (Gleason and Cronquist 1991). Some confusion may arise when only vegetative individuals are encountered. Large-leaved vegetative individuals of *L. loeselii* can be mistaken for *L. liliifolia*. There are no reports of hybridization between the two species.

## **TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY**

In his *Species Plantarum*, Linnaeus first described *Liparis liliifolia* as *Ophrys lilifolia* in 1753. The type specimen, from Virginia, was collected by Clayton on May 26, 1741. Linnaeus continued to refer to the species as *Ophrys lilifolia* throughout his three editions of *Species Plantarum* and in many of his editions of *Systema Naturae*, although the spelling varied somewhat in later versions of the *Systema*. *Ophrys lilifolia* is the basionym for *Liparis liliifolia* (Fernald 1947, Missouri Botanical Garden 2003)

Swartz transferred *Ophrys lilifolia* to the *Malaxis* genus in 1800, naming the species *Malaxis liliifolia*. The use of the double “i” in the specific epithet is the first spelling of this type. Since this time, there has been substantial confusion about the proper spelling of the specific epithet. In 1813, Robert Brown in the second edition of *Hort. Kew.* listed the species as *Malaxis lilifolia*, using only a single “i.” In 1825, Lindley placed the species into the *Liparis* genus, naming it *Liparis liliifolia*, and cited all the synonyms as containing the double “i.” From this date to the present day, most authors maintain the spelling with double “i,” though this does not follow the original Linnaean spelling of the specific epithet (Fernald 1947). Fernald balked at the double “i” spelling in his 1947 article on the Flora of Virginia published in *Rhodora*. His opening statement in that article sums up his opinion on the topic: “*Liparis lilifolia*, not *L. liliifolia*.” Fernald argues for the single “i” is based on two points: the original naming by Linnaeus, and the derivation of the specific epithet. The specific epithet is commonly



inferred as deriving from the genus *Lilium*. This is incorrect. Rather, the name can be traced to *Lilia*, an old class of plants established by Gmelin in 1747. This class of plants included many containing one to a few basal leaves, such as *Erythronium* and *Convallaria*. A derivation from *Lilium* would read *liliifolia*. A derivation from *Lilia* would call for a spelling of *lilifolia* (Fernald 1947). In a 1967 article in *Rhodora*, Bernard Boivin corrected the spelling of a number of species based on Article 73 note 2 of the International Code of Botanical Nomenclature. This article calls for uniformity in the formation of scientific botanical names. In his article, he lists the name *Liparis lilifolia*, and the correction as *Liparis liliifolia*. Debate laid to rest? Perhaps for the time being.

If we follow Fernald's lead in this matter, the common name usually applied to this species, lily-leaved twayblade may also be inaccurate. One of the other common names in use may be a more accurate descriptor. These include large-leaved twayblade, large twayblade, purple twayblade, mauve sleekwort, or brown widelip orchid (Newcomb 1977, Homoya 1993, Magrath 2002).

The generic epithet derives from the Greek term '*liparos*' meaning fat or greasy, in reference to the oily looking leaves of most members of this genus (Homoya 1993). The genus most closely related to *Liparis* is *Malaxis*. It is distinguished from *Malaxis* by its elongated column (Brackley 1985).

The proper citation of this species with author is widely written in two ways. *Liparis liliifolia* (L.) L.C. Rich. ex Ker-Gawl. occurs in several prominent sources (NatureServe 2003, USDA NRCS 2003). Most recent treatments, including the recently published *Flora of North America* volume on orchids cite the species *Liparis liliifolia* (L.) L. C. Rich. ex Lindley (Sheviak 1974, Homoya 1993, Magrath 2002). A comprehensive list of synonyms with dates and authors is provided here (Fernald 1947, Missouri Botanical Garden 2003):

*Leptorchis lilifolia* (Rich. Ex Lindl.) Kuntze 1891  
*Liparis liliifolia* Richards ex Lindley 1825  
*Malaxis lilifolia*, Brown 1813  
*Malaxis liliifolia*, Swartz 1800  
*Ophrys trifolia*, Walter 1788  
*Ophrys lilifolia*, Linnaeus 1753

There are no known varieties or subspecies of *L. liliifolia*. A single accepted form, *L. liliifolia* forma *viridiflora*, does exist. This green-flowered form of *L. liliifolia* is reported from Illinois, Indiana, Ontario, Wisconsin and perhaps several other mid-western states (Wadmond 1932, Sheviak 1974, Whiting and Catling 1986, Homoya 1993). It appears spontaneously in small numbers among populations of the typical purple-flowered form (Wadmond 1932).

There are over 250 species in the genus *Liparis* worldwide. Three are reported from continental North America (Magrath 2002). Two of these, *L. liliifolia* and *L.*

*loeselii*, occur in New England and elsewhere in the northern and central areas of the continent. The third species, *L. nervosa*, is restricted to Florida (Homoya 1993). There is no taxonomic confusion or difficulties with the two overlapping species and they are separated with relative ease in the field.

## **SPECIES BIOLOGY**

### ***Phenology***

*Liparis liliifolia* is a late spring- to early summer-blooming perennial. Flowering times vary from May in the southern areas of its range to July in northern regions (Gleason and Cronquist 1991, Homoya 1993, Brown 1997, Keenan 1998). In the northeast, Seymour (1969) lists the flowering for New England as June 8 to July 6. Brown (1997) lists the flowering period as June 9 to July 15 for the northeastern United States. The best time to observe flowering plants for populations in southern New England is mid-June (personal observation).

No information concerning fruiting times was located. However, the fruiting stalk remains upright for a long period of time (Rasmussen 1995). The capsules seem to rely on an increase in atmospheric moisture to dehisce, which often occurs in the autumn. Snowfall may also induce release of seeds from the capsule as the stalk is weighed down by snow cover (Rasmussen 1995).

### ***Pollination***

Most orchids are outcrossers and have a specific strategy to exchange pollen in order to sexually reproduce (Homoya 1993). Virtually all orchids are pollinated by one to a few species of insects (Gawler 1983). Insects are attracted to orchid flowers due to their coloration, appearance or odor. Most orchids are bee- or wasp-pollinated, but others, like *Liparis*, are pollinated by the Dipterans, the flies. Generally, in comparison to bees, members of this group are poor pollinators, frequently visiting plants, but rarely affecting pollination (Christensen 1994). The group of Dipterans known to frequent flowers of *Liparis liliifolia* are those in the family *Sarcophagidae*, or the flesh flies (Christensen 1994). This large group of flies includes many species that, as the name implies, lay eggs and spend their larval stages in decaying plant or animal matter (Howard 1905). It is not known definitively which flies or other insects pollinate *L. liliifolia*, nor is it known whether the flies are needed to transport pollen or are simply a trigger for the release of pollen. It is likely that due to the tiny population sizes and the scattered nature of the populations, that the pollinator is not a specialist, but that *L. liliifolia* is casually pollinated by any flies that happen to be passing by. The flowers of *L. liliifolia* are reported to have no odor (Species at Risk 2003), but Kallunki (1981) noted that some species with no perceptible odor to humans might have an odor perceptible to a pollinator. *Liparis liliifolia* may be producing a fetid smell similar to that of rotting flesh that aids in attracting pollinators. Additionally, the purple coloration and

striations of the lip in this species may be a form of mimicry. The coloration may have evolved to attract insects interested in feeding or reproducing in carrion.

Although most orchids are outcrossers, many North American species are autogamous or self fertilizing (Homoya 1993). *Liparis loeselii* is an autogamous orchid; it does not require cross-pollination to produce viable seed (Homoya 1993). *Liparis liliifolia* is self-incompatible; requiring cross-pollination to produce viable seed (Whigham et al. 2002). Observations of a large robust plant growing in cultivation at Garden in the Woods in Framingham, Massachusetts support this. The plant at Garden in the Woods has been in cultivation for five years, and in that time it has flowered each year, but never set fruit (personal observation). Observation of plants in the wild, albeit for a shorter period of time follow this same trend (personal observation).

Recorded observations at a number of New England stations have revealed that the production of flowers is rarely followed by the production of fruit (Moorhead, Consulting Botanist, personal communication; personal observation). This absence of fruit may be caused by a lack of pollen available for outcrossing (Jones, Harvard University Herbaria, personal communication). If the plants are self-incompatible, as is the case in many orchids, the individuals within populations may be suffering from a lack of suitable mates given the small population sizes and the small number of populations found in New England (Jones, personal communication). In Maryland, where the taxon is uncommon, there is evidence of severe inbreeding depression (Whigham, Smithsonian Environmental Research Center, personal communication). Hand-pollination studies of the taxon provide evidence of inbreeding depression. Hand-pollinated plants in close proximity to one another are far less likely to produce viable seeds than plants at a geographically distant location (Whigham and O'Neill 1991). The exchange of pollen from plants approximately a kilometer apart yielded viable seeds (Whigham and O'Neill 1991).

These recent studies seem to support Christensen's (1994) findings that Dipterans are poor pollinators, and also cast doubt on the ability of *Liparis liliifolia* to self-pollinate, or at least do so effectively. Inbreeding depression has not been scientifically evaluated at any New England populations.

### ***Seeds, Dispersal and Germination***

Orchid species produce a large number of tiny, dust-like seeds, with some estimates running to the tens or hundreds of thousands per capsule (Rasmussen 1995). The seeds are highly mobile (Sheviak 1990), and are known to travel long distances carried by air currents. Both of these attributes assist in seed dispersal. There have been no studies of seed dispersal in *L. liliifolia*, but it is likely that in open, disturbed, early successional habitats, air is a primary means of dispersal to new locations. In habitats consistent with those found in New England (open wooded slopes), it is unlikely that air currents are responsible for long distance dispersal. Seasonally high winds may remove the seed from the capsules in autumn and disperse them into the immediate habitat area,

but it is unlikely that many seeds make it out of the thin-canopied woodlands occupied by this species. Dispersal by gravity and snowmelt water may also provide for dispersal in New England.

The seeds of this and other orchids do not have endosperm (stored food available for initial growth) and must get this nutrition via a symbiotic relationship between a tracheophyte and a saprophytic or parasitic mycorrhizal fungus (Homoya 1993). Arditti et al. (1990) found no evidence supporting long-term seed dormancy in most orchids, but Whigham (personal communication) found that *L. liliifolia* seeds germinated the spring after a period of winter dormancy in the soil. In studies conducted by Whigham et al. seeds of *L. liliifolia* did not germinate in the absence of a mycorrhizal associate and were found to have a low germination percentage in field experiments on a variety of substrates in the absence of mycorrhizal fungus extracted from adult *L. liliifolia* plants. Germination rates increased on all substrates when seeds inoculated with the mycorrhizal fungus specifically associated with the taxon, indicating that the presence of mycorrhiza may be more important than the substrate for germination (Whigham et al. 2002). This information indicates that the taxon cannot be introduced or maintained at a site without the appropriate mycorrhizal fungus (Whigham et al. 2002).

Seeds of the taxon remain viable a long time, at least four years in seed packet field studies. Over this time, there does not appear to be any loss in seed viability (Whigham, personal communication). During these studies few seeds germinated and those that did were in seed packets from the same site.

### ***Mycorrhizae***

Orchid species differ in their germination strategy, and in many cases, both habitat and fungus specificity play significant roles in successful seedling establishment (Rasmussen and Whigham 1993). Although fungal associations are treated as beneficial, and sometimes required, this relationship is not always positive. In many instances, the fungal associate turns from provider to pathogen, killing the developing embryo (Rasmussen and Whigham 1993). It is unknown how often it this occurs, but given the estimates of seed production in orchids and the relative scarcity of many species, it may be a common event.

In the case of *Liparis liliifolia*, fungal isolates from both protocorms and adult plants are identical (McCormick et al. 2002). The isolates are present and required throughout its entire life cycle (Whigham, personal communication and in review). When produced, the seeds do not contain the fungi infecting the mother plant; rather, each seed must be individually infected in the soil prior to or just after germination (Rasmussen 1995). Fungi are known to promote the growth of seedlings in many species, especially orchids, but their actual effects on germination of seeds have not been fully investigated (Rasmussen 1995). Not all fungi isolated from orchid roots can promote germination (Rasmussen and Whigham 1993). A wide variety of orchid species germinate well *in vitro*, whether inoculated with fungi or not. However, in tests, *L.*

*liliifolia* did not germinate without inoculation; once inoculated, many seeds germinated on a variety of growth media (Rasmussen 1995).

*Liparis liliifolia* has been found to have a very specific fungal associate. The fungus is same over the entire range of the species with virtually no genetic variation (Whigham, personal communication and in review). The specificity of this association and the lack of the genetic variation within the fungus are surprising and not found among other orchids (Whigham, personal communication). To test the fungal specificity in *L. liliifolia*, seeds of the taxon were inoculated with eight different fungal strains isolated from a variety of orchids growing within the same forest habitat. The only strains that increased germination and supported vigorous seedling growth were two extracted from *Liparis liliifolia* and one from *Aplectrum hyemale* (Rasmussen 1995). The fungus isolated from *Liparis* was an undescribed species in the *Tulasnella* genus, typical of those found in the form genus *Rhizoctonia*. Fungi in the *Tulasnella* genus are primarily degraders of leaves and wood (McCormick et al. 2002). Seeds inoculated with the two *Rhizoctonia* isolated and extracted from this taxon achieved a germination of 45%. This inoculation also resulted in rapid and vigorous seedling development.

In studies conducted by Rasmussen and Whigham (1998) asymbiotic germination of *L. liliifolia* in vitro did not occur on a nutrient substrate, yet when seeds were inoculated with the fungus isolated from adult plants, germination occurred on a variety of media. The omission of sucrose from the germination media seemed to have no impact on germination; however, the removal of yeast from the media significantly reduced germination percentages. Furthermore, the omission of yeast extract in the first few weeks following germination also inhibited growth. These studies indicate that some organic compounds required for the germination of *L. liliifolia* could not be synthesized by the seed or the symbiotic fungus, and were therefore derived from the organic matter on which the fungus feeds.

### ***Life History***

Development and life history for *L. loeselii* have been well studied and, in certain aspects, may be similar to that of the less-studied *Liparis liliifolia*. Plants of *Liparis loeselii* are rhizomatous with the leaves and flowering stalks arising from a bulb-like base (Williams and Williams 1983). According to a study by Mrkvica (1990), to go from seed to flowering age takes four years, yet other studies by Fuchs and Ziegenspeck (1927 as reported in Rasmussen 1995) indicate it may take as many as 15 years to reach reproductive age. Seeds sown in August will germinate the following spring and by May of that year, small protocorms can be observed. The protocorm stage of development is defined as growth from germination until a shoot tip with primordial leaves but no roots has developed (Rasmussen 1995). These protocorms can function as parasites on fungi, living underground for weeks, months, and even years after germination in some terrestrial orchids (Rasmussen and Whigham 1993). The next stage of growth, known as the mycorrhizome stage, begins when the apical meristem elongates and the first roots appear. By August of the same year, these protocorms have developed early roots and a

small bulb in *L. loeselii*. By the second spring, a few roots have developed. These ordinary roots form each spring and function throughout the summer (Rasmussen 1995).

The bulbs that are produced tend to enlarge from year to year (Rasmussen 1995). In *Liparis liliifolia*, only one flowering shoot is produced per year. Prior to leaf emergence or the appearance of the inflorescence, each bulb (or pseudobulb) contains two corms: an older and larger corm, often with the previous years' flowering or fruiting stalk attached acting as a storage organ; and a small, young corm that will develop into the present years' aboveground plant. The young corm is enveloped in the previous years' leaf bases on the old corm, and the two corms are attached via a swollen internode along the rhizome (Rasmussen and Whigham 2002). It is likely that the new corm is inoculated with the required mycorrhizal material internally via this rhizome in a similar fashion to that described for *L. loeselii* by Mrvicka (1990) and reported in Rasmussen (1995). The old and new sections of rhizome are partitioned by a zone of hardened cortical tissue, preventing penetration of the fungi from the older, infected portion of the rhizome to the newer, uninfected section. An adaptation to transfer the infection has evolved in the form of an internal root. From the new rhizome segment, an internal root grows, penetrating the sheathing scale and the previous years' rhizome segment to the cortex. The fungus is then transported from the old rhizome cortex to the newly developed rhizome by long hairs developed on the internal root (Rasmussen 1995). In this way, the infection can be transferred without having to pass through the swollen internode.

External roots develop in the spring (Rasmussen 1995). The root development of this taxon seems to be seasonally related to shoot development. The roots show little mycorrhizal infection (Rasmussen and Whigham 2002), and most of this infection appears near the base of the rhizome (Rasmussen 1995). These two factors combine to indicate that the primary function of the external roots is water uptake, and that they do not play a major role in mycorrhizal infection (Rasmussen and Whigham 2002). In fact, *Liparis liliifolia* although seeming to require a fungal associate for successful seedling establishment and growth throughout its life, has only a small amount of mycotrophic material in the rhizome. Its mycotrophic season is also very short and coincides strongly with the aboveground growth or leafy season (Rasmussen and Whigham 2002).

By autumn, when the young corm has functionally replaced the older one, a new bud (the beginnings of a new corm and rhizome segment) begins to form on the innermost leaf sheath. By December, the rhizome along the base of this bud develops the early stages of the following season's ordinary external roots. These roots will begin active growth the following spring, growing into the soil as the new corm develops and produces that season's aboveground plant. There are no reports or studies indicating the species spread clonally.

Populations of *Liparis* are well known for their wide fluctuations in size (Sheviak 1974, Case 1987, Homoya 1993). Large populations have been documented to decline rapidly over a matter of just several years (Homoya 1993). In New England, several

large populations of 30-70 or more plants have declined or disappeared in as little as ten years (personal observation).

The chromosome number for *Liparis liliifolia* is unknown (Angelo and Boufford 2000).

## **HABITAT/ECOLOGY**

*Liparis liliifolia* occupies a variety of habitats throughout its range. The *Flora of North America* makes the following excellent summary of the rangewide habitat requirements for this species: “Mature mesic to moist deciduous forests, pine woods, rich moist humus, often colonizing previously open disturbed habitats during the early to middle stages of reforestation” (Magrath 2002: 624-625). The species is somewhat of a generalist in the heart of its range in the Midwestern and southern states, occupying all early to mid-successional forest habitats (Table 1).

Although not all-inclusive, a general listing of habitats by state and region reveals that range-wide, *L. liliifolia* occurs in a wide variety of habitats from wet to dry, shady to exposed (Table 1). Even though adapted to a lightly shaded environment, plants have displayed an ability to tolerate high heat levels and direct sunlight (Homoya 1993). It is considered by many as a somewhat weedy species, colonizing early to mid-successional forest habitats, and thriving in light shade (Sheviak 1974, Dressler 1981, Homoya 1993; Leoschke, Iowa Natural Areas Inventory, personal communication). Most plants occur in lightly-shaded areas of the forest or in openings created by human disturbance or natural tree fall (Homoya 1993). There appears to be a narrow window of time in which this orchid finds conditions suitable. Immediately following a disturbance event, aggressive, early-successional weeds may exclude or prevent the establishment of *L. liliifolia* (Homoya 1993). As these aggressive weeds begin to decline due to succession, *Liparis* can gain a foothold and become established. It sometimes spreads rapidly, becoming an important and abundant herbaceous species (Sheviak 1974). As succession continues towards a mature forest, the increasing shade decreases the suitability of the habitat for the taxon.

<b>Table 1: Rangewide habitat types for <i>Liparis liliifolia</i> by region</b>	
Personal communication references are from Natural Heritage Botanists from each state.	
<b>Region</b>	<b>Description</b>
<b>Southern states</b>	
AL	Rich, mesic bottomland hardwood forest (Schotz, personal communication)
GA	Rich hardwood dominated woodlands (Allison, personal communication)
NC	Moist forest slopes, floodplain (Franklin, personal communication)
VA	Hardwood forests and bottomlands with a somewhat rich herbaceous flora (Townsend, personal communication)
WV	Mossy roadside bank; rich woods; pine woods; mixed deciduous woods; dry rocky road bank; moist wood; moist organic acidic soil in the shade of mature mixed deciduous forest (Harmon, personal communication)
<b>Northeastern states (outside of New England)</b>	
DE	Rich woods; rich, loamy soils; usually with <i>Liriodendron tulipifera</i> woodlands (McAvoy, personal communication)
MD	Rich mesic woodlands (Frye, personal communication)
NJ	Successional habitats; second growth woods; roadside bank; along trail (Snyder, personal communication)
NY	Dense red cedar stand; deciduous woods on rocky gradual slope; dripping shaded ledges; dry limestone woods; damp woods; swamp with dense shrubs (Young, personal communication)
PA	Rich, rocky woods and slopes (Grund, personal communication)
<b>Midwestern states and provinces</b>	
IA	Deciduous forests, especially disturbed forests; old shrubby pastures (Leoschke, personal communication)
IN	Young successional forests; edges of mature forests (Homoya, personal communication)
MI	South facing oak ridge; disturbed oak-savanna; shrubby second growth; shrubby hillside; early successional/disturbed dry mesic forest (Higman, personal communication)
MN	Oak woods; second growth upland woods; oak-hickory woods; dry sandy wooded slope; dry, loamy wooded slope; cedar glade; brushy pastured edge (Nelson, personal communication)
MO	Mesic forests with acidic substrates (Smith personal communication)
ONT	Wet woods; mature deciduous swamp; edge of pine plantation; open oak woods; dry open oak woodland (Ben-Oliel, personal communication)
WI	Rich mesic woods, mesic pine plantations (Anderson, personal communication)

Populations decline rapidly in both plant numbers and reproduction as the canopy closes (Sheviak 1974, Dressler 1981, Homoya 1993; Leoschke, personal communication). In the primeval woodland, the taxon is considered an extremely rare plant, limited to areas of wind throw and communities with a high degree of sunlight penetration (Sheviak 1974). In regions with large areas of suitable habitat, such as the increasing early successional habitats of the Midwest, *Liparis liliifolia* is increasing both in abundance and distribution, becoming more common today than historically (Sheviak 1974, Homoya 1993). In contrast, its range has shrunk in the northeast, especially New England, with the return of a more forested landscape. The widespread clearing of New England for timber, and sheep and cattle grazing that occurred in the early to mid-1800's



set the stage for an abundance of early- to mid-successional forests in the late 1800's and early 1900's (Wessels 1997): habitats perfect for colonization by *Liparis liliifolia*. This may have been the heyday for this orchid in New England.

The habitats referenced on herbarium specimens collected in New England from 1860 through the 1930's closely parallel those currently known rangewide. Based on the abundance of specimens collected and the number of towns from which the species was known, it appears to have been one of the more common orchid species, at least in southern New England at that time (heaviest collections of this taxon was between 1860 and 1939; personal observation). Since 1939, there have been far fewer observations and collections of this species. This may be the result of a cultural artifact, such as fewer botanists collecting or, more likely, maturing woodlands eliminating suitable habitat for the taxon.

Today in New England, the distribution and abundance of *Liparis liliifolia* may more closely reflect its presence on the landscape before European colonization. The taxon is now found primarily in habitats that permanently maintain conditions similar to early- to mid-successional habitats. These areas have high levels of sunlight penetration, high species diversity, and low levels of highly competitive weedy species. Because there is no way to determine the status of *L. liliifolia* on the landscape at the time of European colonization, we can only refer to the record of collections and observations by early botanists. The first collections known from New England are 1842 from Deerfield, Massachusetts and 1867 from Norwich, Connecticut.

Currently in New England there is also less variability in habitat types supporting extant occurrences than 100 years ago. In the early 1900's, habitats such as "damp moist woods," "deep rich woods," "wooded roadside," or "moist rocky bank" were common. Over the past 100 years, as populations have apparently been eliminated from many locations in New England, the taxon has become restricted to essentially two habitat types; one in southern New England and one in Vermont.

Little is known about the specific habitat around the two *L. liliifolia* extant occurrences in Vermont. At both locations, the plants occur within large swamp complexes for which detailed descriptions exist. However, at the time of discovery the observers were focusing on natural community inventories, and collected little specific information on the habitats surrounding the *L. liliifolia* populations. At each location, the plants were found growing in an area of shaded hardwoods: in one case, in a slight depression where a tree was upturned, and in the second case, on the mass of an uprooted tree. Little or no information on associated species, aspect, slope, or moisture information was provided. The two fragments of important information that can be extracted from the available information are that both populations seemed to be atypical in comparison to those extant in southern New England and each occurred in a disturbed location, both at locations of overturned trees. Based on the discussion above, it is likely that this wind throw increased sunlight penetration at these two locations, allowing for establishment at these sites.

Most of the extant occurrences are found in the southern New England habitat type: thin canopied, glade-like woodlands dominated by *Carya ovata*, *Fraxinus americana*, *Juniperus virginiana*, and *Quercus prinoides*. At these locations, the canopy trees average 30 to 40 feet (10-13 m) in height, there is a very scant subcanopy and shrub layer, and the herbaceous layer is often diverse and dominated by *Carex pensylvanica* (personal observation). Most extant records occur on the eastern or southeastern slopes of the basalt traprock ridges running down the center of Massachusetts and Connecticut: the Mount Holyoke Range and the Metacomet Ridge. There are no reports of *L. liliifolia* occurring on a northern or western facing slope, although based on the vague location information on many herbarium specimens some historic record may have. The slopes where the taxon is found are gentle, rarely exceeding 8%.

Only during recent observations have detailed data on the associated species co-occurring with *L. liliifolia* in New England been recorded. The available information for extant sites reveals the following species to be associated at more than one location: *Juniperus virginiana*, *Carya ovata*, *Carya glabra*, *Fraxinus americana*, *Acer saccharum*, *Tsuga canadensis*, *Quercus prinoides*, *Ostrya virginiana*, *Carpinus caroliniana*, *Betula lenta*, *Carex pensylvanica*, *Asplenium platyneuron*, *Potentilla simplex*, *Hepatica americana*, *Uvularia sessilifolia*, *Carex swanii*, *Eurybia divaricatus*, *Poa compressa*, *Helianthus divaricatus*, *Triosteum aurantiacum*, *Pycnanthemum incanum*, *Viola triloba*, *Hypoxis hirsuta*, and *Arabis missouriensis*. There are other species listed at one site, which probably co-occur at other sites, but their presence has yet to be documented.

There is no reference in the literature to *L. liliifolia* being a fire-dependent or fire-tolerant species. The taxon does grow in an early successional habitat, that may have been maintained historically in part by fire. In a recent talk the demography of *Cypripedium* sp. given by Douglas Gill, he noted that controlled burns stimulated both flowering and seed set (Schmitt, Brown University, personal communication). It is possible that fire or a disturbance such as logging may benefit *L. liliifolia* populations by opening up suitable habitat and establishing an earlier successional stage.

There are repeated references to soils for sites of *Liparis* in the Midwest and south. Most commonly, the sites are referred to as rich (Anderson, Georgia Natural Heritage Program, personal communication; Frye, Maryland Natural Heritage Program, personal communication; McAvoy, Delaware Natural Heritage Program, personal communication), but in other areas soils are listed as mildly acidic or acidic (Sheviak 1974, Homoya 1993; Harmon, West Virginia Natural Heritage Program, personal communication; Smith, Missouri Department of Conservation, personal communication). The composition of soils seems to vary widely, ranging from sands to silty or clayey loams. Most soils supporting the species are low in organic matter (Sheviak 1974). The pH of sites in Illinois varied from 4.5 to 6.6 (Sheviak 1974). From this information, it appears that the taxon does not have any specific affinity for a certain soil pH, but may be more dependent on the successional stage of the community and light levels. This is somewhat corroborated by the historic distribution in New England. *Liparis* was reported from such calcareous areas as Vermont and Berkshire County, Massachusetts, but also from areas with more acidic soils including areas of Rhode Island, eastern

Massachusetts, and New Hampshire. Little specific information on the soil types at *L. liliifolia* locations in New England exists. No soil studies have been conducted at any location of *L. liliifolia*, but the soils overlaying the basalt ridges are typically circumneutral (Swain and Kearsley 2000). The best specific description of soils is found on a field form by Bill Moorhead for CT .010 (Windham) completed in 2001. The soils at this location are described as “loose and fluffy underfoot but probably shallow to bedrock. Mapped as Charlton – Chatfield Complex, but soils on glade probably closer to Hollis – Rock Outcrop Complex in vicinity of EO.”

*Liparis liliifolia* is a facultative upland species, occurring only infrequently in wetland situations (USDA NRCS 2004). The locations in southern New England are referred to on rare plant observation forms as dry to mesic rich woodlands. At several sites, ephemeral or vernal seeps or washes are found in close proximity to the populations, although none pass directly through any population (personal observation). Most extant New England sites grow in a thin layer of soil overlaying talus, indicating the soils are well drained. Populations in Vermont are reported from large swamp complexes but it is unknown if the plants were growing in the swamp itself or in the upland border.

## **THREATS TO TAXON**

Although the species is considered secure globally and nationally, it is critically imperiled in New England. Although a number of lesser potential threats exist, forest succession, browse, inbreeding depression, and (potentially) invasive species are the greatest immediate threats to the species in New England. Natural threats pose an interesting dilemma in attempting to conserve this species on the landscape. Although we may be able to mitigate some of these at individual locations, we should acknowledge that we are then interfering with the natural processes that affect species and over time.

### ***Forest Succession***

The single greatest threat is forest succession. As was discussed in the Habitat/Ecology section, *Liparis liliifolia* is an early- to mid-successional forest species. When sites become too shady, the species is quickly eliminated (Sheviak 1974). During the late 1800's to early 1900's, this species was abundant, apparently taking advantage of the early successional forests of that time. Today, with much of the region forested, and in many areas densely forested there is a lack of abundant suitable habitat. Succession, shading or competition was inferred or listed as a threat at the following populations VT .005 (Cornwall), MA .004 (East Longmeadow), MA .005 (Sunderland), MA .006 (Sunderland), MA .007 (Sunderland), MA .012 (Lexington), RI .001 (Glocester), RI .002 (Coventry), RI .003 (West Greenwich), RI .004 (West Greenwich), RI .006 (West Greenwich), CT 002 (Cheshire), and CT .003 (East Haddam). Many of these populations have disappeared, even though they are officially considered extant by the state Natural Heritage programs. It is likely that all but VT .005 (Cornwall) and CT .003 (East

Haddam) have been eliminated by succession. As for the remaining historic sites, this factor could be responsible for their loss, but there is no way to verify this.

### ***Browse***

Browse is a major concern at a number of sites in Connecticut and Massachusetts. Orchids are known to be a favorite food of deer. As the deer population in southern New England has reached epic proportions, the forests in many areas, especially Connecticut have been picked clean of any plant even marginally palatable to these insatiable ungulates. Browse, not only deer, but rabbits and turkeys as well has been noted as a threat to some *Liparis liliifolia* occurrences [MA .003 (South Hadley), CT .002 (Cheshire), CT .003 (East Haddam), CT .009 (Berlin), and CT .010 (Windham)]. The turkeys are not browsing on the plants specifically, but are scratching and pecking throughout the habitat, potentially unearthing individual plants. This browse is most acute in the ash/oak/hickory glade forests along the basalt ridges in central Massachusetts and Connecticut. At CT .009 (Berlin), the author observed a large herd of deer browsing vegetation in an ash/oak/hickory glade forest where *Liparis liliifolia* occurs. At CT .003 (East Haddam), the browse is having such a detrimental effect on the population that the landowner took it upon herself to cage the few remaining plants.

### ***Poor Reproductive Output***

The vast majority of plants in New England populations produce no fruit, following successful flowering. The reasons for this reproductive failure are unclear, but may be related to self-incompatibility, lack of available outcross pollen, or lack of pollinators.

The plants are self-incompatible and require some mechanism to cross-pollinate the individual plants. Inbreeding depression due to the small size of extant populations is of concern. Based on findings of severe inbreeding depression and lack of viable seed production at populations in Maryland, this may, in fact, be the most critical threat facing the taxon in New England (Whigham, personal communication). Although this factor is only listed as a threat for CT.009 (Berlin) and CT .010 (Windham), it should be considered a potential threat at VT .005 (Cornwall), MA .001 (Holyoke), MA .030 (Middleboro), MA .035 (Holyoke), RI No EO # (Smithfield, if extant), CT .002 (Cheshire, if extant), CT .003 (East Haddam), CT .008 (Hamden), and CT New (Lyme) based on their small population sizes. This list includes, therefore, nearly every extant site in New England. This, combined with a reliance on insects known to be poor pollinators, puts the taxon at great risk of inbreeding depression.

### ***Invasive Species***

Invasive species, including *Cynanchum* sp., *Berberis thunbergii*, *Berberis vulgaris*, *Euonymus alatus*, and *Celastrus orbiculatus*, are potential threats at several of the extant populations. Invasives are listed as threats or associated species at MA .001 (Holyoke), RI .004 (West Greenwich), CT .002 (Cheshire), and CT .003 (East Haddam). At the present time, there have been no documented impacts to the taxon at any site by invasive plant species. However, given the scope of this problem in southern New England and documented impacts by invasive plant species at other rare plant locations, it bears monitoring.

### ***Other Threats***

Logging is listed as a potential threat to the to extant Vermont sites, VT .005 (Cornwall) and VT .006 (Brandon). This activity could have a detrimental impact on the occurrences if it occurs directly at the population or results in the physical destruction of the site. The disturbance caused by logging may also create the early- to mid-successional communities favored by *L. liliifolia*, encouraging colonization or expansion of an existing population.

Trampling and collection are also listed as potential threats at CT .010 (Windham). These are minor potential threats. Repeated trampling would have a detrimental impact on the plants, but a random on time event is unlikely to have a long-term impact. No currently extant population of this taxon grows in close proximity to a trail or roadway so repeated trampling is unlikely. Given the scarcity and cryptic nature of *Liparis liliifolia*, it is unlikely to be a species presently targeted for collection on a regular basis. Collection is not considered a significant threat at the current time, but historically it most certainly was. A number of herbarium sheets at the George Safford Torrey Herbarium at the University of Connecticut contain multiple individuals and multiple collections from the same location.

## **DISTRIBUTION AND STATUS**

### ***General Status***

*Liparis liliifolia* ranges throughout the eastern and north-central United States. The range is defined as Maine to Minnesota south to Georgia, Arkansas and Oklahoma (Gleason and Cronquist 1991). The taxon also occurs in Ontario, Canada (NatureServe 2003). The global Natural Heritage status rank is G5, indicating the species is Globally Secure. In the United States, it is ranked N5, reflecting the species is secure nationally. In Canada, the only other country where this species occurs, it is ranked N2 or imperiled (NatureServe 2003).

In the United States, the taxon is reported from 26 states. There are a number of states in which the taxon is listed as SR (reported but unverified) or SU (status unknown). In most instances, it is not tracked due to the abundance of individuals or populations (see Table 2). In Iowa, there are 50 or more populations, containing over 1,000 plants (Leoschke, personal communication). In Indiana, it is considered one of the most common forest and edge orchids in the state, and is known from 90% of the counties in that state (Homoya, Indiana Department of Natural Resources, personal communication). Missouri reports it from 50 out of 114 counties and considers the species fairly common (Smith, personal communication). In North Carolina, it occurs in 31 counties (Franklin, North Carolina Natural Heritage Program, personal communication). In South Carolina there are few records but it is seen commonly in the Blue Ridge regions, probably occurring in eight to ten counties (Allison, Georgia Natural Heritage Program, personal communication).

After a careful examination of the information in Table 2 and communications with many Natural Heritage program botanists about this taxon, it is clear that it is most common in the Midwestern and southern states. Further to the north, and especially northeast, it becomes increasingly uncommon. The current northern limit its range is Ontario, New York, and Vermont. Oklahoma marks the western extent of the taxon; only one population is reported from that state (Hoagland, Oklahoma Natural Heritage Inventory, personal communication). Mississippi and Alabama mark the southern limit of the range. No information could be discovered on the Mississippi populations beyond the heritage status rank of SR. Alabama reports two extant and no historic populations (Schotz, Alabama Natural Heritage Program, personal communication).

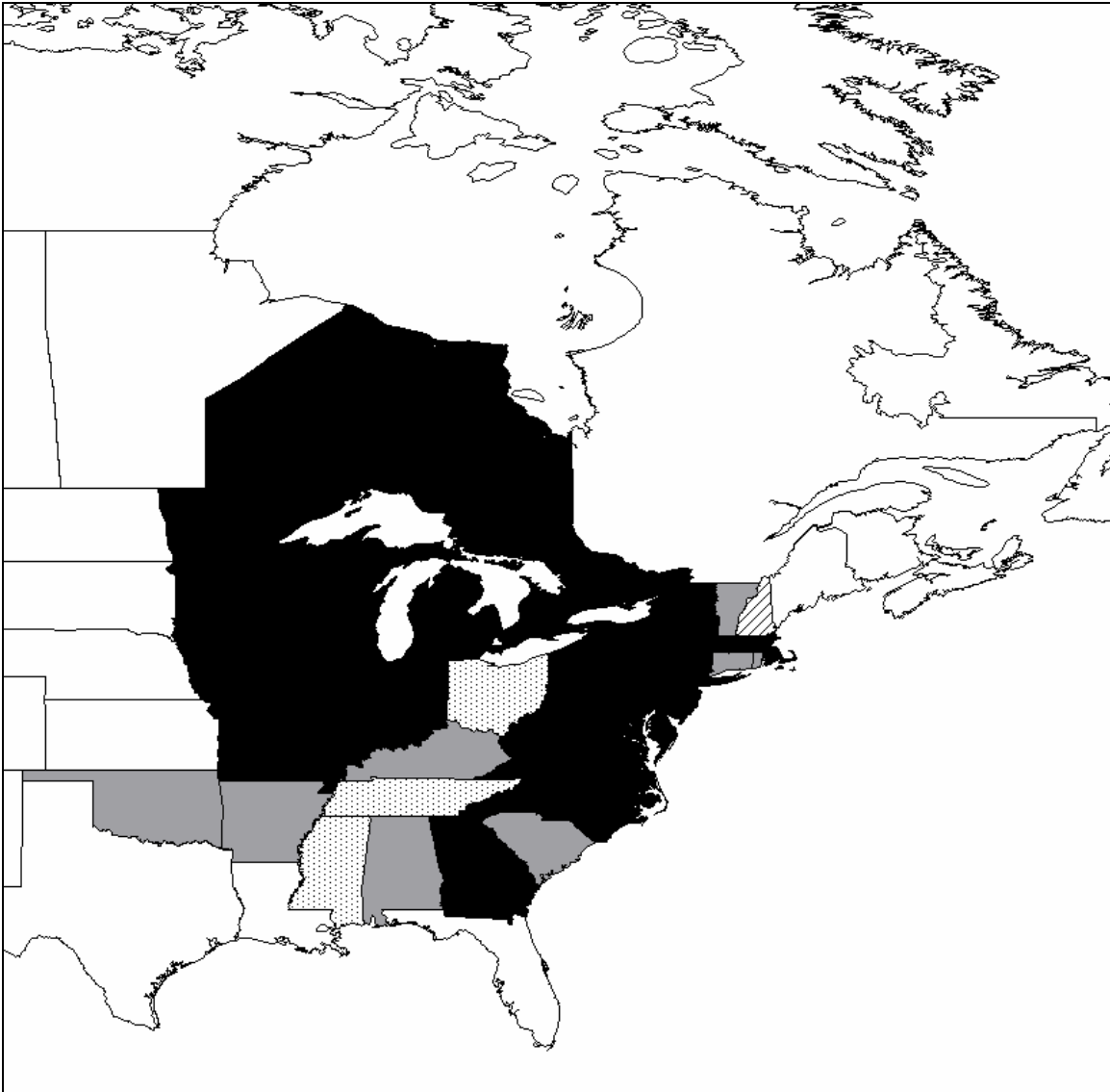
<b>Table 2. Occurrence and status of <i>Liparis liliifolia</i> in the United States and Canada based on information from Natural Heritage Programs.</b>			
<b>OCCURS &amp; LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURS &amp; NOT LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURRENCE REPORTED OR UNVERIFIED</b>	<b>HISTORIC (LIKELY EXTIRPATED)</b>
Alabama (S1, E): 2 extant occurrences and no historic (Schotz, personal communication)	Arkansas (S?)	Minnesota (SU): 61 records. Occurs in many counties (Nelson, Minnesota Natural Heritage and Nongame Research, personal communication)	NH (SX): based on two specimens. There is some doubt concerning the identification of one specimen (Haines, Consulting Botanist, personal communication)
Connecticut (S1, E): 5 extant occurrences and many historic record and specimens (personal observations)	District of Columbia (S?)	Mississippi (SR)	

<b>Table 2. Occurrence and status of <i>Liparis liliifolia</i> in the United States and Canada based on information from Natural Heritage Programs.</b>			
<b>OCCURS &amp; LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURS &amp; NOT LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURRENCE REPORTED OR UNVERIFIED</b>	<b>HISTORIC (LIKELY EXTIRPATED)</b>
Delaware (S2, no status): 17 extant occurrences (McAvoy, personal communication)	Illinois (S3/S4)	Ohio (SR)	
Massachusetts (S3 WL, being upgraded to S2, T): 10 extant and 25 historic	Indiana (S5): Occurs in 90% of the 92 counties. Probably the most common forest and edge species of orchid in the state (Homoya, personal communication)	Tennessee (SR)	
New York (S1, E): 7 extant and 19 historic occurrences (Young, personal communication)	Georgia (S3, no status): Few records but seen commonly in Blue Ridge region. Known from five counties (probably occurring in 8 – 10) (Allison, personal communication)	Wisconsin (SR): occurs in 21 counties supported by 59 specimens in the state herbarium (Anderson, personal communication)	
Oklahoma (S1): Taxon may not be extant in state. S1 based on a literature report and vegetative specimen (Hoagland, personal communication)	Iowa (S3): 50 or more populations, some with 1,000 or more individuals (Leoschke, personal communication)	Missouri (SR): Occurs in 50 out of 114 counties. Considered relatively common. A more accurate S-rank would be S4 (Smith, personal communication)	
Ontario (S2, T): 11 extant and 5 historic populations. Less than 150 plants total in the province (Ben-Oliel, personal communication)	Kentucky (S?)		
Rhode Island (S1, T): 2 populations reported. Likely 0 extant populations, and six historic (Enser personal communication)	Maryland (S3/S4): Uncommon (Frye, personal communication)		

<b>Table 2. Occurrence and status of <i>Liparis liliifolia</i> in the United States and Canada based on information from Natural Heritage Programs.</b>			
<b>OCCURS &amp; LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURS &amp; NOT LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURRENCE REPORTED OR UNVERIFIED</b>	<b>HISTORIC (LIKELY EXTIRPATED)</b>
Vermont (S1, E): 2 extant and 4 historic occurrences	Michigan (S3, SC): 13 extant in 5 counties and no historic occurrences (Higman, personal communication)		
	New Jersey (S3/S4, no status): Occurring in most counties (Snyder, personal communication)		
	North Carolina (S3): Occurring in 31 counties (Franklin, personal communication)		
	Pennsylvania (S?): Upcoming revision will probably assign a rank of S4. Most records from eastern counties in urbanized areas and Populations tend to be small (Grund, personal communication)		
	South Carolina (S?, SC)		
	Virginia (S4): uncommon, recently re-ranked from S5 to S4 (Townsend, personal communication)		
	West Virginia (S4): Extant records in 39 out of 55 counties (Harmon, personal communication)		

The distribution and status of *Liparis liliifolia* in North America are summarized in Figure 1.





**Figure 1. Occurrences of *Liparis liliifolia* in North America.** States and provinces shaded in gray have one to five (or an unspecified number of) current occurrences of the taxon. Areas shaded in black have more than five confirmed occurrences. The state (New Hampshire) with diagonal hatching is designated “historic,” where the taxon no longer occurs. States with stippling are ranked “SR” (status "reported" but not necessarily verified). See Appendix for explanation of state ranks.

### ***Status of All New England Occurrences — Current and Historical***

*Liparis liliifolia* appears, based on herbarium specimens, to have been quite common in parts of southern New England at the turn of the last century. Perhaps some of these populations remain extant, but the location data for most historic populations is scant at best. The New England Plant Conservation Program lists *Liparis liliifolia* as Division 2 or Regionally Rare in *Flora Conservanda: New England* (Brumback and Mehrhoff et al. 1996). This status ranking is reserved for taxa with fewer than 20 current occurrences (seen since 1970) within New England. A tally of those populations that have been documented extant since 1993 reveals 12 occurrences: two in Vermont, four in Massachusetts, and six in Connecticut. Three of these were newly discovered in 2002 or 2003. One of these has not been seen since the 1990's, despite repeated searches, and is ranked F ("Failed to find"), so its status is in doubt.

### ***Status of Maine Occurrences***

No extant or historic occurrences are listed for Maine. Nor does NatureServe or The *Flora of Maine* (Haines and Vining 1998) list the species as occurring in the state. No specimens exist for that state. However, in the book *The Maine Woods* by Henry David Thoreau (1864: 242), he refers to an observation of *Liparis liliifolia* in Maine. In the chapter entitled "The Allegash and East Branch," Thoreau, while discussing the plants of Mt. Kineo on Moosehead Lake states that "I have also received *Liparis liliifolia*, or twayblade, from this spot." It is an unusual statement. What does he mean, "received from this spot?" This is the only reference to the taxon ever occurring in Maine. Thoreau is most likely referring to a *Listera* or *Malaxis* species, also commonly known as twayblades, but the fact that he refers to the species using its proper botanical name is intriguing. Mt. Kineo is an unusual mountain and the location of a number of rare and calcareous species. It is possible that *Liparis liliifolia* once occupied the slopes of Mt. Kineo. Whether this is truth or fiction will forever remain a mystery.

### ***Status of New Hampshire Occurrences***

The New Hampshire Natural Heritage Bureau (NHNHB) considers *Liparis liliifolia* as SX in the state based on a single collection made by P. Batchelder. On September 20, 1909, Batchelder collected a specimen from an unknown location in Manchester. Arthur Haines observed this specimen as part of the Herbarium Recovery Project (HRP) and noted that the "specimen is in fruit and difficult to determine. Further study is needed for this specimen to confirm identification. Fruits are significantly longer than pedicels on the specimen." In *Liparis liliifolia*, the stipe should be considerably longer than the capsule. This may indicate that the specimen is actually not *Liparis liliifolia*.

A survey of the G. Safford Torrey Herbarium at the University of Connecticut revealed an additional specimen collected from New Hampshire. On July 6, 1878, an

unknown individual made a collection from a location described only as “Hubbard.” No additional information is available.

### ***Status of Vermont Occurrences***

The Vermont Nongame and Natural Heritage Program tracks six occurrences of *Liparis liliifolia*. An herbarium specimen on file at NEBC supports one additional population. Of the seven populations known to have existed in Vermont historically, only two are considered extant. The plant is listed as S1 and Threatened in Vermont.

**VT .001 (Sharon)** – Three collections exist at the Pringle Herbarium at the University of Vermont (VT) to support this occurrence. All date from the same year 1925. D. Dutton made two collections; one a plant, and the other a black and white photograph of the plant. The label information for these two collections state “Edge of woods. Alt. 1400ft.” and “Under trees at edge of woods” respectively. The collection date is listed as July 9, 1925. H. Ridlon collected *Liparis liliifolia* on July 7, 1925 from Downer State Forest. Although not specifically referenced, it is assumed these collections were made from the same location. No additional specific location, habitat or population information is provided on the specimen labels. No attempts to locate these plants have been made. The landowner is the Vermont Department of Forests, Parks and Recreation. The occurrence is currently unranked.

**VT .002 (Pownal)** – Two separate collections were made from Pownal in July 1907. On June 2, 1907, N. F. Flynn collected a specimen from “Kriger Rocks, No. Pownal.” The next day D. S. Carpenter collected a specimen from “Pownal.” Although not specifically referenced, it is assumed these collections were made from the same location. No additional specific location, habitat or population information is provided on the specimen labels. No attempts to locate these plants have been made. Due to many other unusual species found in Pownal, the general vicinity has been heavily botanized in recent times. The landowner is unknown. The occurrence is currently unranked.

**VT .003 (Colchester)** – W. Eggleston collected a specimen from “sandy bluffs opp. Fort Ethan Allen” on July 3, 1906. There are several areas that could be classified as sandy bluffs opposite Fort Ethan Allen today. In 2002, Mattrick attempted to locate the plants at the top and along the steep sandy bluff to the south of Fort Ethan Allen and Route 15 without success. Suitable habitat does remain at the site, but there has also been a great deal of development and habitat alteration since the original sighting. No additional specific location, habitat or population information is provided on the specimen labels. The landowner is unknown. The occurrence is currently unranked.

**VT .004 (Middlebury)** – E. Brainerd collected from this location three times in the 1880’s: June 26, 1880, June 26, 1882, and June 30, 1883. Collections are on file at both the Pringle Herbarium and the Gray Herbarium. Only one notation as to habitat was made on any of the labels and it is of little use, simply stating “moist woods.” No specific location, habitat or population information is provided on the specimen labels.

No attempts to locate these plants have been made. The landowner is unknown. The occurrence is currently unranked.

**VT .005 (Cornwall)** – This population is found in a large swamp complex. The central and western portions of the swamp are dominated by a hardwood/cedar swamp. Further north, cedar becomes scarce and a red maple-black ash-yellow birch hardwood forest is dominant. There is a thorough description of the various plant communities found in this swamp in the biological conservation database (BCD) at Vermont Nongame and Natural Heritage Program (VTNNHP), but no description of the area where *Liparis liliifolia* was located is specified. The only specific habitat description provided indicates that the observed plants were “growing in shaded hardwoods in slight depression where a tree was upturned.”

Liz Thompson, Peter Hope, and Frank Thorne originally observed the plants while scouting a field trip location for the Vermont Bird and Botanic Club. Thirty plants were observed with 13 in flower on June 8, 1986. Thompson provided very general directions to the population. Marc Lapin searched for the plants on July 12, 1993 without success. On July 6, 1993, Jon Binhammer of the Vermont Chapter of The Nature Conservancy, while conducting an environmental hazard assessment of some potential land acquisitions, located two plants of *Liparis liliifolia*. Binhammer provided a map of the area indicating the location of the plants observed. When this map is compared to the general directions provided by Thompson from her 1986 visit, it appears the observations are from the same general area, if not the exact location.

In 2003, Thompson and Dorothy Allard discovered two plants, both in fruit, while scouting a field trip at this site in mid-September. The plants were in fruit and no other information is available. It is unknown whether these plants were the same as observed by Thompson in 1986 or Binhammer in 1993. The files at VTNNHP indicate the landowner to be either the Vermont Department of Fisheries and Wildlife or a private landowner. In his handwritten note, Binhammer states that “we are in the process of acquiring these two parcels,” implying that the location where he observed *Liparis* may now be owned by The Nature Conservancy. Forest succession is noted as a potential threat, and Thompson mentions that logging has occurred in the overall area. The occurrence has been assigned an Element Occurrence (EO) rank of E.

**VT .006 (Brandon)** – Marc Lapin observed two colonies of *Liparis liliifolia* growing in a large swamp complex in Brandon on September 4, 1996. A total of 18 plants were observed: ten in one subpopulation with one in fruit, two with evidence of flowering, and seven vegetative. The second subpopulation contained eight vegetative plants. Specific directions to the swamp are provided, but directions to the two subpopulations are lacking. The plants at the first subpopulation were growing on a low mound of *Calliargon* sp. (a moss) and associated with *Galium palustre*, *Glyceria striata*, *Impatiens capensis*, and *Thelypteris palustris*. Only a few single trees of *Thuja occidentalis* were observed in the area.

There is some confusion about the number of plants and subpopulations at this site. The

VTNNHP Element Occurrence Record (EOR) indicates Lapin reported two subpopulations totaling 18 plants. In reviewing his field notes, Lapin (Ecosystem Science and Conservation, personal communication), has a record of only the one subpopulation with ten plants. It is unclear whose records are accurate.

There is an extensive description of the swamp and its natural communities provided by Lapin. The swamp is one of the large Otter Creek swamps and less than 200 acres of the 1,000-acre site is forest. Although *Liparis* is mentioned in this description, it is difficult to decipher exactly which one of the multiple natural communities supports the taxon. Lapin states, “In the hardwood forests is where the state-Threatened lily-leaved twayblade (*Liparis liliifolia*) has been seen.” The hardwood forests he mentions are likely the transition forest between the upland hardwood forests and the more central cedar-hardwood swamp (Lapin, personal communication). The group of associates listed above is unusual for the taxon as they are all wetland or hydrophilic plants.

Lapin noted logging as a threat and that protection is needed. He also states that the plants are likely to persist at the site, and that more plants may exist at the site as it is very large. There is some question about the identification of the plants (Lapin, personal communication). The plants were in leaf and fruit only, and Lapin wonders if they were not large-leaved forms of *Liparis loeselii*. Multiple private landowners own the property and it is unclear on specifically whose property the plants occur. No attempts have been made to locate the plants since 1996. The lack of specific directions to the population will make relocating the population time-consuming. The occurrence has been assigned an EO rank of B.

**VT (Wells) – C.** Weatherby collected a specimen from “disintegrating slate outcrops in thin woods” on June 28, 1936. No additional information is provided on the specimen label. The landowner is unknown and the occurrence is currently unranked.

### ***Status of Massachusetts Occurrences***

*Liparis liliifolia* was once widespread in Massachusetts, occurring from eastern areas in Middlesex County, to the Connecticut River Valley, to Berkshire County. It is unclear if any of these populations were ever large, as many of them are based on a single observation or herbarium collection. The species is currently restricted to a handful of widely scattered populations concentrated in the Holyoke Range. There are nearly 50 collections of *Liparis liliifolia* in Massachusetts; from these, the Massachusetts Natural Heritage and Endangered Species Program (MANHESP) plans to designate 39 occurrences. Of these 39 occurrences, only 12 are considered extant (observed since 1970). Of these 12 occurrences, despite multiple searches at most locations, only five have been seen since 1993. Eastern populations have been searched for on multiple occasions without success. The populations in the Berkshires are based on specimens with scant information on which to base searches. Presently, the species is considered S1 in Massachusetts with a status of Watch List. In a pending revision of the Massachusetts

Endangered Species list, *Liparis liliifolia* has a proposed rank of Threatened (Melissa Dow Cullina, MANHESP, personal communication). The Element Occurrence (EO) numbers here are tentatively assigned and largely based on logbook numbers at MANHESP. It is likely that these numbers will be maintained as the actual EO numbers (Dow Cullina, personal communication).

**MA .001 (Holyoke)** – This population has been observed repeatedly since 1984. The population is located in an oak/ash/hickory glade on the eastern slopes of a mountain. The area in which the plants occur is quite distinctive from the surrounding woodlands. The canopy is relatively open and low. There is virtually no shrub layer and the herbaceous layer is dominated by *Carex pensylvanica*. Additional associated species include *Carya glabra*, *Carya ovata*, *Acer saccharum*, *Ostrya virginiana*, *Arabis missouriensis*, *Hypoxis hirsuta*, *Hedyotis caerulea*, *Asplenium platyneuron*, *Saxifraga virginiana*, *Potentilla simplex*, *Viola palmata*, *Hystrix patula*, *Oryzopsis racemosa*, *Hepatica americana*, *Uvularia perfoliata*, and *Agrimonia gryposella*.

In 1984, Bruce Sorrie observed 30 plus plants with immature fruit. At that time, the population was described as being very vigorous, with no threats apparent. On June 24, 1998, Karen Hirschberg and Nancy Putnam located 12 plants in the same area as Sorrie described. Eleven out of the twelve plants were in flower and the vigor was described as good and no threats were noted. Mattrick and Lynn Harper searched the area on June 25, 2002, and located only two plants. Although the plants were very small, both were in flower and appeared to have normal vigor. No immediate threats were observed. *Cynanchum louiseae* (Black swallowwort) is present in the habitat but is distant from the location of *Liparis* at the present time. No deer browse was observed, but is certainly possible.

There is no apparent explanation for the decline in this population over time. Hirschberg and Putnam created an excellent hand-drawn map of the area and gave exact locations of the plants within the population. The loss of ten plants from 1998 and 2002 is of grave concern. Although no browse has ever been noted at this site, it is a plausible explanation. The extremely dry conditions in 2002 may also have caused some of the plants at the site to remain belowground, although none of the research conducted by Rasmussen and Whigham provide any evidence of dormancy in the species (Whigham, personal communication). A herbarium specimen from this site was collected by Sorrie and deposited at the New England Botanical Club herbarium (NEBC). The property is owned by the Massachusetts Department of Conservation and Recreation. The population has no EO rank.

**MA .002 (Greenfield)** – This occurrence was apparently observed on several occasions by R. E. Ruhfel in the 1980's. There also exist two collections deposited at the NEBC Herbarium by Mrs. G. W. Thacher. These specimens are dated from two consecutive days in 1910. Little habitat information is provided on the only MANHESP data collection form on file. The plants occur in thin woods on a steep sedge dominated slope with no leaf debris on the forest floor. The population occurs on an upper to mid-elevation, east-facing slope in mesic soils. R. E. Ruhfel observed 50 plants with 34% in

flower on June 9, 1987. A note on the field form from this date states, “I only have record of my first visit here, I believe I have found more at a later date.” It is unclear whether the 1987 survey is the first or the last time plants were observed. No attempts to relocate this population have been made. The property is town-owned. The population has no EO rank.

**MA .003 (South Hadley)** – This EO number refers to a large scattered population on a mountain slope in the Holyoke Range. The population consists of at least three distinct subpopulations. There are most likely additional small subpopulations scattered throughout the abundant suitable habitat on the southern and southeastern slopes of this mountain. The various subpopulations occur in a dry oak hickory woodland on a trap rock slope. The canopy varies from location to location from fairly open to fairly dense. Associated species include *Quercus prinoides*, *Carya glabra*, *Carya ovata*, *Quercus rubra*, *Fraxinus americana*, *Rosa caroliniana*, *Poa compressa*, *Smilacina racemosa*, *Viola frimbriatula*, *Helianthus divaricatus*, *Danthonia spicata*, *Hypoxis hirsuta*, *Thalictrum thalictroides*, *Senecio pauperculus*, *Eurybia divaricata*, *Hystrix patula*, *Eupatorium sessilifolium*, and *Carex pensylvanica*. Two state-listed species also occur at this location *Arabis missouriensis* and *Carex flaccosperma* var. *glaucodea*.

An herbarium specimen exists for this same general site at the University of Massachusetts (UMASS) herbarium. It was collected by A. Pease dated September 17, 1925. The number of plants observed was not noted, but the specimen label states they were collected from “Rocky woods.” Sorrie next observed the plants on this mountain slope on July 19, 1984. A specimen located at NEBC from this date by Sorrie was located, but the label indicates it came from the Town of Amherst. This is likely a labeling error. The accompanying field form and maps clearly indicate the population being in South Hadley. Sorrie observed a total of 6 plants (2 mature, 4 immature), 25% with immature fruit. The vigor of these plants was described as “OK.” No threats were noted. A curious note in the comments section of the data collection form suggests that he observed more plants on the mountain either on that date or at an earlier time. The note reads, “The two plants that had flowered were browsed so that only cut-off flower stalks are left. Another 15 plants or more, occur along the old (pre-1983) trail....” This statement leads to the conclusion that up to 23 plants may have occurred at the Sorrie subpopulation(s).

On June 28, 2000, Mattrick and others observed 13 plants growing in a small, damp area less than 1 square meter in size. The plants were of normal vigor. The number of plants in bloom was not noted, but a photograph taken during the visit shows at least one plant in bloom. The reproductive portions of two plants were browsed either by rabbit or deer. The plants are growing on a southern slope in an open canopy woodland. The ground in the area is scattered with small basalt boulders less than one foot in diameter.

Hirschberg, Putnam, and Nancy Goodman located an additional subpopulation on June 24, 2001. The subpopulation occurs in an area 2 ft x 2 ft (0.36 m<sup>2</sup>) and consists of 5 plants (3 mature, 2 of unknown age). At the time of observation, 75% of the plants were in bloom and the plants were noted to be in good vigor.

A total of 41 plants have been observed at distinct locations on this mountain slope over the past twenty years, making it the largest, recently documented extant population in Massachusetts and New England. Threats to this population consist of browsing of plants and potential canopy closure noted in 2001. The occurrence is currently unranked.

**MA .004 (East Longmeadow)** – This population was first observed by Tad Zebryk in an abandoned sandstone quarry in 1988. The old quarry site has transitioned from open quarry to mature forest. The site is a maze of old quarry pits, many half-filled with leaf and branch debris and others filled with water. The forest is an uneven-aged, mixed hardwood stand with the oldest trees approximately 70 to 90 years old. Associated species include *Betula allegheniensis*, *Betula papyrifera*, *Acer saccharum*, *Acer rubrum*, *Viburnum recognitum*, *Rosa multiflora*, *Berberis thunbergii*, *Cypripedium acaule*, *Pyrola elliptica*, *Goodyera pubescens*, *Maianthemum canadense*, *Smilacina racemosa*, *Carex swanii*, *Mitchella repens*, and *Parthenocissus quinquefolius*.

Zebryk observed the population on at least two occasions. In 1988, he observed 20 plants, 6 with immature fruit pods, and several more with last year's seedpods. The plants were described as growing on the edge of a quarry ledge under a moderately open canopy in an area of sparse shrubs and herbs. Zebryk visited the site again on August 17, 1994 and discovered 73 plants in the same area; 31 mature and 42 immature. Forty-two percent of the observed plants had immature fruit. The plants were noted to be in very good vigor and growing on a humus and soil covered sandstone ledge. Zebryk provides very specific directions to the site. Trampling, competition from woody plants, over shading from canopy, and deer browse were all noted as threats during this visit. It is unclear whether they are actual or potential threats. There is also an implication that the canopy may be more closed in than it was in 1988. During the 1994 visit, he was concerned about over shading by the canopy, whereas during the 1988 visit he described the canopy as moderately open.

The population has been searched for numerous times by several competent botanists without success: Kate Leary in 1999, Arieh Tal in 2000, 2001, and 2003, Matrick in 2001 – 2003, and Bill Christensen in 2002. Several of these surveyors have commented that the site appears too shady overall to support the species. The directions provided by Zebryk in 1994 refer to a very specific area, but this area does not seem to exist when following the directions closely. There are areas nearby that seem to match the general description and appear suitable to support the taxon. These areas have been checked repeatedly without success. Repeated attempts to contact Zebryk for further information have failed.

If located, this would be the largest population in New England; however, it is unlikely that the species still occurs at the site. Threats include canopy closure and competition from other vegetation. The area is owned by the Town of East Longmeadow and managed as a conservation area. The site is currently unranked.



**MA .005 (Sunderland)** – This occurrence was observed only one time in 1985 or 1986 by R. E. Ruhfel and Bruce Goodchild. The plants were reported from the edge of an unimproved road on the eastern slope of a mountain. The plants were so close to the edge of the road that the observers were concerned a vehicle could crush them or that road maintenance activities would destroy the site. The plants were growing with *Uvularia sessilifolia* and *Botrychium dissectum* in an area that water may have flowed across seasonally. The site consists of an unevenly-aged mixed forest, with some areas dominated by *Tsuga canadensis* and *Pinus strobus*. Eight plants were observed; four mature and four immature. All the plants were noted as being in good vigor.

The population has been looked for on several occasions without success: twice by Christensen in 1998; four times in 1999 by Goodman; by Lynn Harper and Elizabeth Farnsworth in 2001; and by Mattrick and Erin Haney in 2002. Although acres of potential habitat exist in the general area, much of it appears too shady to support the species. Due to the specific nature of the directions the site, and its perilous position on a road edge, it is likely that this population is extirpated.

There are also three historic collections from Sunderland. Two of the collections give ambiguous information on the town, listing it as Leverett or Sunderland. All collections are treated here. Boutwell collected a specimen from this mountain in 1881. On September 7, 1892 Elwell collected a specimen from the same mountain. A June 17, 1909 collection by R. A. Ware is deposited at Smith College Herbarium (SCHN). No additional information is provided on the specimen labels. It is unclear whether these collections relate to this occurrence. The landowner is unknown and the occurrence is currently unranked.

**MA .006 (Sunderland)** – This occurrence is located in the same vicinity as MA .005 and MA .007 (Sunderland), and the three sites should probably be merged under one EO number. The population was observed growing on the southeastern slope of a mountain in a vernal wet area with white birch. R. E. Ruhfel and Bob Goodchild observed 11 plants at this location on the September 22, 1984. Four plants had flowered and one plant contained mature fruit and the vigor was described as “ok.” The reporting form is somewhat confusing, but it appears these same observers visited the site in 1985 and 1986 as well. The date is reported on the same form, but the months and dates are not provided. In 1985, 11 plants were observed with five in bloom. In 1986, it appears that no plants were found at the site; however, no explanation for their absence is given. No threats are mentioned.

The population has been looked for on several occasions without success: twice by Christensen in 1998; four times in 1999 by Goodman; by Lynn Harper and Elizabeth Farnsworth in 2001; and by Mattrick and Erin Haney in 2002. Although acres of potential habitat exist in the general area, much of it appears too shady to support this species. The directions are somewhat vague, relying on four birch trees and a flat area as landmarks. Relocating the exact spot is unlikely. The three historic collections from Sunderland or Leverett discussed above may also relate to this occurrence. The landowner is unknown and the occurrence is currently unranked.

**MA .007 (Sunderland)** – This occurrence is located in the same vicinity as MA .005 and MA .006 (Sunderland), and the three sites should probably be merged under one EO number. The population was reported growing on a moist clayey flat below a now torn-down cabin. No additional site or population information is provided. The only reference to this population is an entry in the Massachusetts Natural Heritage and Endangered Species Program log sheet for this species. The entry is in Bruce Sorrie’s handwriting, but it is unknown if he was the observer. The population has been looked for on several occasions without success: twice by Christensen in 1998; by Lynn Harper and Elizabeth Farnsworth in 2001; and by Mattrick and Erin Haney in 2002. Bayard Ewing visited the site in 1998 searching for another species, and reported the site to be very overgrown. In a report from their 2001 search of the area, Harper and Farnsworth indicate that the area “seems inappropriate habitat now for the taxon.” The three historic collections from Sunderland or Leverett discussed above may also relate to this occurrence. The landowner is unknown and the occurrence is currently unranked.

**MA .008 (West Springfield)** – On August 23, 1990, Sorrie located a population near an old quarry. Thirty-five plants were located in an old sandstone quarry on a low wall with *Selaginella rupestris*, *Polygonum tenue*, and *Juniperus virginiana*. No further information is available. The landowner is unknown and the site is currently unranked.

**MA .009 (Canton)** – There are a number of reports from Canton referring to populations on Great Blue Hill. Little location, habitat, or population information can be extracted from any of these records. On June 8, 1889, E. H. Hitchings made a collection from “Blue Hills, Reads ville, MA.” E. F. Williams made another collection from “Blue Hill, Blue Hills Reservation” on June 10, 1900. R. A. Ware collected a specimen from the “wooded rocky south slope of Great Blue Hill” on September 9, 1905. Nancy Webb and Ray Abair searched areas on Great Blue Hill matching the general description of the areas referenced in the previous reports during the summer of 1997. They were unable to locate any plants in the areas searched, however the search area is extremely large. The property is owned by the Massachusetts Department of Conservation and Recreation. The population is currently unranked.

**MA .010 (Deerfield)** – There are two reports of *Liparis liliifolia* from Deerfield. Although the available site information for each occurrence is vague, it is unlikely the reports are from the same population. No population or habitat information is given for either observation. R. Poland observed the population referenced by this occurrence three times in the 1950’s. She collected specimens from the site on July 13, 1952 and June 2, 1953. On June 18, 1955, she returned to the site and observed 15 plants in bloom along a stream bank in an area east of Pine Nook Road. Due to the vague nature of the location information provided for the observation, no subsequent searches have been made. The EO is currently unranked.

**MA .011 (Concord)** – This population was observed growing in the backyard of a home in Concord. The property owner first reported the population in 1959. A 1961 visit to the site by R. J. Eaton revealed three plants growing on an east-facing slope in leaf mold

over sandy soils near the base of a steep cliff rising from the backyard of the home. A collection from this visit was deposited at NEBC. In 2000, Gretel Clarke, Cynthia Moller, and Marion Larson, along with the landowner and original observer, searched the site without success. The surveyors commented that the site no longer seemed to support any suitable habitat. In 2002, Arthur Haines studied this specimen as part of the Herbarium Recovery Project (HRP) and reported that two collections appear on the sheet. It is possible that the collection from the population had a detrimental effect and caused the extirpation of this occurrence. The site is privately owned. The occurrence is currently unranked.

**MA .012 (Lexington)** – R. Tryon (a former Harvard University botany professor) reported that a single plant “appeared spontaneously in open site near *Pinus strobus* at ...in Lexington.” The plant occurred behind his home in pine needle duff. It was first observed in flower in 1970. Tryon reports that “the original plant and offset developed in 1971, no seeds were produced.” There is a collection deposited at NEBC by Tryon. In 1999, Marylee Everett and Moller searched the site without success. In 2001, Nancy Free and Betty Wright searched site and were unable to locate any plants. They reported the property is largely overgrown with half the property a wetland with a small streamlet flowing through it. It no longer supports any suitable habitat. It is possible that the collection of a specimen had a detrimental effect on, and caused the extirpation of this occurrence. The property is privately owned. The occurrence is currently unranked.

**MA .013 (Granby)** – There are possibly three collections from Granby of *Liparis liliifolia*, each provides little location information, and no specific habitat or population information. Two are listed here; the third is listed as MA .021 (Granby). A collection made from “woods” was made by E. Hunnewell on June 30, 1931. On July 31, 1952, Poland observed the species at “The Notch.” It is unknown whether these three disparate observations all relate to the same or different occurrences. Due to the paucity of information about any of these sightings, no efforts have been made to relocate the occurrence. The landowner is unknown. The EO is currently unranked.

**MA .014 (Canton)** – This occurrence was observed at least once by T. Otis Fuller in 1884 on Little Blue Hill in Canton. It is unclear how this occurrence relates to the other occurrences collected from this same time period in the Blue Hills area of Canton and Milton. There is no population or habitat information provided. There is a peculiar note written on the specimen label stating “1 blossom transplanted to Dedham from Canton in 1884.” There is no indication whether the actual collection represented on the herbarium sheet was collected from the wild or a cultivated location. Due to the lack of any location information, no searches for this population have been made. The area is publicly owned by the Massachusetts Division of Conservation and Recreation. The EO is currently unranked.

**MA .015 (Ashland)** – Two collections from the same date exist for this population. It appears this was the only observation for the taxon at this location. On the same sheet at the NEBC herbarium are two collections: one by Thomas Morong, and a second by Eaton both made on June 28, 1878. No other information is provided. No attempts to locate

this population have been made. The landowner is unknown. The EO is currently unranked.

**MA .016 (Amesbury)** – There are three known collections from Amesbury, all dating from 1896. It is unknown if these three collections relate to the same or three distinct occurrences, but it is assumed they relate to a single occurrence. In July 1896, F. F. Forbes made a collection of a vegetative individual. Two other collections from an area known as “Great Swamp” were made in 1896: one by J. Warren Huntington in June; and a second on by an unknown collector on July 10<sup>th</sup>. Both of these later collections were noted to be in flower. No specific location, habitat or population information is provided on any of the specimen labels. No attempts to locate these plants have been made. The landowner is unknown. The EO is currently unranked.

**MA .017 (West Springfield)** – Two old reports of a population from West Springfield exist. Neither of them provides any population or habitat information. At the NEBC Herbarium, there is a M. L. Owen collection from a cultivated plant dated June 1879. The comments on the herbarium label state “plant brought from West Springfield woods June 1876.” F. H. Sargent collected a specimen from a “dry, rocky wooded ridge” on September 12, 1934. No specific location, habitat or population information is provided on either of the specimen labels. No attempts to locate these plants have been made. The landowner is unknown. The occurrence is currently unranked. It is possible that these records relate to the population that Sorrie discovered in 1990.

**MA .018 (Southwick)** – One collection of *Liparis liliifolia* from Southwick by H. A. Seymour is dated September 11, 1914. The collection was made from a “swampy, wooded border of brook.” The collection is on file at Amherst College. No specific location, habitat or population information is provided. There remains abundant habitat fitting this description in Southwick (personal observation), but due to the vague nature of the site information, no attempts to locate these plants have been made. The landowner is unknown. The EO is currently unranked.

**MA .019 (Belchertown)** – *Liparis liliifolia* was collected from Belchertown from a shaded roadside on August 19, 1930. The collector is unknown, but the initials “ASP” on the specimen on deposit at Amherst College, most likely refer to A. S. Pease. No specific location, habitat, or population information is provided on the specimen labels. No attempts to locate these plants have been made. The landowner is unknown. The EO is currently unranked.

**MA .020 (Amherst)** - There is a confusing series of collections referencing specific and vague areas of Amherst. None of the occurrences are considered current and it is unclear (and unlikely) that all of these reports relate to one population. They are presented in this document as two distinct occurrences, but they may merit only one occurrence in the MANHESP database. Four collections were made from “rich hillsides” or “hillsides nr. Amherst, MA” in 1870, 1879, 1881, and in an unspecified year of the same era. The specimens are on file at NEBC and Amherst College. Two of these collections were made by R. P. Clark, the remaining two by an unknown observer. No specific location,

habitat or population information is provided on the specimen labels. No attempts to locate these plants have been made. The landowner is unknown. The occurrence is currently unranked.

**MA .021 (Granby?)** – A collection from this population took place on June 21, 1879 by W. E. Stone. This collection was made from Mount Norwottuck and the specimen was deposited at the UMASS herbarium. There is no town listed on the specimen label, but it is assumed to be from Granby. This occurrence may be the same as that listed in MA .013 (Granby). No specific location, habitat, or population information is provided on the specimen labels. No attempts to locate these plants have been made. The landowner is unknown. The EO is currently unranked.

**MA .022 (Williamsburg)** – Two collections from this location have been deposited in the NEBC Herbarium. Both collections were made on the same date, June 17, 1908: one by Jesup, and a second by H. St. John. Both collectors name a definable location but specific directions are lacking, as is any reference to population numbers or habitat type. No searches for this population have taken place since the original sighting and collection. The EO is currently unranked.

**MA .023 (Deerfield)** – This record dates from an 1842 collection by Dr. George Pierce deposited at the NEBC herbarium. The label indicates that it was collected from Mount Sugarloaf. Due to the vague nature of the location information provided for observation, no subsequent searches have been made. The EO is currently unranked.

**MA .024 (North Leverett)** – R. Torrey collected a specimen from a “damp wood” in North Leverett on June 18, 1910. No specific location, habitat, or population information is provided on the specimen label. No attempts to locate these plants have been made. The landowner is unknown. The EO is currently unranked.

**MA .025 (Alford)** – R. Hoffman made a collection of *Liparis liliifolia* from “rich woods” August 20, 1904. No specific location, habitat, or population information is provided on the specimen labels. No attempts to locate these plants have been made. The landowner is unknown. The EO is currently unranked.

**MA .026 (Mount Washington)** – This occurrence was observed on July 10, 1915 growing in “rocky woods.” F. Walker collected a specimen and deposited it in the NEBC Herbarium. No specific location, habitat, or population information is provided on the specimen label. No attempts to locate these plants have been made. The landowner is unknown. The EO is currently unranked.

**MA .027 (West Stockbridge)** – R. Hoffman collected a specimen from “pine woods” in West Stockbridge on August 22, 1902. No specific location, habitat or population information is provided on the specimen label. No attempts to locate these plants have been made. The landowner is unknown. The EO is currently unranked.

**MA .028 (Monson)** – Little information for this occurrence is available. A collection exists on file at the New York Botanical Garden Herbarium (NY) by F. H. Blodgett from September 13, 1894. At SCHN, there is a collection of *Liparis liliifolia* dated May 30, 1895. The specimen was collected by an unknown individual. No specific location, habitat or population information is provided on the specimen labels. No attempts to locate these plants have been made. The landowner is unknown. The occurrence is currently unranked.

**MA .029 (Westfield)** – There are several reports of *Liparis liliifolia* from Westfield, but it is unclear whether they all refer to the same population. The oldest report dates from sometime in the 1890's, but the exact date is unknown. A specimen in fruit was collected by Shurtleff and deposited at NY. In 1987, Ed Piela reported observing one plant on a slope near a former serpentine quarry on Westfield Mountain. On May 26, 1988, Sorrie searched the area without luck.

On August 29, 1986, Sorrie located 30 plants in fruit growing on thin soil of a ledge on a mountain in Westfield. The plants were associated with *Betula lenta*, *Ostrya virginiana*, and *Celastrus scandens*. In 2002, Arthur Haines observed several small colonies of *Liparis* growing at this same location. He did not record any specific information about the area or the population. The owner at this location is the City of West Springfield. The occurrence is extant and currently unranked.

**MA .030 (Middleboro)** – This record is based solely on a hand-drawn map by Gilbert George dated July 24, 1986. The map was at some point given to Bill Brumback and placed in New England Wild Flower Society files. The map is fairly descriptive as to the location of the plants, but when ground-truthed, proves to be inaccurate. The map shows the plants occurring on the edge of the vernal wet area of a borrow pit pond. One plant with two seedpods from the previous year was observed. The map indicates that the occurrence is located near a rest area off Route 24 south of Middleboro and north of Cape Cod. These directions are inaccurate: Route 24 does not pass through Middleboro. Interstate 495 does pass through Middleboro, and if it is substituted for Route 24 the directions do lead to a location similar to what George originally described. An attempt to access this area off interstate 495 in 2003 was made by Mattrick and Danielle Ogurcak. The highway fencing and posted private property prevented a site visit to the borrow pit. The landowner is unknown. The occurrence is currently unranked.

**MA .031 (Amherst)** – There is a confusing series of collections referencing areas near or on Mount Holyoke. None of the occurrences are considered current and it is unclear, and unlikely that all of these reports relate to one population. Adding to the confusion is that Mt. Holyoke is located in Hadley and South Hadley, not Amherst. H. G. Jesup collected specimens of *Liparis liliifolia* on June 1873 “swamp near Mt. Holyoke” on June 20, 1874, and again on June 2, 1879. Hitchcock collected a specimen that is now on file at Amherst College from Mt. Holyoke on an unspecified date. No specific location, habitat or population information is provided on the specimen labels. No attempts to locate these plants have been made. The landowner is unknown. The occurrence is currently unranked.

**MA .032 (Goshen)** – Ames observed and collected *Liparis liliifolia* growing along a “brook in moss somewhat open situation” on June 8, 1905. The collected plants were in bloom. No specific location, habitat or population information is provided on the specimen label. No attempts to locate these plants have been made. The landowner is unknown. The EO is currently unranked.

**MA .033 (South Hadley)** – C. A. Perkins and Clark made separate collections from a location known as “South Hadley Falls” in autumn 1879. Perkins brought a live plant home and it apparently flowered during the first week in May 1880. No specific location, habitat or population information is provided on the specimen label. No attempts to locate these plants have been made. The landowner is unknown. The EO is currently unranked.

**MA .034 (Milton)** – There are a large number of collections from Milton, and all are considered historic. Collections were made on June 11, 1876, June 1887 and July 8, 1890 by Churchill and Hitchings, June 10, 1900 from Blue Hills Reservation, July 6, 1894 from Forest nt., and June 5, 1878 from Blue Hill by C. E. Faxon. Two of the collections directly refer to the Blue Hill Reservation and a third references a location named as “Forest nt.” In his article entitled “A Few Plants of the Blue Hills Reservation” published in the April 1902 issue of *Rhodora*, Arthur Clark (1902: 74) states that “*Liparis liliifolia* is found growing upon a clayey plateau at an elevation of about 400 feet [130 m], accompanied by *Anemone virginiana* and *Asclepias quadrifolia*, while a little farther on are large plants of *Geranium robertianum* with innumerable seedlings.” It is likely the historic collection pressures at Great Blue Hill combined with changes in plant communities since the early 1900’s have extirpated the plants from the site. No additional specific location, habitat or population information is provided on the specimen labels. No attempts to locate these plants have been made. The landowner is the Massachusetts Department of Conservation and Recreation. The occurrence is currently unranked.

**MA .035 (Holyoke)** – On June 14, 2003, while conducting biological inventories on newly acquired property in Holyoke, José Garcia discovered five plants, four in flower, near the summit of a mountain. The plants occur in a fairly flat area along the ridgetop just above the talus. The habitat is a dry oak/hickory/hop hornbeam forest lacking a strongly developed herbaceous layer. The canopy is fairly open. No further information is available. The property is owned by The Trustees of Reservations. The occurrence is currently unranked.

**MA .036 (Prescott)** – This occurrence is based on a report in the “Flora of the Swift River Watershed.” A. Goodale collected a fruiting specimen on August 13, 1931 from Prescott. The specimen was originally collected as *Orchis spectabilis* and annotated by Harry Ahles in 1966. Prescott was a village in what is now New Salem and was flooded to create the Quabbin Reservoir in the 1930’s. The population was likely extirpated by the creation of the reservoir. The occurrence is currently unranked.

**MA .037 (Millbury)** – The only record of this occurrence is a specimen collected in 1879 from Millbury. The specimen was part of the herbarium of Joseph Jackson and now resides at Clark University Herbarium (CUW) in Worcester. Arthur Haines located the specimen as part of the Herbarium Recovery Project. It is unknown if Jackson was the original collector. No specific location, habitat, or population information is provided on the specimen label. No attempts to locate these plants have been made. The landowner is unknown. The EO is currently unranked.

**MA .038 (Williamstown?)** - There is a report of this taxon in LeRoy Andrews' article "Orchids of Mt. Greylock, Massachusetts" in the August, 1900 issue of *Rhodora*. In this article he states, "The area referred to as the lower wooded slopes are possibly the richest in species and afford approximately in the order of ascent *Orchis spectabilis*, *Cypripedium acaule*, *Habenaria hookerii*, *Liparis liliifolia*, *Habenaria bracteata*, *H. hyperborea*, *Corallorhiza multiflora*, *Habenaria orbiculata*, and *Goodyera tessellata*" (Andrews 1900: 180). It is unclear which town containing Mount Greylock this observation is based on. No specific location, habitat or population information is provided. No attempts to locate these plants have been made. The landowner is unknown, but likely the Massachusetts Department of Conservation and Recreation. The EO is currently unranked.

**MA .039 (Sturbridge)** – The only reference to this population is three lines in an article in the February 1940 issue of *Rhodora* by Potter et al. In the article, they state, "*Liparis liliifolia* holds the distinction of being one of the rarest plants in the county. Only one plant in one locality in Sturbridge is known. This single plant has persisted for several years" (Potter et al. 1940: 40). Due to the small population size, it appears a voucher specimen was never collected. No specific location, habitat or population information is provided. No attempts to locate these plants have been made. The landowner is unknown. The occurrence is currently unranked.

### ***Status of Rhode Island Occurrences***

*Liparis liliifolia* has apparently never been common in Rhode Island. The Rhode Island Natural Heritage Program (RINHP) only tracks six records. The NEWFS Herbarium Recovery Project discovered no additional records in regional herbaria. Two non-vouchered reports of additional populations exist in the files of the RINHP and NEWFS. Each report is from a credible source. Seven populations have been observed since 1970. One of these is extirpated. There are no populations that have been reliably observed since 1993 despite intensive searches by multiple surveyors at all locations. Little information exists for most of the populations. Currently, there are no populations that should be considered extant in Rhode Island.

**RI .001 (Glocester)** – Richard Champlin reported this population from a "deciduous forest under maples and hickories with *Uvularia perfoliata*." The condition and number of plants were not noted at the time of the original observation in 1967. Julie Lundgren searched for the population in 1988 without success. Mattrick, Enser, Underwood, and



Brumback searched the site in 2002 and, although two areas of the listed associated species were located, no *Liparis* was found. Prior to the 2002 site visit, the site was heavily logged and the slash scattered everywhere. It was, as one surveyor stated, “possibly the poorest logging operation ever.” Due to the amount and depth of logging slash left behind, it is unlikely *Liparis* persists or will in the near future. In 2003, the Gloucester Land Trust acquired the site and a great deal of the remaining slash was cleaned up and removed. The population is currently unranked.

**RI .002 (Coventry)** – This population was first observed in 1971 according to RINHP files, but Peter Lockwood reported Richard Champlin last observed the species at this site in 1969. This phrasing implies that it had been seen prior to 1969. No indication of population size has been discovered. Lockwood visited the site with Champlin in 1996 and searched the area for two hours with no success. At that time, Champlin recalled the plant occurring on the north aspect of a slope in an area with some butternuts, white baneberry and rattlesnake fern. The plants were in an area of rather sparse herbaceous cover. Lockwood searched again in 1998 and 2000. Brumback, Mattrick, Underwood, and Enser searched the area in 2002. Despite repeated searches in a small area, no plants have been found. The occurrence is currently unranked.

**RI .003 (West Greenwich)** – This population was reported at the base of a big-tooth aspen growing on an earthen dam in the Big River Wildlife Management Area. The population was first observed in 1971. Anecdotal notes in New England Wild Flower Society files indicate that Richard Champlin may have been the original observer, but George Seavey is listed as the best source in the RINHP database. Champlin provided very specific directions to the site to Eugenia Marks in 1996. Marks and Hamilton searched in 1995. Marks, Sindy Hempstead, and Lockwood searched in 1996. Marks searched in 2000. Despite these repeated searches and specific directions, the population has not been discovered. A 1998 note from Eugenia Marks to Bill Brumback recalls a conversation Marks had with an individual concerning some “rare plants” that had been dug from the Big River Area and relocated to a nearby cemetery. Marks recalls the plants being in question were orchids (Marks, Audubon Society of Rhode Island, personal communication). The plants were moved at a time when the Big River Area was threatened with inundation for a reservoir. If this were true, the plants would have been moved sometime between 1968 and 1988. It is unknown if the “rare plants” reference concerns *Liparis* or not. The EO is unranked.

**RI .004 (West Greenwich)** – This population was first observed in 1971 at a location known as the Acid Factory Brook Wildflower site. RINHP records do not reveal any significant information about this site such as population size, directions, or original observer. Notes in NEWFS files from Bill Brumback indicate that Richard Champlin may have been the original observer and Irene Stuckey was the last to observe the species at this site. These same notes also indicate the area that has been searched in 1998 by Brumback, Enser and Lockwood, 2001 by Hinds, and in 2003 by Mattrick, Seavey, Wagner and others. These searches have all been based on a dot on a map made by George Seavey, who was shown the plant by Richard Champlin in the 1970’s. However, during the 2003 search, George Seavey said he had never been to the site before and

Champlin had never showed him any plants in the area (Seavey, Consulting Botanist, personal communication). It is unclear whether the proper location is being searched.

The area that has been searched is a west-facing slope with rich site indicator species including *Asplenium platyneuron*, *Eupatorium rugosum*, *Trillium cernuum*, and *Botrychium matricariifolium*. There is also an abundance of invasive species in the surrounding woodland including *Berberis thunbergii*, *Berberis vulgaris*, and *Euonymus alatus*. These species are in sharp contrast to those in the surrounding more acidic woodlands. The EO is unranked.

**RI .005 (Lincoln)** – RINHS records indicate that this population was first observed in 1970; however, a herbarium specimen collected by J. Collins in 1928 from Lincoln, Rhode Island does exist. The specimen label states the plant was collected from “woods.” This specimen could refer to this population or many other locations in Lincoln, but it does indicate that *Liparis* has occurred in Lincoln for some time. The modern observation of this population is from an abandoned railroad line in a moist mesic forest. The plants occurred on a shelf along a ledge that was cut through for the railroad line in the 1800’s. At the time of last observation in 1985, a small group of plants consisting of about ten stems were located. The plants had flowered just prior to the observation.

This occurrence was searched for annually from 1995 to 1999 by a variety of competent botanists but the plants were not found. Mattrick, Rick Enser, and Kathy Barton searched this and a nearby site in 2003 without success. Enser says in the years prior to the plants, disappearance, they seemed to slip closer and closer to the edge of the shelf on which they were growing. He feels that ultimately the population slipped over the edge of the shelf and vanished (Enser, Rhode Island Natural Heritage Program, personal communication).

There are anecdotal accounts of plants occurring in a valley on the opposite side of the railroad line and from another location in Lincoln. These locations were searched in 2000 and 2003 but no plants were located. Suitable habitat does continue to exist in the vicinity of all locations. The population has an EO rank of C(X).

**RI .006 (West Greenwich)** – This occurrence as known is a result of a 1980 conversation between Millie House and Rick Enser. There is no voucher or additional sightings of this occurrence. House stated she observed a small population 50 feet (16 m) north of a pond in the Big River Wildlife Management Area. In 1997 and 1998, Eugenia Marks searched without success. In 2002, Norm Boyer searched and was unable to locate the plants. In 2003, Mattrick, Wagner and Bradford Gove searched the described area, finding it very overgrown with *Smilax rotundifolia* and *Toxicodendron radicans*. No plants were located. A 1998 note from Eugenia Marks to Bill Brumback recalls a conversation Marks had with an individual concerning some “rare plants” that had been dug from the Big River Area and relocated to a nearby cemetery. Marks recalls the plants in question were orchids (Marks, personal communication). The plants were moved at a time when the Big River Area was threatened with inundation for a reservoir.

If this were true the plants would have been moved sometime between 1968 and 1988. It is unknown if the “rare plants” reference concerns *Liparis* or not. The occurrence is unranked.

**RI (Scituate)** – The original source of this report is vague; it seems to have been originally seen by either Paul Martin Brown or Richard Champlin sometime prior to 1994. Champlin reports having seen the population on an unspecified date. New England Wild Flower Society (NEWFS) records indicate that Brown got directions to the site using a map that Champlin had in his possession. Searches of the site from 1994-1996 by Brumback, Enser, Champlin, and Gil George revealed suitable habitat and other rich site species including *Cypripedium parviflorum* var. *pubescens*, but not *Liparis*. However, NEWFS records indicate that Brown observed the species at the site as recently as 1994. In 1998, Champlin, Charlie Brown, Jerry Melaragno, and neighbor Bob Bushnell searched the site and Champlin commented he thought the site was now too shaded to support this species. Mattrick searched the site in 2003, finding a limited amount of suitable, albeit slightly overgrown habitat, but no *Liparis*. There remains potential habitat in the area, and given the small stature and sparse nature of most known populations of this species, it could be hiding in there somewhere.

**RI (Smithfield)** – This record is based solely on a hand-drawn map by Gilbert George dated July 24, 1986. The map was at some point given to Bill Brumback and placed in NEWFS files. There is little information on the map, but it does indicate that on this date one individual of *Liparis liliifolia* was observed on the shore of a pond, perhaps occurring in a sandpit.

### ***Status of Connecticut Occurrences***

Records indicate that Connecticut was the stronghold for this species in New England. Historically, the species was documented with herbarium specimens from 42 towns. Fifty-six separate collections exist from these 42 towns (Haines, personal communication). This specimen count is based on observations at regional herbaria as part of the HRP and specimens on file at the G. Safford Torrey Herbarium (CONN). The specimen count discounts duplicates filed at multiple locations. Many sheets contained multiple plants. At CONN, one sheet contained six plants in flower or with the past season’s fruit pod attached. There are many herbarium specimens in support of populations that do not appear in the records of the Connecticut Natural Diversity Database (CTNDDDB). These are provided in Appendix 2. Only three of these populations have specimens that provide searchable location information. These are listed as the last three listing in the Connecticut status section. Ten occurrences have been observed since 1970; however, three of these are known to have been extirpated. Two additional sites have not been seen since the early 1990’s despite multiple attempts to locate them. Only five occurrences from five separate towns have been seen since 1993. The largest of these populations contains two plants.

**CT .001 (Ledyard)** – This population was first observed by Les Mehrhoff in 1989, when it consisted of “a few clumps on bank” of a side road. Although the first documented sighting in recent times was in 1989, an A. G. Avery collection from 1923 in “dry woods” exists and could be this same site. Little site information exists for this occurrence except that it was on a dry roadside under hemlocks. Mehrhoff reported that the site had been destroyed by development in 1992. It is not ranked by the CTNDDDB.

**CT .002 (Cheshire)** – This occurrence consists of two subpopulations along a traprock ridge, discovered by Laurie Sanders and Fred Morrison in 1989. The site is a relatively flat ridgetop and east-facing slope dominated by *Juniperus virginiana* and grasses. The eastern slope is dotted with numerous seeps. At the time of original observation, only a subdivision was listed as the threat at the northern subpopulation. However, presently succession and shading are current threats at both subpopulations.

On August 25, 1989, Sanders and Morrison observed only a single plant at the northern subpopulation. The plant was in fruit at the time of observation. The plant was growing on a 3-8% slope in partial shade. Associated species listed included *Juniperus virginiana*, *Solidago bicolor*, *Prunus serotina*, *Fraxinus americana*, *Asplenium trichomanes*, *Fragaria vesca*, *Triosteum aurantiacum*, and *Pycnanthemum incanum*. Sanders and Ken Metzler observed this same plant in June 1990. The vigor during both observations was listed as vigorous.

The southern subpopulation, also discovered on August 29, 1989, contained 12 plants, including a clump of 5 plants. All plants were listed in feeble vigor and non-reproductive. The plants were growing on an 8-15% slope in partial shade. Associated species included *Pycnanthemum incanum*, *Acalypha rhomboidea*, *Anemone canadensis*, *Solidago bicolor*, and *Juniperus virginiana*.

Searches for both subpopulations have been conducted by Metzler and Bill Moorhead in 1997, Moorhead and Sanders in 1999, Moorhead in 2000, and Mattrick and Sanders separately in 2003. None of these attempts were successful in locating any plants. Mattrick observed the area of the northern subpopulation to be heavily shaded and unlikely to support the taxon without future management. The area of the southern subpopulation still contains suitable habitat but shows signs of heavy browse by both turkeys and deer. The occurrence is unranked, but is presumed extirpated.

**CT .003 (East Haddam)** – This occurrence relates to a somewhat confusing set of subpopulations in a mesic, mixed deciduous woodland. The occurrence spans both private conservation and privately owned land. It is unclear exactly when the subpopulations were first observed. Little specific information on the subpopulation on the conservation land is available, except that Dick Goodwin observed it only once in 1988. Goodwin has searched for the plants since 1988 without success.

The subpopulation on private land has been reported regularly since 1994 by Goodwin and Carol Redfield. Although the date of first observation is unknown, the plants were present prior to 1994 according to Goodwin. The plants are located in a post-agricultural

deciduous woodland in deep shade. Associated species include *Betula lenta*, *Carya glabra*, *Liriodendron tulipifera*, *Acer saccharum*, *Cornus florida*, *Carex swanii*, *Carex rosea*, *Carex gracillima*, *Potentilla canadensis*, *Galium circaezans*, and *Eurybia divaricata*. Deer browse is listed as a threat, and *Celastrus orbiculatus* is listed as being nearby. The population has been in steady decline since the time of the first report. In 1988, Goodwin photographed the plants but no indication of population size was given. On June 15, 1994 Redfield observed the plants, estimating the population size at between 11 and 50 plants. In 1995, Goodwin observed 25 plants with 80% in flower. By 1999, when Goodwin visited the population on June 7<sup>th</sup>, only six plants (three in flower) could be located. When Goodwin visited the population in 2000, the numbers had dropped to two plants. On June 10, 2003, Mattrick, Goodwin, Redfield, and Martha Tonucci surveyed the population and found two plants with no evidence of reproduction.

The owner fenced the population area with chicken wire in 1994 to prevent damage by deer, yet the population continues to decline. Shade being cast by a maturing forest is a continuing threat to the remaining plants. Redfield and Goodwin report that another colony of *Liparis* once existed about 100 yards upslope from the current population. The plants in that area have not been seen in a couple of decades. The EO is currently ranked E.

**CT .004 (Rocky Hill)** – This historic occurrence is based on a single specimen at CONN. The specimen was collected in flower from “dry, deciduous woods” on June 8, 1933 by an unknown collector. The occurrence is unmappable. No specific location, habitat or population information is provided on the specimen label. No attempts to locate these plants have been made. The landowner is unknown.

**CT .005 (Hartford)** – William M. Kellogg collected *Liparis liliifolia* in flower on July 6, 1887 from an undisclosed location in Hartford. Given the amount of development that has occurred in Hartford over the last 100 years, it is unlikely the population remains extant. The occurrence is unmappable. No specific location, habitat or population information is provided on the specimen label. No attempts to locate these plants have been made. The landowner is unknown.

**CT .006 (Wethersfield)** – This historic occurrence is based on a single specimen at CONN. The specimen was collected in fruit on July 6, 1939 by an unknown collector. The specimen was collected from “low rich woods.” The occurrence is unmappable. No specific location, habitat or population information is provided on the specimen label. No attempts to locate these plants have been made. The landowner is unknown.

**CT .007 (Essex/Old Saybrook)** – Martha Tonucci first observed this population in 1982 in a mixed deciduous woodland. Tonucci next observed the population in 1995, when one plant was observed. There is an implication in the writing of the EO record that in 1982 there was more than one plant present, but this is unknown. The population occurs in a mixed deciduous woodland adjacent to a logging road. The area on the opposite side of the logging road was extensively logged sometime prior to 1995. The logging caused vigorous growth of *Betula lenta* near around the *Liparis* plant. Other associates include

*Carpinus caroliniana*, *Quercus* sp., *Carya* sp. *Viburnum acerifolium*, *Lycopodium complanatum*, *Dennstaedtia punctilobula*, *Polystichum acrostichoides*, and *Parthenocissus quinquefolius*.

On September 15, 1996 Tonucci again visited the site and found only one plant. She commented on her field form that the plant had flowered and one of the two basal leaves was badly chewed, possibly by slugs. The dense growth of *Betula lenta* at the site is listed as a potential threat. She also indicated that she cut back some of the competing vegetation. In 1997, Tonucci and Judy Preston visited the site and could not locate the plant. The area had been bulldozed within yards of the former location of the plant. They stated they felt the plant no longer occurred at the site. The Connecticut Natural Diversity Database ranks the occurrence F.

**CT .008 (Hamden)** – This is perhaps the most unusual occurrence of *Liparis liliifolia* in the region. It consists of two plants growing on a narrow (2 m-wide) strip of land between a parking lot and the gravel driveway of a residential home. The plants exist under a hedge of *Euonymus alatus* and *Taxus* sp. They have purportedly grown at this location for over 40 years. The grandfather of the current owner first discovered the plants at this location. The grandfather was an avid wildflower gardener as is evidenced by the large natural wildflower garden to the rear of the residence. The current landowner insists her grandfather did not move the plants to this location. They simply appeared at this site sometime prior to 1958, when the grandfather died.

The landowner first reported the population in 1996. Bill Moorhead visited the site on August 13, 1996 and observed two plants about 1 m apart, both having flowered but not setting fruit. One plant was significantly larger than the other. In 2002, Mattrick visited the site and found the same situation. Two plants were observed about 0.5 m apart, with one plant significantly larger than the other. Neither plant showed evidence of flowering or fruiting in that year.

The habitat is a residential yard. Associated species include *Pinus strobus*, *Euonymus alatus*, *Taxus* sp., *Lonicera morrowii*, *Hedera helix*, *Aster cordifolius*, and *Linnaria* sp. The landowners are quite protective of the plants and have been advised by the Connecticut Department of Environmental Protection and NEWFS to avoid disturbing the plants and to keep the encroaching vegetation from overwhelming the site. The site is threatened by trampling, inbreeding depression, invasive species, shading, being driven over – you name the threat and it is present at this site – yet the plants continue to persist. Historic herbarium specimens for the town of Hampden do exist, but is unclear whether they could refer to this occurrence or not. The site is privately owned. The occurrence has been given a rank of D by the Connecticut Natural Diversity Data Base (CT NDDB).

**CT .009 (Berlin)** – This site was first discovered by Moorhead in 1997 in a hickory/ash/cedar glade on a traprock ridge. One plant was located. The individual had flowered but not set any fruit. Moorhead, and later Moorhead and Karen Zyko observed the same plant in 1999 and 2000 respectively. During neither observation period was the

plant reproductive. In 2003, Mattrick observed the plant on several occasions, and saw no sign of flowering or fruiting. During all observations, the plant was indicated to be in normal vigor.

The plant is situated in the northeastern corner of a 10+/- acre glade-like forest on dry, mesic traprock soils. The aspect is northeast. The forest canopy is thin. The habitat is heavily impacted by deer browse, but no evidence of browse directly on *Liparis* has been observed. Associated species include *Carya glabra*, *Fraxinus americana*, *Juniperus virginiana*, *Tsuga canadensis*, *Carex pensylvanica*, *Ulmus americana*, *Hypoxis hirsuta*, *Veronica arvensis*, *Oxalis europaea*, *Uvularia sessilifolia*, *Potentilla simplex*, *Panicum* sp., and *Poa compressa*. Another rare species, *Carex oligocarpa*, also occurs nearby in the same habitat. Despite several hours of searching over the course of the 2003 field season, no additional plants of *Liparis* could be located in the surrounding suitable habitat.

The population is located within 200 m of the Metacomet Trail. Threats include deer browse and “genetic suppression” due to the small population size. The landowner is the Town of Berlin. The property is under the control of the local water company. There are a series of reservoirs down, slope of the site. The occurrence has been given an EO rank of D by the CT NDDB.

**CT .010 (Windham)** – This population was discovered by Moorhead and Nels Barrett in August 2000. It consists of a single plant in an ash/hickory glade-like woodland. Moorhead visited the site again in June 2001 and located the same plant in flower. The plant is located near a large light gap in the forest canopy.

Associated species include stunted individuals of *Carya glabra* and *Fraxinus americana* in the canopy, and a dense herbaceous layer consisting of *Eupatorium sessilifolium*, *Solidago ulmifolia*, *Agalinus tenuifolia*, *Helianthus divaricatus*, *Triosteum aurantiacum*, *Agrimonia pubescens*, *Pycnanthemum incanum*, and *Viola triloba*. There is large amount of suitable habitat that remains unexplored at this location.

On his field form Moorhead comments, “the community looks nice but heavily deer browsed and perhaps not open enough for optimum *Liparis* health.” Other threats at this site include trampling, inbreeding depression due to small population size, and digging. A local land trust owns the site. The population has been given an EO rank of CD by the CT NDDB.

**CT NEW (Lyme)** – Moorhead discovered this occurrence in 2003 in an open power line corridor with a rich, dense herbaceous layer. Only a single plant was observed. The plant was growing in the shade of a clump of dogwoods and associated with another rare species, *Aristolochia serpentaria*. The landowner is Northeast Utilities. No threats are listed but inbreeding depression is likely due to the small population size. The use of herbicide to maintain the powerline right of way is an unlisted, but potential threat. No additional information on the population or site is currently available. The CT NDDB has not ranked the population.

**CT (Hamden)** – Ken Metzler reported observing a population of *Liparis liliifolia* in a large State Park in Hamden in 1991 or 1992. Little information is available about this population except that it occurred on a rocky slope in a fairly rich and open woodland. Repeated attempts to find this population by Metzler and Moorhead in 1997, Metzler in 1998 and 1999, and Mattrick in 2002 and 2003 have been unsuccessful. Old herbarium specimens for the town of Hamden do exist, but it is unknown whether they refer to this population. The State Park has large areas of suitable habitat.

**CT (East Haddam)** – Scant information exists for this report. It is based on a potted plant brought by an elderly woman to a talk given by Tonucci in the late 1970's. The woman stated she had collected the plant from along Landing Hill Road. The exact date of the talk or the collection is unknown. Tonucci made several attempts to locate the population in 1995, 1996 and 1999 without success. Several herbarium collections for East Haddam do exist. E. Swan also had made a collection in June of 1898. An individual only identified as "EBJ" on the specimen collected a flowering individual on July 1, 1890. The collected plant also contained a dried stalk and fruiting pod from the previous year. C. Hammer also collected an individual from the "base of a woody hillside" on June 23, 1907. Neither the modern report, nor any of the collected specimens provides specific location, habitat or population information. The landowner is unknown.

**CT (Willington)** – In 1992, while on a wetlands site walk on private land, Ken Metzler observed several plants at a location in Willington. When Metzler returned to the site to collect data, no plants could be located. He returned to the site several additional times with no success. The Connecticut Natural Diversity Data Base considers the population gone. The location of the reported plants is privately owned. No further information is available.

**CT (Farmington)** – On June 12, 1904, H. S. Clark collected a plant from "Electric Park" in Farmington. No other information is provided.

**CT (Glastonbury)** – H. M. Denslow collected a specimen from "Addison" in Glastonbury on January 31, 1937. Addison is a site name that occurs on a number of rare plant records for Glastonbury. There is also a collection by Denslow from "near Diamond Lake" dated February 22, 1938. Both collections consisted of fruiting stalks and pods. Whether these two collections refer to the same, a nearby, or an entirely different location is unknown. No further information is available.

**CT (Branford)** – Rydberg and Driggs collected specimens from "Pond Rock Woods" in Branford on July 25, 1916. No additional information is available.

The distributions of extant and historical occurrences of *Liparis liliifolia* in New England are shown in Figures 2 and 3, respectively.



## **CURRENT CONSERVATION MEASURES IN NEW ENGLAND**

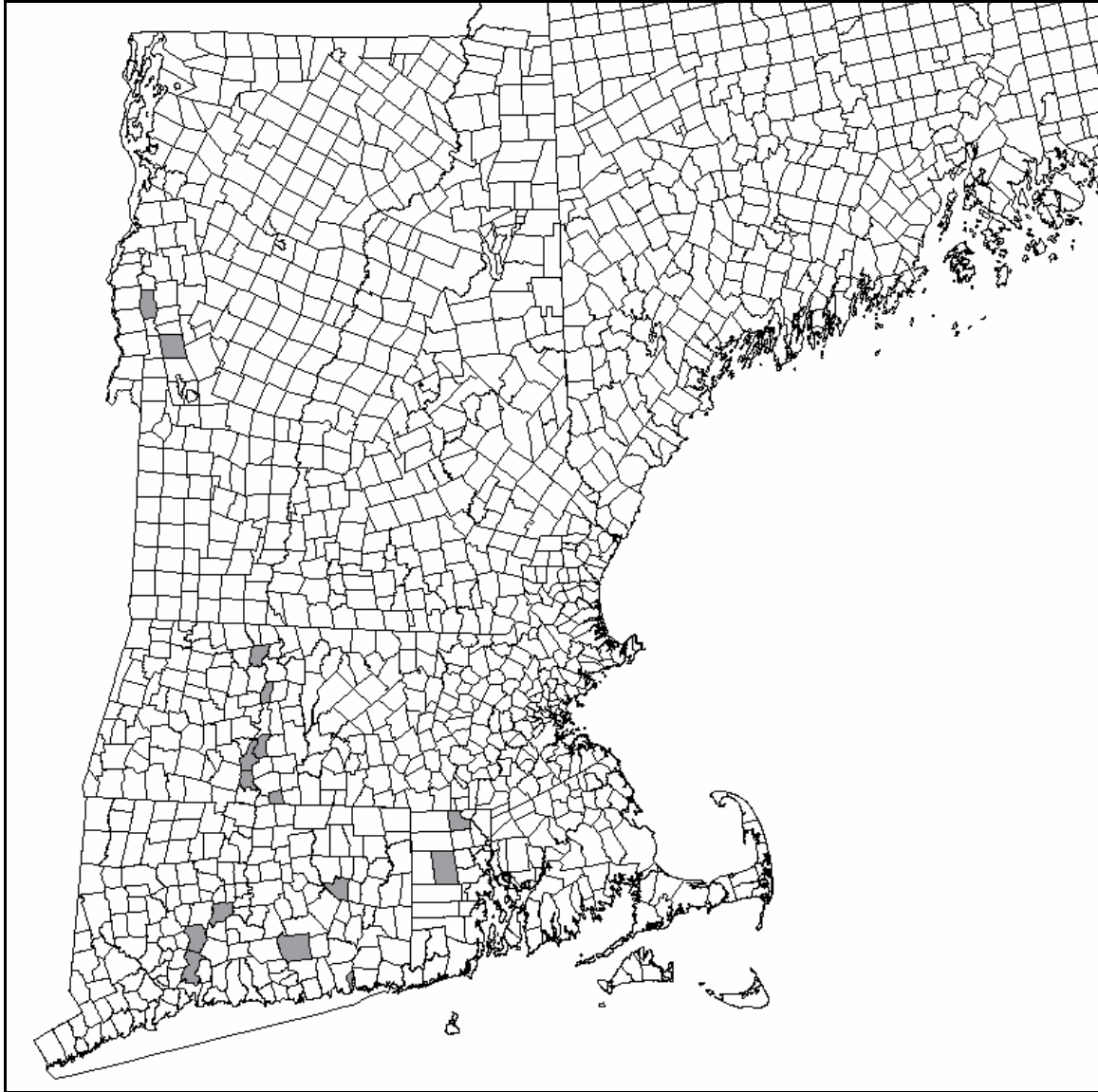
### ***State Endangered Species Acts***

*Liparis liliifolia* is listed as Threatened in Vermont, Massachusetts, and Rhode Island and Endangered in Connecticut. The Massachusetts listing is pending approval by the Commonwealth. It has been proposed for a status change from Watch List to Threatened based on recent surveys. New Hampshire considers the taxon to be extirpated and historic. State Endangered Species laws provide some protections to species ranked Endangered or Threatened, therefore offer some protection to *L. liliifolia*. These protections vary from state to state.

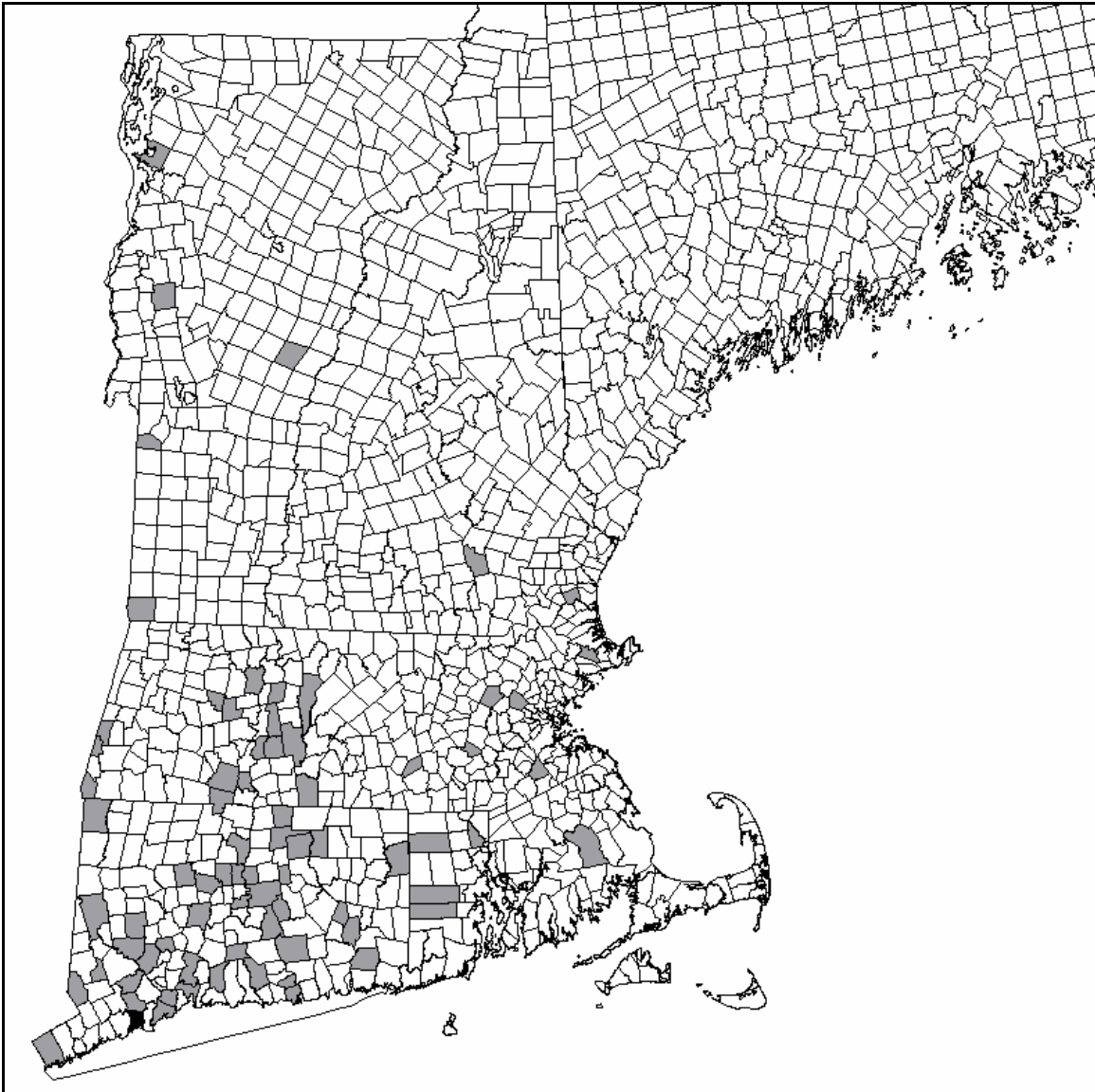
In Vermont, where the species is listed as Threatened, it is protected under the Vermont Endangered Species Act (10 V.S.A, Chapter 123). This act protects any listed species from injury or taking (picking, collecting, killing). This act only protects the plants, and not the habitat in which it occurs. Permits have been granted to allow for the relocation or removal of a listed species when a project could not be planned around the plants.

The 1992 Massachusetts Endangered Species Act (MGL c. 131A and its implementing regulations 321 CMR 10.00) protect rare species from sale or taking (picking, collecting, killing). The habitat of the rare species is usually protected as well. Special circumstances sometimes arise that allow for a permit for a taking. This is the only state Endangered Species Act with any “teeth” to it, providing for penalty.

In Rhode Island, *Liparis liliifolia* receives protection under the Rhode Island Endangered Species Act, Title 20 of the General Laws of the State of Rhode Island 20-37-3. This law only protects the species from digging and transport for the purposes of sale of the plants.



**Figure 2. Extant occurrences of *Liparis liliifolia* in New England.** Town boundaries for New England states are shown. Towns shaded in gray have one to five extant occurrences of the taxon.



**Figure 3. Historical occurrences of *Liparis liliifolia* in New England.** Towns shaded in gray have one to five historical records of the taxon.

Public Act 89-224 protects the plants in Connecticut. Under this act, the species is protected from collection or destruction on publicly (i.e. state-) owned properties. It also prevents state agencies from knowingly destroying or adversely impacting populations. It also prohibits the collection of the species for sale or transport across state lines.

*Liparis liliifolia* is listed by the Convention on International Trade in Endangered Species Protection Status (CITES) as an Appendix II species. Export trade in species from this list is allowed provided that trade will not be detrimental to the survival of the species and if the appropriate permits and certificates are obtained; import permits are not necessary (CITES 2002).

### ***Land Protection***

Most extant populations of the taxon are on protected public or private lands. Although this type of ownership does not ensure protection of the species, these populations are thought to be more secure than those on privately owned land. Additionally two sites, CT .003 (East Haddam) and CT .008 (Hamden) are owned by private individuals, and are being protected or stewarded by the landowner. Occurrences on publicly owned land include VT .005 (Cornwall), MA .001 (Holyoke), MA .003 (South Hadley), MA .004 (East Longmeadow), MA .029 (Westfield), CT (Hamden), and possibly CT .009 (Berlin). Private non-profit land trusts own MA .035 (Holyoke), CT .002 (Cheshire), CT .010 (Windham), and possibly VT .005 (Cornwall). Several additional non-extant sites are also owned by private land trusts or state or local agencies.

### ***Monitoring***

Most extant and recently historic populations have been monitored on a somewhat regular basis through the state Natural Heritage programs or the NEPCoP monitoring programs. Most of these sites were also field investigated as part of the research for this document. Regularly monitored populations include MA .001 (Holyoke), MA .003 (South Hadley), MA .004 (East Longmeadow), MA .005-.007 (Sunderland), MA .011 (Concord), MA .012 (Lexington), MA .029 (Westfield), MA .035 (Milton); RI .001 (Glocester), RI .002 (Coventry), RI .003 (West Greenwich), RI .004 (West Greenwich), RI .005 (Lincoln), RI .006 (West Greenwich), and RI No EO # Scituate; and CT .002 (Cheshire), CT .003 (East Haddam), CT .008 (Hamden), CT .009 (Berlin), CT .010 (Windham), CT New (Lyme), Hampden, and East Haddam.

### ***Land Management***

No large-scale land management has been undertaken at any site. At CT .003 (East Haddam), the landowner has been advised to remove a number of over-shading tree

by NEWFS. She has also erected a small cage around the plants to protect them from deer browse.

### ***Ex-situ Activities***

No seeds, plants, or plant parts have been collected from any New England population for storage at NEWFS or any other facility. The New England Wild Flower Society does maintain a single plant in the New England Garden of Rare and Endangered Plants at Garden in the Woods in Framingham, Massachusetts. The plant was acquired from an outside nursery and is presumably of a non-New England genetic lineage. The plant grows in a somewhat open area with high shade. The plant is vigorous, larger than any known individual in the wild in New England (personal observation). It has flowered annually for the past four years, but has not produced fruit. It does not seem to mind being dug up every spring and re-planted as part of a panic ritual concerning its possible demise over the winter.

**Table 3. New England Occurrence Records for *Liparis liliifolia*. Shaded occurrences are considered extant.**

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date)	Comments	Threats
NH		Hillsborough	Manchester	Unknown	1909	1909		X	Observed (1909)	Collected by F. Batchelder	Unknown
NH		No data	No data		1878	1878	“Hubbard”		Observed (1878)	Unknown	Unknown
VT	.001	Windsor	Sharon	Vermont Department of Forest, Parks, and Recreation	1925	1925	“under trees at edge of woods” “edge of woods. alt 1400ft”		Observed (1925)	Dutton record. Three collections from site. Date in question as to month and day	Unknown
VT	.002	Bennington	Pownal	Unknown	1907	1907	“Pownal” and “Pownal Krigger Rocks”		Observed (1907)	Flynn record. Two separate collections in 1907 by different collectors	Unknown
VT	.003	Chittenden	Colchester	Unknown	1906	1906	“Sandy bluff, opp. FT. Ethan Allen”		0 (2002)	Eggleston, Brainerd, and Jones record. A single collection	Unknown
VT	.004	Addison	Middlebury	Unknown	1880	1883	Moist woods		Observed (1883)	Brainerd collection	Unknown
VT	<b>.005</b>	<b>Addison</b>	<b>Cornwall</b>	<b>Vermont Department of Fish and Wildlife, Private, The Nature Conservancy perhaps</b>	<b>1986</b>	<b>1993</b>	<b>Under hardwoods in slight depression where a tree was upturned in cedar swamp</b>	<b>E</b>	<b>2 (1993) 30 (1986)</b>	<b>Two observations. May not refer to exact same location. Thompson record</b>	<b>Succession, Logging</b>
VT	<b>.006</b>	<b>Rutland</b>	<b>Brandon</b>	<b>Multiple private</b>	<b>1996</b>	<b>1996</b>	<b>Hardwood forest within swamp. In two subpopulations</b>	<b>B</b>	<b>18 (1996)</b>	<b>Large area with very vague directions. Observer commented that more plants might be present in other areas. Lapin record</b>	<b>Logging</b>

**Table 3. New England Occurrence Records for *Liparis liliifolia*. Shaded occurrences are considered extant.**

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date)	Comments	Threats
VT		Rutland	Wells	Unknown	1936	1936	“Disintegrating slate outcrops in thin woods”		Observed (1936)	Weatherby collection	Unknown
MA	.001	Hampden	Holyoke	Commonwealth of Massachusetts	1984	2002	Low sloped laced with vernal seeps		2 (2002) 12 (1998) 30 (1984)	Sorrie record.	Invasive species in vicinity
MA	.002	Franklin	Greenfield	Tow of Greenfield	1910	1987	Flowering		50 (1987)	Thacher 1910: Ruhfel 1987:	None
MA	.003	Hampshire	South Hadley	Commonwealth of Massachusetts	1925?	2001	Population scattered over southern and western slopes of mountain. Population numbers likely refer to unique suboccurrences		5 (2001) 13 (2000) 23 (1984)	Pease collection Sorrie record	Browse
MA	.004	Hampden	East Longmeadow	Town of East Longmeadow	1988	1994	“Sandstone table in old quarry”		0 (2003) 0 (2001) 0 (1999) 56 (1994) 20 (1988)	Found originally by Tad Zebryk, but repeated searches by multiple surveyors have been unable to locate	Shading
MA	.005	Hampshire	Sunderland	Unknown	1985	1986	“Uneven age, mixed forest along road edge”		0 (2002) 8 (1985)	Ruhfel record	Shading
MA	.006	Hampshire	Sunderland	Unknown	1984	1985	Hillside, “southeast slope in vernal wet area.”		0 (2002) 0 (1986) 11 (1985) 11 (1985)	Ruhfel record	Shading
MA	.007	Hampshire	Sunderland	Unknown	1990	1990	Tyler Cabin		0 (2002)	Sorrie record	Shading
MA	.008	Hampden	West Springfield	Unknown	1990	1990	“Low wall in old sandstone quarry”		35 (1990)	Sorrie record	Unknown
MA	.009	Norfolk	Canton	Commonwealth of Massachusetts	1889	1905	“Ledges.” Fruiting		Observed (1905)	Hitchings and Williams record	Unknown

**Table 3. New England Occurrence Records for *Liparis liliifolia*. Shaded occurrences are considered extant.**

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date)	Comments	Threats
MA	.010	Hampshire	Deerfield	Unknown	1955	1955	“Along stream bank”		15 (1955) Observed (1952-1953)	Poland collection	Unknown
MA	.011	Middlesex	Concord	Private	1959	1961	Steep slope, near base of cliff in residential backyard		0 (2000) 3 (1959)	Original observation by Eaton	None
MA	.012	Middlesex	Lexington	Private	1970	1971	“Open site near <i>Pinus strobus</i> ”		0 (2001) 0 (1999) 2 (1971) 1 (1970)	Tryon record. Property very overgrown. Repeated searches have failed to locate	Shading
MA	.013	Hampshire	Granby		1952	1952	“Woods”		Observed (1952)	Poland and Hunnewell collections.	Unknown
MA	.014	Norfolk	Canton	Commonwealth of Massachusetts	1884	1884	Flowering		Observed (1884)	Fuller collection	Unknown
MA	.015	Middlesex	Ashland	Unknown	1878	1878	Flowering		Observed (1878)	Unmappable, Morong collection	Unknown
MA	.016	Essex	Amesbury	Unknown	1896	1896	Flowering		Observed (1896)	Unmappable, Forbes and Huntington collections	Unknown
MA	.017	Hampden	West Springfield	Unknown	1896	1896	“W. Springfield Woods” “dry, rocky wooded ridge”		Observed (1896)	Owen collection. Cultivated plant taken from wild population	Unknown
MA	.018	Hampden	Southwick	Unknown	1914	1914	“Swampy, wooded border of brook”		Observed (1914)	Seymour collection	Unknown
MA	.019	Worcester	Belchertown	Unknown	1930	1930			Observed (1930)	Pease collection	Unknown
MA	.020	Hampshire	Amherst	Unknown	1870	1881	“Rich hillside” “hillside”		Observed (1881)		Unknown
MA	.021	Hampshire	Granby?	Unknown	1879	1879			Observed (1879)	Stone collection	Unknown
MA	.022	Hampshire	Williamsburg	Unknown	1908	1908			Observed (1908)	Jesup and St. John collections	Unknown
MA	.023	Franklin	Deerfield	Unknown	1842	1842	Flowering		Observed (1842)	Pierce collection	Unknown



**Table 3. New England Occurrence Records for *Liparis liliifolia*. Shaded occurrences are considered extant.**

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date)	Comments	Threats
MA	.024	Franklin	N. Leverett	Unknown	1910	1910	“Damp woods”		Observed (1910)	Torrey collection	Unknown
MA	.025	Berkshire	Alford	Unknown	1904	1904	“Rich woods” fruiting		Observed (1902)	Unmappable. Hoffman collection	Unknown
MA	.026	Berkshire	Mt. Washington	Unknown	1915	1915	“Rocky woods”		Observed (1915)	Walker collection	Unknown
MA	.027	Berkshire	West Stockbridge	Unknown	1902	1902	“Pine woods” fruiting		Observed (1902)	Hoffman collection	Unknown
MA	.028	Hampden	Monson	Unknown	1894	1895			Observed (1895)	Blodgett collection	Unknown
MA	<b>.029</b>	<b>Hampden</b>	<b>Westfield</b>	<b>City of West Springfield</b>	<b>1986</b>	<b>2002</b>	<b>“On thin soil of ledge under <i>Betula lenta</i>, <i>Ostrya virginiana</i>, <i>Celastrus scandens</i>.” Fruiting</b>		<b>Observed (2002) 30: 1986</b>	<b>Sorrie and Haines. Fruiting 1986</b>	<b>Unknown</b>
MA	<b>.030</b>	<b>Plymouth</b>	<b>Middleboro</b>	<b>Unknown</b>	<b>1986</b>	<b>1986</b>	<b>Edge of borrow pit pond</b>		<b>1: 1986</b>	<b>Gil George record. Map to site does not make sense</b>	<b>Unknown</b>
MA	.031	Hampshire	Amherst?	Unknown	1873	1873	“Swamp near Mt. Holyoke” flowering		Observed (1873)	Jesup and Hitchcock collections	Unknown
MA	.032	Hampshire	Goshen	Unknown	1905	1905	Brook in moss somewhat open situation. Bloomed June 1		Observed (1905)	Ames collection	Unknown
MA	.033	Hamden	South Hadley	Unknown	1879	1880			Observed (1880)	Flowering. Plant collected from wild in 1879	Unknown
MA	.034	Norfolk	Milton	Commonwealth of Massachusetts	1876	1900	“Clayey plateau at elevation of 400 ft.”		Observed (1876, 1887, 1894, 1900, 1900)	Ames record. Flowering. Multiple collections from Milton – whether they refer to this one occurrence or several is unknown. All are treated under this record	Unknown

**Table 3. New England Occurrence Records for *Liparis liliifolia*. Shaded occurrences are considered extant.**

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date)	Comments	Threats
MA	.035	Hamden	Holyoke	The Trustees of Reservations	2003	2003	“Dry, oak/hickory/hop hornbeam forest”		5 (2003)	Garcia record	None
MA	.036	Franklin?	Prescott	Commonwealth of Massachusetts	1931	1931	Fruiting		Observed (1931)	Area believed to now be submerged beneath Quabbin Reservoir. Goodale collection	
MA	.037	Worcester	Millbury	Unknown	1879	1879			Observed (1879)	Specimen at CUW	
MA	.038	Berkshire	Williamstown?	Unknown	1900	1900	“Lower wooded slopes”		Unknown	From Leroy Andrews article in <i>Rhodora</i>	Unknown
MA	.039	Worcester	Sturbridge	Unknown	No data	1940?	A single plant persisting for several years		1 plant	From Potter et al., article in <i>Rhodora</i>	
RI	.001	Providence	Glocester	Glocester Land Trust	1967	1967	Deciduous forest along brook		0 (2002) Observed (1967)	Number of plants and condition unknown in 1967. Champlin record	Logging Shading
RI	.002	Kent	Coventry	Private	1969	1971	Rich hardwood slope		0 (2002) 0 (2000) 0 (1998) 0 (1996) Unknown (1969)	Very little information. Champlin record	Shading
RI	.003	Kent	West Greenwich	State of Rhode Island	1971	1971	Foot of aspen on dam		0 (1995) 0 (1996) 0 (2000) Unknown (1969)	Very little information. Champlin record	Shading
RI	.004	Kent	West Greenwich	State of Rhode Island	1971	1971	Rich woodland		0 (2003) 0 (2001) 0 (1999)	Very little information. Irene Stuckey last to observe	Invasive species Shading
RI	.005	Providence	Lincoln	The Nature Conservancy	1970	1985	Plants on shelf of ledge in mesic forest	C (X)	0 (2003) 0 (1995-1999) 10 (1985)	Plants fell off shelf, never to be seen nor heard from again	Precarious ledges

**Table 3. New England Occurrence Records for *Liparis liliifolia*. Shaded occurrences are considered extant.**

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date)	Comments	Threats
RI	.006	Kent	West Greenwich	State of Rhode Island	1980	1980	North of pond		0: 2003 6: 1980	Good directions to location. Millie House record	Shading
RI		Providence	Scituate	Unknown	1994?	1994?	Rich woodland along trail next to brook		0 (2003) 0 (1994–1998)	No specimen in support of record. P. M. Brown record	Shading
RI		Providence	Smithfield	Unknown	1986	1986	Pond shore		1 (1986)	Directions very vague. George record	Unknown
CT	.001	New London	Ledyard	Unknown	1989	1990	Fairly dry roadside under hemlocks	X	Observed (1990) A few clumps (1989)	Site totally destroyed in 1992	
CT	.002	New Haven	Cheshire	Cheshire Land Trust	1989	1990	Seepy cedar dominated glade		0 (2003) 0 (2000) 0 (1999) 0 (1997) 1 (1990) (at northern location) 12 (1989)	Northern site now very degraded, suitable habitat remains at southern location	Browse Canopy closure
CT	.003	Middlesex	East Haddam	Private	1988	2003	Deciduous woodlands	E	2 (2003) 2 (2000) 6 (1999) 25 (1995)	This is a confusing site with several widely spaced subpopulations. Only a single subpopulation remains	Browse Canopy closure
CT	.004	Hartford	Rocky Hill	Unknown	1933	1933	Dry, deciduous woodland	U	Observed (1933)	Unmappable	Unknown
CT	.005	Hartford	Hartford	Unknown	1887	1887		U	Observed (1887)	Unmappable Kellogg collection	Unknown
CT	.006	Hartford	Wethersfield	Unknown	1933	1933	“Low, rich woods”	U	Observed (1939)	Unmappable	Unknown

**Table 3. New England Occurrence Records for *Liparis liliifolia*. Shaded occurrences are considered extant.**

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date)	Comments	Threats
CT	.007	Middlesex	Essex/Old Saybrook	Private	1982	1996	Mixed woodland	F	0 (1997) 1 (1996) 1 (1995)	Area within yards of plant bulldozed. Considered extirpated. Tonucci record	Unknown
CT	.008	New Haven	Hamden	Private	1957	2002	Residential yard under <i>Euonymus</i> and <i>Taxus</i> hedge	D	2 (2002) 2 (2001) 2 (1996)	Owners have purportedly observed plants for 39 years. A herbarium specimen from Mt. Carmel could be this site from 1911	Everything
CT	.009	Hartford	Berlin	Town of Berlin	1997	2003	Ash/Hickory/Cedar glade	D	1 (2003) 1 (1997)	One plant in perfect habitat. Moorhead record	Browse Inbreeding depression
CT	.010	Windham	Windham	Joshua Tract	2000	2001	Ash/Hickory Woodland	C/D	1 (2001) 1 (2000)	Site needs additional searching. Moorhead record	Trampling, Browse, Inbreeding depression
CT	New	New London	Lyme	Northeast Utilities	2003	2003	In open power line right of way with dense rich herbaceous layer	E	1 (2003)	Under a dogwood clump with <i>Aristolochia serpentaria</i> . Moorhead record	Inbreeding depression
CT		New Haven	Hamden	State of Connecticut	1991	1991	Rocky slope in fairly rich open woodland		0 (2003) 0 (2002) Observed (1991)	Metzler observed in 1991 or 1992	Unknown
CT		Middlesex	East Haddam	Unknown	?	Pre-1980	Along Landing Hill Road		0 (1999) 0 (1996) 0 (1995)	Word of mouth record based on a potted plant. Although multiple herbarium records occur for East Haddam	Unknown

**Table 3. New England Occurrence Records for *Liparis liliifolia*. Shaded occurrences are considered extant.**

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date)	Comments	Threats
CT		Tolland	Willington	Unknown	1992	1992			0 (1999) 3 (1992)		Unknown
CT		Hartford	Farmington	Unknown	1904	1904	Pods		Observed (1904)	Clark collection	Unknown
CT		Hartford	Glastonbury	Unknown	1937	1938	Fruit		Observed (1938)	Denslow collections	Unknown
CT		New Haven	Branford	Unknown	1916	1916			Observed (1916)	Rydberg and Driggs collections	Unknown

## II. CONSERVATION

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### CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

Based on herbarium collections and recent field observations, a minimum of 100 populations of *Liparis liliifolia* have existed on the landscape of New England. The majority of these occurrences were found in Massachusetts and Connecticut, and most date from the period of 1860 to 1939.

Modern records of the species are scarce. The mature forests that occupy most of New England do not provide abundant suitable habitat for the taxon. Since 1970, only 31 populations have been observed. Of these, four [RI .005 (Lincoln), CT .001 (Ledyard), CT .007 (Essex/Old Saybrook), and CT No EO Number (Willington)] are known to have been extirpated. Of the remaining 27, only 12 (VT .005 [Cornwall], VT .006 [Sunderland], MA .001 [Holyoke], MA .003 [South Hadley], MA .004 [East Longmeadow], MA .029 [Westfield], MA .035 [Milton], CT .003 [East Haddam], CT .008 [Hamden], CT .009 [Berlin], CT .010 [Windham], and CT New [Lyme]) have been observed since 1993. Of these, MA .004 [East Longmeadow] should be ranked F (“failed to find”) or considered historic, last observed in 1994.

The small sizes of the remaining extant populations provide additional concern for the conservation of this taxon. The largest known population is a large, scattered population of approximately 35 plants at a site in the Mount Holyoke Range of Massachusetts. The next largest population in Massachusetts contains five plants. In Vermont, two occurrences are extant: one with 18 plants, one with two. In Connecticut, the largest population contains two plants. By all accounts, the species no longer exists in Rhode Island. None, or very few of these populations seem to be effectively reproducing.

There are several populations last observed in the 1980’s that have not been surveyed since: MA .002 (Greenfield), MA .008 (West Springfield), MA .030 (Middleboro), and RI No EO Number (Smithfield). Any of these populations could be extant. Additionally, there is abundant suitable habitat on many of the ridges making up the Mount Holyoke Range in Massachusetts and the Metacomet Ridge in Connecticut. These areas could harbor as yet undiscovered populations.

Overall, these statistics do not present an encouraging picture for this taxon in New England. The need for conservation action is apparent. However, establishing conservation objectives based on such small population sizes is difficult. The primary objective is to ensure the long-term survival of the 11 populations that are currently known to be extant since 1993. This will involve increasing plant numbers at most sites and enhancing the reproductive ability at each site. Each population should maintain at least 30 to 50 individuals, scattered in several subpopulations if possible. Each of the established subpopulations should contain reproductive individuals, with 50% of the total

population reproductive each year. This spatial arrangement of subpopulations and level of reproduction should alleviate the potential for inbreeding depression.

A secondary objective is to increase the number of known populations. Locating pre-1994 or historic records and/or discovering new populations can achieve this objective. The discovery of new populations should not be considered a wild goose chase or an unachievable objective. Since 2000, three new populations have been discovered: two in Connecticut and one in Massachusetts. The primary focal area for *de novo* searches should be the Connecticut River Valley in Massachusetts and Connecticut. Vermont may harbor undiscovered populations, but it is difficult to target potentially suitable habitat in that state based on the paucity of information currently available for the extant sites. Neither New Hampshire nor Rhode Island contain extant populations. It is possible, although somewhat unlikely, that new populations will be discovered in these states based on changes in the landscape (increasing forest cover and development). An overall target objective for the number of extant populations in New England is 20 to 25. These populations should be roughly spatially arranged as follows: two to three populations in Vermont, eight to ten populations in Massachusetts, and 10 to 12 populations in Connecticut.

### **GENERAL CONSERVATION ACTIONS FOR THE TAXON**

The following general conservation actions are required to achieve the stated objectives. The actions are listed and discussed in priority order.

#### ***Regular Surveys (and Inventory) of Known Occurrences***

Keeping track of the currently known extant occurrences is essential. The loss of a single population, or in some cases even a single plant, could have significant consequences. There are so few occurrences that all should be monitored on a regular basis. All populations containing less than ten plants should be monitored annually. Data on the number of plants, reproductive status, height, evidence of browse, presence of other threats, and the total population area occupied should be gathered. Additionally, all populations and subpopulations should be mapped using GPS coordinates. A second visit in late August or early September should be made to any site where flowering was noted. It is important to understand the percentage of flowering individuals producing fruiting capsules with viable seed. The collection and analysis of these data may reveal what is ultimately limiting fruit set: resources or outcross pollen.

Monitoring the sites for decline and the need for management is critical. The species is known to prefer early to mid-successional habitats, as the canopy closes in and as shade increases the species declines. It will be important for regular surveys to give some measure of canopy closure or to quantify the levels of sunlight penetration during each survey. All extant occurrences should be monitored for the presence and impact of invasive plants and browse. If either of these threats are noted, management actions to mitigate the threat should be enacted. This may include the removal of invasive plants or

the caging of individual plants or small sub-populations. Due to the scarcity of this species in New England, no voucher samples should be collected during regular monitoring activities.

Individual colonies are known to be fairly short-lived, but the taxon often persists in the general location for many years (David Snyder, New Jersey Natural Heritage Program, personal communication). A thorough inventory – not only of the known population area but any additional suitable habitat in the surrounding area – should be undertaken at each extant and recently historic location. This may be a time-consuming process, as some areas contain vast amounts of seemingly suitable habitat, and the species is fairly cryptic.

An understanding of the minimum viable population size for the taxon would be beneficial for conservation planning purposes. Unfortunately, the current small size of extant populations in New England precludes performing a population viability analysis (PVA). It would be worthwhile to work with ecologists and conservation professionals in regions of the country where the species is more common. A PVA performed in one of these regions may provide information with practical applications in New England.

### ***De novo Searches for New Populations***

The secondary objective stated above is contingent upon the location of new, previously unknown populations. To fulfill the secondary objective, approximately 15 new populations must be located. This seems at first reckoning to be an unachievable objective; however, three of the 12 currently extant populations were discovered since 2000. Each of these newly discovered populations are small, but surrounded by larger areas of suitable habitat that have not been thoroughly searched. New populations likely remain undiscovered in New England.

*De novo* searches should be targeted in states and areas where extant occurrences are present. No large-scale effort to locate new populations in Vermont should be undertaken, as specific habitat information about the extant sites in that state is scarce. The Connecticut River Valley of Massachusetts and Connecticut, with the basalt ridges of the Mount Holyoke Range and the Metacomet Ridge, harbor the greatest amount of remaining suitable habitat. Specifically, open glade-like woodlands with a diverse herbaceous layer dominated by *Carex pensylvanica*, a sparse or absent shrub layer, and a low, open canopy of *Fraxinus americana*, *Juniperus virginiana*, *Quercus prinoides*, *Carya ovata*, and/or *Carya glabra* should be targeted. This type of natural community is most common on the east-, southeast-, and south-facing slopes along these ridge systems. Searches of suitable habitat on Long Mountain, Mount Norwottuck, Bare Mountain, Mount Hitchcock, Mount Holyoke, Goat Peak, Whiting Peak, Little Mount Tom, and Mount Tom in Massachusetts, and Short Mountain, Higby Mountain, Meriden Mountain, Talcott Mountain, Rattlesnake Mountain, Bradley Mountain, Ragged Mountain, the Hanging Hills, Lamentation Mountain, Beseck Mountain, Southington Mountain, Mount Sanford, Fowler Mountain, Totoket Mountain, Mount Carmel, and West Rock Ridge in



Connecticut may yield as yet undiscovered populations. Areas of suitable habitat at these locations may be discernable on digital orthophotographs. Searches in Rhode Island or New Hampshire are not recommended at this time.

Searching for new populations in these areas will be a time-consuming process. The species is somewhat cryptic and areas of suitable habitat often number into the tens of acres at a particular location. The small stature of most plants of this taxon found in New England often requires observers to be standing right over the plants before they are noticed. *De novo* searches should be planned from mid to late June, when the species is in flower. If any new populations are found, data similar to that collected on rare species data collection forms should be recorded. To ensure that a newly-discovered population is accurately mapped and can be easily relocated, it is imperative that a global positioning system (GPS) be used to record coordinates. Due to the scarcity of this species in New England, no voucher samples should be collected during *de novo* searches.

### ***Species Biology Research***

Although orchids are generally a heavily-studied group, only a moderate amount of research has been directed at this taxon. Rasmussen and Whigham have dedicated research into its ecology, germination and mycorrhizal associations, but little other work has been performed. In contrast, its cousin, *L. loeselii*, has received a great deal of attention from researchers and orchid ecologists. Although some of this information may be applicable to *L. liliifolia*, to what degree is unknown. Critical questions that need to be answered include:

#### Pollination

- What are the specific pollinators in the Sarcophagidae or other fly families?
- Are these pollinators present in habitats that currently support the taxon?
- Can we increase viable seed production and population size through manual cross-pollination?
- How abundant is the specific mycorrhiza required for germination and growth in New England?

#### Reproduction/Population

- Are New England populations suffering from inbreeding depression?
- What is the minimum viable population size?
- What is the maximum number of years seed can survive in the soil seed bank?
- How long does an individual plant survive?
- Do adult plants of this species show an ability to or tendency for dormancy?

#### Habitat Requirements

- Can we pinpoint the successional stage that marks the beginning of the end for this species at particular sites?
- At what level of canopy closure does *L. liliifolia* begin to decline?

- Can we correlate the rise of some species with the point that *L. liliifolia* begins to decline? What types of disturbance favor colonization by *L. liliifolia*?
- By disturbing a community in which the taxon is extant but apparently on the decline, can we recover the species?
- Does fire stimulate flowering or seed set?

Prior to any augmentation or reintroduction efforts, it is critical to determine whether the appropriate, specific mycorrhiza is present in the soil; without this, any effort is doomed. To accomplish this, seed packet studies similar to those employed by Whigham et al (2002) can be used as ‘baits’ to determine whether the fungus is present or not. Due to the small size of most extant New England occurrences, it may not be possible to conduct many of these activities at New England stations or with local genetic stock (for seed studies). Where study is suggested at New England stations, this appears in the action narratives for that occurrence. For those activities unable to be carried out in New England, it is suggested that ecologists and researchers working in other areas where the taxon is more abundant be informed of the research needs for New England.

### ***Augmentation, Introduction, and Reintroduction***

No introductions or reintroductions are recommended as part of this conservation plan. The population declines and disappearances of the taxon from New England appear to be due to natural causes: the succession of woodlands to a densely shaded canopy. Although humans have influenced this successional process by clearing the landscape and then allowing it to heavily reforest, these remain natural processes.

Augmentation in the traditional sense of the word is not recommended either. For the remaining extant populations, inbreeding depression is of great concern. Most populations that do flower rarely develop a fruiting capsule. It is recommended that if flowering individuals can be located at a number of the smaller populations (MA .001 [Holyoke], MA .035 [Holyoke], CT .003 [East Haddam], CT .008 [Hamden], CT .009 [Berlin], CT .010 [Windham], CT New [Lyme]), cross-pollination should be effected through the exchange of pollen by humans. To maintain a sufficient soil seed bank at each location, hand-pollination should be done at least every three years at all extant locations in Massachusetts and Connecticut, as well as any newly discovered sites through out the region. Manual pollination by humans is necessary to ensure that the dark specter of inbreeding depression does not eliminate any of the remaining populations, and to secure the production of viable seed. The exchange of pollen between populations or subpopulations is preferred, based on the findings of Whigham et al (2002). For example, pollen could be exchanged between CT .009 (Berlin) and CT .010 (Windham), or MA .001 (Holyoke) and MA .035 (Holyoke). This activity should begin within the next three years.

### ***Habitat or Site Management***

The habitats in which *Liparis liliifolia* occurs will require management periodically to maintain suitable, early- to mid-successional conditions for the taxon. None of the extant populations are imminently threatened by forest succession at present. Several occurrences in New England exist in habitats that seem to maintain suitable conditions naturally (MA .001 [Holyoke], MA .003 [South Hadley], CT .009 [Berlin], CT .010 [Windham]), but even these communities can become degraded over time, as in the case of the northern subpopulation at CT .002 (Cheshire). At other locations where there is no natural check on forest succession, such as CT .003 (East Haddam) and perhaps the Vermont occurrences, human intervention will be required to reset the successional clock to a condition suitable to the survival of this taxon. In most instances, management will take the form of canopy thinning, the removal of shading vegetation or possibly small-scale logging operations.

The results of the habitat research suggested above will inform management activities. Although research is needed to inform some specific aspects of management, management activities should not wait for the research to be completed. Populations have been known to decline drastically over very short periods of time. If population declines are observed at any population, management needs should be assessed and addressed immediately.

Due to the small number of plants and locations throughout the region, any plant with developing flowers or fruits should be protected from herbivory. Small cages can be erected over each reproductive plant. The production of viable seed is imperative. If fruits develop successfully, seed should be scattered in areas of suitable conditions at the site, particularly areas of thin canopy or light gaps.

It may be possible to reclaim the species at locations where it has recently disappeared by opening up the canopy and disrupting the successional processes. Small-scale logging operations and prescribed burns should be considered on an experimental basis at least two sites. Although this is not a suggested action for all sites, it may be possible at MA .004 (East Longmeadow), MA .007 ([Sunderland] suggested to merge with MA .005), RI No EO Number (Scituate), and the northern subpopulation of CT .002 (Cheshire). This type of activity should only be conducted on protected land and should be considered a low priority. Detailed information concerning the specific locations of the plants prior to their disappearance is required prior to undertaking this activity at historic locations.

Prior to any management activity being undertaken, an evaluation of how this activity will impact other rare elements and the overall community should be undertaken.

### ***Ex-situ Activities Including Seed Banking, Germination Research, and Propagation***

There is a basic understanding of the germination requirements and propagation techniques for *Liparis liliifolia*. Much of the current knowledge derives from the work of Hanne Rasmussen and Dennis Whigham. There is no need to conduct further research into these aspects for this taxon at this time.

There are currently no seeds in storage in the NEPCoP seed bank at NEWFS. Collections from populations that produce viable seed and can tolerate such an activity is highly desirable. Seed should be collected from populations on both public and private lands due to the species ability to suddenly “blink out.” Although there are no suggested actions that involve introduction or reintroduction at this time, the collection of seed from populations currently extant will provide a genetic record of the taxon in this region in the event that the species declines dramatically or disappears from the region.

### ***Education of Landowners and General Public***

Most of the twelve extant occurrences documented since 1993 occur on publicly or privately protected lands (VT .005 [Cornwall], MA.001 [Holyoke], MA .003 [South Hadley], MA .004 [East Longmeadow], MA .029 [Westfield], MA .035 [Holyoke], and CT .010 [Windham]). The land managers of these locations should be notified of the species' presence and location. Two occurrences are privately owned (CT .003 [East Haddam] and CT .008 [Hamden]). One population was recently discovered in a power line right-of-way. The State of Connecticut and NEWFS have worked successfully with the corporation to protect and manage other rare species locations. The lands manager for the corporation should be made aware of the location and importance of the species. For the remaining two sites (VT .006 [Brandon] and CT .009 [Berlin]), the landowner is currently unknown. It is a high priority to determine the landowners at these locations so they can be made aware of the species presence and importance.

All landowners should be informed about the ecological requirements of the species and how their land management activities can encourage the continued presence and expansion of known populations. Botanists and land managers working in the Mount Holyoke Range and the area of the Metacomet Ridge should be informed of the habitat preferences for the taxon and be alerted to the potential for its presence in the area. Similarly, botanists and land managers in Vermont (especially those in Middlebury area) and Rhode Island should be informed of the plants identification and habitat preferences.

### ***Land Acquisition or Protection of Occurrences***

Eight of the extant occurrences are located on protected lands and three additional properties are owned sympathetic private owners. The final known extant occurrence is located in a large swamp complex in Vermont. Multiple private landowners own the site,

but the exact owner of the location of the plants is unknown. Due to the conservation value of the swamp, it may be protected by the state at some point in the future.

Active land acquisition to protect extant occurrences is not necessary at this time due to the number of occurrences already protected. Land acquisition to protect this species is not recommended because without active land management the species is fleeting. In the future, if new populations are located on unprotected land, acquisition should be evaluated, but the presence of this taxon should not be the sole reason for protection.

### **RECOMMENDED CONSERVATION ACTIONS FOR EACH OCCURRENCE**

#### ***New Hampshire***

**NH (Manchester)** – There is some question as to the proper identification on which this report is based. The identification must be confirmed or refuted. The specimen should be sent to an expert in this genus for confirmation, perhaps Lawrence Magrath, who is the *Flora of North America* author for this genus.

**NH (Unknown)** – The herbarium specimen on which this population is based provides no location information. No action is suggested.

#### ***Vermont***

**VT .001 (Sharon)** – This is an old record with scant location information on which to base a search. A State Park is mentioned with some vague reference to a location. The park should be surveyed for suitable habitat similar to that described on the original specimen and the species searched for. The occurrence is currently unranked; an EO rank of H is suggested.

**VT .002 (Pownal)** – The Pownal area has been heavily botanized over the last several decades due to a number of other rarities occurring in the area. A site name is mentioned on one specimen collected from this town. Botanists working in the area should be made aware of the potential for this species occurring in early to mid-successional forest habitats in the area. The occurrence is currently unranked; an EO rank of H is suggested.

**VT .003 (Colchester)** – Some suitable habitat remains in the area of this 1906 observation. Field surveys to attempt to locate this old population should be undertaken.

**VT .004 (Middlebury)** – This is an old record with no specific information available on which to base a search. No action is recommended at this time. The occurrence is currently unranked; an EO rank of H is suggested.

**VT .005 (Cornwall)** – This occurrence was last observed in 2003. It should be resurveyed to determine current population status. Good directions to the site do not exist. The original surveyor should be contacted to ascertain more accurately where these plants are located. The occurrence should be monitored every one to three years. The site should be assessed for threats and any management needs once the plants are located. This is an important site as it is the larger of the two remaining sites in Vermont. If found, the subpopulations should be mapped using GPS coordinates. The land manager at the site should be made aware of the presence and location of the population.

**VT .006 (Brandon)** – The only observation of this population was in 1996. It should be surveyed, and threats and management needs assessed. There is some doubt as to the identification of these plants, as none were in bloom and they occur in an atypical habitat. The confirmation of their identification is of utmost importance as this represents one of only two extant sites in Vermont. The subpopulations should be mapped using GPS coordinates. The population should be monitored every one to three years.

### ***Massachusetts***

**MA .001 (Holyoke)** – Since its first observation in 1984, this population has steadily declined from 30 plants to two plants. The reason for this decline is not apparent. Although deer are certainly in the area there is no evidence of browse, and the habitat seems ideal for the species. The population is now so small it may be suffering from inbreeding depression. The large amount of suitable habitat surrounding the remaining plants should be intensively searched to see if other individuals are extant. The population should be monitored annually to determine the cause of its continued decline. If deer browse is determined to be a threat in the future, fencing should be considered. The invasive species present along the trail and other areas of the habitat should be monitored. If blooming individuals can be located pollen should be manually exchanged between these plants and those plants at MA .008, MA .029 or MA .035. The land manager at this location should be made aware of the presence of the species and its location. Seed packet studies near the plants and other areas nearby should be undertaken to determine if the mycorrhiza necessary for the germination of *L. liliifolia* is present in the soils. A small scale prescribed burn should be considered for this site. These studies should follow the format described in Whigham et al. (2002). An EO rank of C is suggested.

**MA .002 (Greenfield)** – Fifty plants were observed at this location in 1987. Since that time, the site has not been by state or NEPCoP. It should be surveyed immediately to determine its current status. Any threats or management needs should be assessed and plans for their mitigation developed. If found, a schedule for regular monitoring should be established based on population size, vigor, and threats. An EO rank of E is suggested.

**MA .003 (South Hadley)** – This occurrence, made up of a number of widely scattered subpopulations is currently the largest population in New England. It does not appear to

be under any threat at the current time. Regular monitoring of known subpopulations should take place every three years. *De novo* searches in other areas are recommended as time permits. The location of all existing and future subpopulations should be mapped and latitude and longitude acquired. This site is an excellent location to study the demography of the species, including annual fluctuations in individuals, longevity of subpopulation, and reproduction of subpopulations. Manual cross-pollination should be made between plants in the widely separated sub-populations at this location. Seed should be collected from several of the subpopulations for storage in NEWFS seed bank. The land manager at this location should be made aware of the presence of the species and its location. An EO rank of B is suggested.

**MA .004 (East Longmeadow)** – This population has been searched for without success since 1999. Attempts to contact the original observer for more detailed information have proven fruitless. The dense shade currently found at this location may have excluded this species. If true, this would be a dramatic decline, as 73 plants were observed at this location in 1994. Without assistance from the original observer, further surveys at this site are not recommended. If the plants are located, any threats or management needs should be assessed and addressed. If the original observer cannot locate the plants, a plan to disturb the site and thin the canopy should be developed and enacted to see if the population can be reclaimed. The population is currently unranked; an EO rank of F is suggested.

**MA .005 (Sunderland)** – This is one of three separate EO's in close proximity to one another. It is recommended that MA .005, MA .006, MA .007 (all Sunderland) be merged under MA .005. Although each of the populations has been observed in the past twenty years, and therefore each is technically extant, none have been located in the past ten years despite repeated attempts. No further survey activity is recommended at any of the sites. A low-priority action would be to remove the encroaching vegetation at the immediate location of the former MA .007 subpopulation in hopes of reclaiming the population. The population is currently unranked; an EO rank of H is suggested.

**MA .006 (Sunderland)** – This is one of three separate EO's in close proximity to one another. It is recommended that MA .005, MA .006, MA .007 be merged under MA .005.

**MA .007 (Sunderland)** – This is one of three separate EO's in close proximity to one another. It is recommended that MA .005, MA .006, MA .007 be merged under MA .005.

**MA .008 (West Springfield)** – Thirty plants were observed at this location in 1990. No survey attempts have been made since that time. The landowner of this location needs to be determined. The site should be surveyed immediately to determine its current population status. If the population is found, any threats or management needs should be assessed and plans for their mitigation enacted with landowner permission. If blooming individuals can be located pollen should be manually exchanged between these plants and those plants at MA .001 (Holyoke), MA .029 (Westfield), or MA .035 (Holyoke).

Seed packet studies near the plants and other areas nearby should be undertaken to determine if the mycorrhiza necessary for the germination of *L. liliifolia* is present in the soils. These studies should follow the format described in Whigham et al. (2002). Seed should be collected for storage in NEWFS seed bank if the population could support such activity. The population is currently unranked; an EO rank of E is suggested.

**MA .009 (Canton)** – There is no information on which to base an effective search for this population. The site of this species is a large area that is heavily used and has been well botanized over the last 100 years. No further activity is recommended for this location. The population is currently unranked; an EO rank of H is suggested.

**MA .010 (Deerfield)** – Although the last time this population was observed was in 1955, there are directions to a general search area. The area described on the herbarium specimen collected should be searched to see if any suitable habitat or plants remain at the site. If plants are located, any threats or management needs should be assessed. The population is currently unranked; an EO rank of H is suggested.

**MA .011 (Concord)** – Very specific directions to this occurrence exist. It has been searched for without success. No suitable habitat remains for this taxon in the area of the original sighting. The surrounding landscape has been developed residentially for decades.

No further action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .012 (Lexington)** – Very specific directions to this occurrence exist. The site is a residential backyard and is quite overgrown. Little suitable habitat remains. The population has been searched for without success in recent years. No further action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .013 (Granby)** – There is little available information on which to base a search for this population, last observed in 1952. However, the Mount Holyoke Range was, and remains a stronghold for this species in Massachusetts. *De novo* searches of the open glade-like woodlands on the southern or eastern slopes of Mount Norwottuck are merited. The population is currently unranked; an EO rank of H is suggested.

**MA .014 (Canton)** – Another of the several records relating the Blue Hills, this record provides scant information on which to base a search. The general area has been heavily used and botanized over the past 100 years. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .015 (Ashland)** – No information aside from date of collection and town exist for this occurrence. No action is recommended. The population is currently unranked; an EO rank of H is suggested.



**MA .016 (Amesbury)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .017 (West Springfield)** – This is an 1896 collection from a cultivated plant that was originally collected from an unspecified wooded location in West Springfield. There is no information that would enable a search for the population. Due to its similarity to MA .008 also occurring in West Springfield, it is suggested to merge this record with MA .008. It is unlikely that the three collections/observations making up these two occurrences all refer to the same population, but it is possible.

**MA .018 (Southwick)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .019 (Belchertown)** – No information aside from date of collection and town exist for this occurrence. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .020 (Amherst)** – There is little information on the location of this population. Based on the descriptions provided on the specimens, this population occurred on the slopes of Mount Holyoke. This is somewhat confusing, as Mount Holyoke occurs in Hadley and South Hadley. The exact location is unknown. Although current-day *Liparis* records all occur on the southeastern or eastern slopes of the Mount Holyoke Range, it is possible that historically, the plants occurred on the northern slopes. The incorrect town may be collector error. Due to the affinity for this species to the Mount Holyoke Range, *de novo* searches of any open, glade-like forests on the northern slopes of this range including Mount Holyoke are suggested. The population is currently unranked; an EO rank of H is suggested.

**MA .021 (Granby?)** – There is little available information on which to base a search for this population, last observed in 1879. Based on its similarity to MA .013 (Granby), it is suggested the two records be merged under that number.

**MA .022 (Williamsburg)** – A specimen from this population was collected from a park in 1908. A street with the same name as the park exists in Williamsburg, but it is unknown if the park is still in existence. A search for the park and surrounding suitable habitats should be undertaken. If plants are found, an assessment of any threats or management needs should be undertaken. The population is currently unranked; an EO rank of H is suggested.

**MA .023 (Deerfield)** – Little information exists concerning this population. A general site is referenced, and much of the site noted is now a state park, but none of the information is specific enough to validate an intensive search. A cursory survey of the park for suitable habitat is recommended. If suitable habitat is located, a search for this taxon should be undertaken. Additionally, the park managers should be informed of the

species potential presence and educated as to its identification. The population is currently unranked; an EO rank of H is suggested.

**MA .024 (North Leverett)** - Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .025 (Alford)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .026 (Mt. Washington)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .027 (West Stockbridge)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .028 (Monson)** – No information aside from date of collection and town exist for this occurrence. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .029 (Westfield)** – This population was observed in 2002, but no detailed information concerning its population size, vigor, or phenology was gathered. The only information available is that a handful of plants were seen in a scattered area. If this is the same population as the 1986 observation and there is evidence to support this, the population has decreased dramatically. This population should be surveyed immediately to determine the present status of the population and the habitat that supports it. Information on the number of plants their location and reproductive status should be gathered. The location of the population should be mapped using GPS coordinates. If blooming individuals can be located pollen should be manually exchanged between these plants and those plants at MA .001 (Holyoke), MA .008 (West Springfield), or MA .035 (Holyoke). Seed packet studies near the plants and other areas nearby should be undertaken to determine if the mycorrhiza necessary for the germination of *L. liliifolia* is present in the soils. These studies should follow the format described in Whigham et al. (2002). Seed should be collected from this location for storage in NEWFS seed bank if the population is large enough to support this activity. Any threats and management needs should be assessed and a plan for their mitigation developed. The land managers at this location should be made aware of the presence and location of the population if it is located. A schedule for regular monitoring should be established based on population size, vigor, and threats. The population is currently unranked; an EO rank of E is suggested.

**MA .030 (Middleboro)** – There is some question concerning the exact location of the population. A map to the site does exist but is confusing, referring to major highways

that do not pass through the indicated town. It was observed only once in 1986, and since that time the observer has passed away. With a map to the population and a road atlas it may be possible to locate the area of the original sighting. A search for this site is a high priority as it represents the only modern day occurrence in eastern Massachusetts. The landowner needs to be identified. If the population is located, any threats and management needs should be assessed and addressed. The landowner situation should be investigated to determine if the plants could be protected. The population is currently unranked; an EO rank of E is suggested.

**MA .031 (Amherst)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. Based on the notes found on the original specimens, this population was certainly not the same as that referred to in MA .020 (Amherst); however, it does refer to the same general location: Mount Holyoke. This is somewhat confusing, as Mount Holyoke occurs in Hadley and South Hadley. Although current-day *Liparis* records all occur on the southeastern or eastern slopes of the Holyoke Range, it is possible that historically, the plants occurred on the northern slopes. For convenience sake and to eliminate any future confusion, it is recommended that this occurrence be merged with MA .020 (Amherst).

**MA .032 (Goshen)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .033 (South Hadley)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .034 (Milton)** – The final of the occurrences referencing an area in the Blue Hills of eastern Massachusetts, the specimens collected for this population provide little location information. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .035 (Holyoke)** – This population was found in 2003 during intensive field surveys of recently acquired state and private conservation properties. Further surveys in the area are merited in an attempt to locate additional subpopulations. Due to its small size, this population should be surveyed annually to determine population trends. Suitable habitat surrounding this population should be intensively searched for additional plants. If no additional plants can be found, and the population fails produce viable seed within three years, manually exchanging pollen between these plants and those plants at MA .001, MA .008 or MA .029 is recommended. Seed packet studies near the plants and other areas nearby should be undertaken to determine if the mycorrhiza necessary for the germination of *L. liliifolia* is present in the soils. These studies should follow the format described in Whigham et al. (2002). Any threats or management needs should be assessed and a plan for their mitigation developed and implemented. Seed should be collected if the population can support such an activity. The land managers at this location should be made aware of the presence and location of the population.

Management strategies put in place at this location should strongly consider the impact on this taxon. An EO rank of E is suggested.

**MA .036 (Prescott)** – This occurrence was extirpated by the creation of the Quabbin Reservoir. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .037 (Millbury)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .038 (Williamstown)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

**MA .038 (Sturbridge)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended. The population is currently unranked; an EO rank of H is suggested.

### ***Rhode Island***

**General Actions** – Based on the information uncovered in this plan, it is suggested that the Rhode Island Natural Heritage Program change the state status of this taxon to historic (SH).

**RI .001 (Glocester)** – This property was recently purchased by a local land trust and the large amounts of slash remaining from a previous logging operation removed. Although it is unlikely that this population will return to this site, the site should be checked in five years to determine if the population has reappeared. The combination of the removal of the slash and logging returning some areas of this site to early successional woodland may favor recolonization by *Liparis liliifolia*. The population is currently unranked; an EO rank of H is suggested.

**RI .002 (Coventry)** – This site has been searched for multiple times in recent years, including once with the original observer. No plants have been observed during any recent search. Although some areas of marginal habitat do exist it should be considered historic and no further energy expended on searching at this location. The population is currently unranked; an EO rank of H is suggested.

**RI .003 (West Greenwich)** – Several attempts to locate this small population have been undertaken without success. The directions are very specific. The habitat has changed dramatically since the last observation and the population has likely been shaded out. No further action is recommended. The population is currently unranked; an EO rank of H is suggested.

**RI .004 (West Greenwich)** – Little information exists concerning this population, and none of what is known is specific enough to mount an effective search. The site is extremely large, but has limited areas of suitable habitat. Several attempts to locate the population in these areas have been undertaken with no success. It is likely the population has been shaded out. No further action is recommended. The population is currently unranked; an EO rank of H is suggested.

**RI .005 (Lincoln)** – This site is known to be extirpated. The plants slumped off a shelf on a ledge and have not been seen since despite multiple surveys. There is some marginally suitable habitat for the taxon in the area, although it is becoming heavily shaded. No further action is recommended.

**RI .006 (West Greenwich)** – Several attempts to locate this small population have been undertaken without success. The directions are relatively specific. The habitat seems to have changed significantly since the last observation and the population has likely been shaded out. No further action is recommended. The population is currently unranked; an EO rank of H is suggested.

**RI (Scituate)** – Although technically extant, this occurrence has been searched for multiple times without success. The habitat, although suitably rich to support this taxon, has become very shady in most areas and the population has likely been shaded out. The site is currently in private ownership by multiple landowners. If it were to be protected, a low priority action would be to develop a plan to disturb the site and thin the canopy should be developed and enacted to see if the population can be reclaimed. No further action is recommended.

**RI (Smithfield)** – This occurrence should be searched for immediately. A detailed map of the area and the location of the population are available. The described habitat seems unusual and marginal, but this may represent the last hope of the taxon in Rhode Island. If the population is found, any threats or management needs should be assessed and a plan for their mitigation developed and implemented.

### ***Connecticut***

**CT .001 (Ledyard)** – This site was extirpated in 1992. No action is recommended. An EO rank of X is suggested.

**CT .002 (Cheshire)** – The original observer, among others familiar with the taxon, have searched for this population in recent years without locating it. Deer browse and turkey digging heavily impact the area and the northern subpopulation site is heavily shaded. The northern subpopulation is privately owned. If this area were to be protected in the future, a plan to thin the canopy and remove aggressive vegetation should be developed and enacted. This action may allow for the recolonization of the site by *L. liliifolia*. The southern subpopulation is owned by a local land trust and still contains suitable habitat, but the browse has likely eliminated the taxon from the site. If plants can be located,

deer fence or caging should be immediately erected to prevent browse. One final search is recommended prior to considering this site historic. A small scale logging or prescribed burn should be considered for this site. The occurrence is currently unranked; an EO rank of F is suggested.

**CT .003 (East Haddam)** – A sympathetic landowner has caged the individual plants on her property to protect them from voracious deer. This may be a case of too little, too late. Only two plants remain at this occurrence, and are suffering from past deer browse and shading by a maturing forest. The location of the remaining plants abuts a large area of protected land with some suitable habitat for this species. The fencing around the existing plants should be maintained and expanded to encompass a larger area. The tree canopy should be thinned to 50% of the current canopy closure to allow additional sunlight penetration. Annual monitoring is recommended. If the plants produce flowers but fail to produce fruit for two consecutive years, pollen should be manually transferred between plants at this location and other local populations such as CT .008 (Hamden), CT .009 (Berlin), or CT New (Lyme). Seed packet studies near the plants and other areas nearby should be undertaken to determine if the mycorrhiza necessary for the germination of *L. liliifolia* is present in the soils. These studies should follow the format described in Whigham et al. (2002). The landowner can conduct the monitoring and report the findings to NEWFS. *De novo* searches in suitable habitat on the surrounding protected lands is warranted.

**CT .004 (Rocky Hill)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended.

**CT .005 (Hartford)** – No information aside from date of collection and town exist for this occurrence. No action is recommended.

**CT .006 (Wethersfield)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended.

**CT .007 (Essex/Old Saybrook)** – This site was likely destroyed in 1997. One final search of the area is recommended. Perhaps the disturbance that extirpated the known plants created suitable habitat for colonization.

**CT .008 (Hamden)** – This is the most unusual site for this taxon in New England. It has persisted at this high-risk, odd location for over 40 years as just two plants. Little can be done to protect this site in the long term. If the plants produce flowers but fail to produce fruit for two consecutive years, pollen should be manually transferred between plants at this location and other local populations such as CT .003 (East Haddam), CT .009 (Berlin), or CT New (Lyme). Periodic monitoring every three to five years is needed. The landowners are aware of the plant and are very protective. No further action is recommended.

**CT .009 (Berlin)** – One plant is known from this location in seemingly ideal habitat. Deer browse is a significant threat. The population should be monitored annually. The

single plant should be caged to protect it from browse; it has not flowered in the past several years, and evidence of fruiting has never been observed. The extensive area of suitable habitat should be thoroughly searched for more plants. Additionally, there may be other areas of suitable habitat on this mountain. If additional flowering plants can be found in the known habitat or in any newly discovered habitat, but fail to produce fruit for two consecutive years, pollen should be manually transferred between plants at this location and other local populations such as CT .003 (East Haddam), CT .008 (Hamden), or CT New (Lyme). Seed packet studies near the plants and other areas nearby should be undertaken to determine if the mycorrhiza necessary for the germination of *L. liliifolia* is present in the soils. These studies should follow the format described in Whigham et al. (2002). A small prescribed burn should be considered for this site.

**CT .010 (Windham)** – This occurrence represents another Connecticut population of one plant in seemingly suitable habitat. Deer browse is a significant threat. The land managers should be made aware of the presence and location of the population. The single plant should be caged to protect it from browse. Areas of additional suitable habitat should be thoroughly searched for more plants. Additionally, there may be other areas of suitable habitat in the vicinity. If the plants produce flowers but fail to produce fruit for two consecutive years, pollen should be manually transferred between plants at this location and other local populations such as CT .003 (East Haddam), CT .008 (Hamden), CT .009 (Berlin), or CT New (Lyme). Seed packet studies near the plants and other areas nearby should be undertaken to determine if the mycorrhiza necessary for the germination of *L. liliifolia* is present in the soils. These studies should follow the format described in Whigham et al. (2002).

**CT (Lyme)** – One plant has been located at this site. As this plant occurs in a power line right-of-way, the power company and maintenance company should be made aware of the presence and location of the population. The single plant should be caged to protect it from browse. Areas of additional suitable habitat should be thoroughly searched for more plants. If the plants produce flowers but fail to produce fruit for two consecutive years, pollen should be manually transferred between plants at this location and perhaps exchanged with other local populations such as CT .003 (East Haddam), CT .008 (Hamden), or CT .009 (Berlin). Seed packet studies near the plants and other areas nearby should be undertaken to determine if the mycorrhiza necessary for the germination of *L. liliifolia* is present in the soils. These studies should follow the format described in Whigham et al. (2002).

**CT (Hamden)** – This population has not been seen since 1991 or 1992, despite searches by the original observer and others familiar with the taxon. The site is a large State Park with ample suitable habitat. Additional searches are merited in an attempt to relocate this population or to discover new subpopulations. If any plants are discovered, any threats or management needs should be assessed and plans for their mitigation implemented. Any located plants should be mapped using GPS coordinates.

**CT (East Haddam)** – Little information exists concerning this population, and none of what is known is specific enough to mount a search. No action is recommended.

**CT (Willington)** – This population is considered extirpated. No action is recommended.

**CT (Farmington)** – Search to determine if the site named on the original specimen still exists. If so, conduct a search of the site for suitable habitat and the presence of *Liparis liliifolia*.

**CT (Glastonbury)** – Search general areas of Addison and Diamond Lake for suitable habitat and presence of *Liparis liliifolia*. Both sites are mentioned on early specimens.

**CT (Branford)** – Search to determine if the site named on the original specimen still exists. If so, conduct a search of the site for suitable habitat and the presence of *Liparis liliifolia*.

**CT (Multiple)** – There are many herbarium specimens in support of populations that have never made it into the records of the CT Natural Diversity Database (CT NDDB). These records, located through the writing of this plan and the NEWFS Herbarium Recovery Project, should be entered into the CT NDDB.

### ***Prioritized Implementation Table***

The prioritized implementation table that follows (Table 4) lists and ranks actions that should be undertaken in order to implement the conservation plan for *Liparis liliifolia*. The schedule is subject to revision based on annual review of conservation objectives, and no action should occur without the permission and consultation of Natural Heritage Programs for the relevant states. 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 will not be listed separately for each occurrence unless special circumstances exist. Conservation activities to follow assume landowner permission has been acquired



**Table 4: Prioritized Implementation Table for *Liparis liliifolia*. Landowner permission is prerequisite to these actions.**

No action should be undertaken without the review of conservation professionals and the prior consultation and consent of state Natural Heritage Programs.

State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
NH		Manchester			Send specimen to expert for confirmation.	
NH		Unknown				No action recommended
VT	General					Make botanists and land managers in the Middlebury area aware of identification, suitable habitat and potential for this species.
VT	.001	Sharon				Survey park for suitable habitat and search for taxon.
VT	.002	Pownal			Make botanists working in area aware of potential for taxon.	
VT	.003	Colchester				Search suitable habitat.
VT	.004	Middlebury				No action recommended.
VT	.005	Cornwall	Contact original surveyor for accurate directions. Survey population. Map using GPS coordinates.	Assess threats and management needs. Survey every one to three years.		
VT	.006	Brandon	Determine landowner. Contact original surveyor for accurate directions. Survey. Confirm identification.	Assess threats and management needs. Survey every one to three years.		

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No action should be undertaken without the review of conservation professionals and the prior consultation and consent of state Natural Heritage Programs.

State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
MA	General actions			<i>De novo</i> searches of suitable habitat in the Holyoke Range.	Make botanists and land managers in the working in the Holyoke Range aware of identification, suitable habitat and potential for this species.	
MA	.001	Holyoke	Search adjacent suitable habitat thoroughly. Monitor annually. Notify land manager.	Monitor expansion of <i>Cynanchum louisiae</i> along trail and in habitat. Hand pollinate and cross with plants at MA .035, MA .029 or MA .008. Collect soil samples for mycorrhizal studies.	Erect deer fence if needed. Conduct a small prescribed burn.	Assign EO rank of C. Collect soil samples for mycorrhizal studies.
MA	.002	Greenfield	Survey.	Assess threats and management needs. Establish survey schedule based on population numbers.		Assign EO rank of E.
MA	.003	South Hadley	Monitor every three years. Map subpopulations using GPS coordinates. Notify land manager.	Conduct species biology research and demographic monitoring. Cross pollinate plants in the various sub-populations.	Search other areas of suitable habitat at site. Conduct seed packet studies to determine presence of mycorrhiza.	Collect seed. Assign EO rank of B.
MA	.004	East Longmeadow	Contact original observer to survey.			Develop plan to disturb site and thin canopy. Assign EO rank of F.

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No action should be undertaken without the review of conservation professionals and the prior consultation and consent of state Natural Heritage Programs.

State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
MA	.005	Sunderland				Develop plan to disturb site and remove competing vegetation at location of former MA .007. Assign EO rank of H.
MA	.006	Sunderland	Merge with MA .005.			
MA	.007	Sunderland	Merge with MA .005.			
MA	.008	West Springfield	Determine landowner. Survey.	Assess threats and management needs. Hand pollinate and cross with plants at MA .035, MA .029 or MA .001.	Conduct seed packet studies to determine presence of mycorrhiza.	Collect seed. Assign an EO rank of E.
MA	.009	Canton				No action recommended. Assign an EO rank of H.
MA	.010	Deerfield				Search for suitable habitat and plants. Assess threats if found.
MA	.011	Concord				No action recommended. Assign an EO rank of H.
MA	.012	Lexington				No action recommended. Assign an EO rank of H.
MA	.013	Granby		<i>De novo</i> searches.		
MA	.014	Canton				No action recommended. Assign an EO rank of H.
MA	.015	Ashland				No action recommended. Assign an EO rank of H.

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State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
MA	.016	Amesbury				No action recommended. Assign an EO rank of H.
MA	.017	West Springfield	Merge with MA .008.			
MA	.018	Southwick				No action recommended. Assign an EO rank of H.
MA	.019	Belchertown				No action recommended. Assign an EO rank of H.
MA	.020	Amherst				De novo searches on the north slopes of Mt. Holyoke.
MA	.021	Granby?	Merge with MA .013.			
MA	.022	Williamsburg	Search for park named on specimen. If found search for suitable habitat and plants.			
MA	.023	Deerfield			Search state park at location named on specimen for suitable habitat and plants.	
MA	.024	North Leverett				No action recommended. Assign an EO rank of H.
MA	.025	Alford				No action recommended. Assign an EO rank of H.
MA	.026	Mt. Washington				No action recommended. Assign an EO rank of H.
MA	.027	West Stockbridge				No action recommended. Assign an EO rank of H.
MA	.028	Monson				No action recommended. Assign an EO rank of H.

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No action should be undertaken without the review of conservation professionals and the prior consultation and consent of state Natural Heritage Programs.

State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
MA	.029	Westfield	Survey. Map using GPS coordinates. Notify land managers.	Assess threats and management needs. Establish a monitoring schedule. Hand pollinate and cross with plants at MA .035, MA .008 or MA .001.	Conduct seed packet studies to determine presence of mycorrhiza.	Collect seed. Assign an EO rank of E.
MA	.030	Middleboro	Search for site. Determine landowners. Search for plants.	Assess threats and management needs. Notify landowners.		Assign an EO rank of E.
MA	.031	Amherst	Merge with MA .020			
MA	.032	Goshen				No action recommended. Assign an EO rank of H.
MA	.033	South Hadley				No action recommended. Assign an EO rank of H.
MA	.034	Milton				No action recommended. Assign an EO rank of H.
MA	.035	Holyoke	Search areas of nearby suitable habitat for additional plants. Survey annually. Notify land managers.	Assess threats and management needs. Hand pollinate and cross with plants at MA .008, MA .029 or MA .001.	Conduct seed packet studies to determine presence of mycorrhiza.	Collect seed.
MA	.036	Prescott				No action recommended. Assign an EO rank of H.
MA	.037	Millbury				No action recommended. Assign an EO rank of H.
MA	.038	Williamstown				No action recommended. Assign an EO rank of H.

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No action should be undertaken without the review of conservation professionals and the prior consultation and consent of state Natural Heritage Programs.

State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
MA	.039	Sturbridge				No action recommended. Assign an EO rank of H.
RI	General actions				Inform botanical community in Rhode Island to be on the lookout for this species.	Change state status to H.
RI	.001	Glocester			Survey in five years.	Assign an EO rank of H.
RI	.002	Coventry				No action recommended. Assign an EO rank of H.
RI	.003	West Greenwich				No action recommended. Assign an EO rank of H.
RI	.004	West Greenwich				No action recommended. Assign an EO rank of H.
RI	.005	Lincoln				No action recommended.
RI	.006	West Greenwich				No action recommended. Assign an EO rank of H.
RI		Scituate				If site is becomes protected, consider disturbing site by thinning the canopy in an attempt to reclaim the species, otherwise no action.
RI		Smithfield	Search for plants.	If found, assess threats and management needs.		

**Table 4: Prioritized Implementation Table for *Liparis liliifolia*. Landowner permission is prerequisite to these actions.**

No action should be undertaken without the review of conservation professionals and the prior consultation and consent of state Natural Heritage Programs.

State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
CT	General actions			<i>De novo</i> searches of suitable habitat along the Metacomet Ridge.	Make botanists and land managers working in the Metacomet Ridge area aware of identification, suitable habitat and potential for this species.	Enter specimens uncovered in researching this plan and those found during the HRP into the records at the CT NDDDB.
CT	.001	Ledyard				No action recommended. Assign an EO rank of X.
CT	.002	Cheshire		Conduct one last search.		If area of northern subpopulation becomes protected, consider disturbing site by thinning the canopy in an attempt to reclaim the species. Consider a small prescribed burn.
CT	.003	East Haddam	Monitor annually. Thin canopy over plants.	Expand fenced area. Hand pollinate and cross with plants at CT .008, CT .009, CT .010, and CT Lyme.	<i>De novo</i> searches of suitable habitat on surrounding lands.	Collect soil samples for mycorrhizal studies.
CT	.004	Rocky Hill				No action recommended.
CT	.005	Hartford				No action recommended.
CT	.006	Wethersfield				No action recommended.
CT	.007	Essex/Old Saybrook	Conduct one final search of the site and surrounding area.			
CT	.008	Hamden		Hand pollinate and cross with plants at CT .003, CT .009, CT .010, and CT Lyme.	Monitor every three to five years.	Manually pollinate plants.

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No action should be undertaken without the review of conservation professionals and the prior consultation and consent of state Natural Heritage Programs.

State	EO #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
CT	.009	Berlin	Monitor annually. Cage plant. Search other areas of suitable habitat at site. Determine landowner.	Hand pollinate and cross with plants at CT .003, CT .008, CT .010, and CT Lyme. Conduct seed packet studies to determine presence of mycorrhiza.	Conduct a small prescribed burn.	
CT	.010	Windham	Monitor annually. Cage plant. Search other areas of suitable habitat at site. Notify land managers.	Hand pollinate and cross with plants at CT .003, CT .008, CT .009, and CT Lyme. Conduct seed packet studies to determine presence of mycorrhiza.		
CT		Lyme	Monitor annually. Cage plant. Search other areas of suitable habitat at site. Notify land managers.	Hand pollinate and cross with plants at CT .003, CT .008, CT .009, and CT .010. Conduct seed packet studies to determine presence of mycorrhiza.		
CT		Hamden			Search for this population in suitable habitat.	
CT		East Haddam				No action recommended.
CT		Willington				No action recommended.
CT		Farmington			Search for named site, suitable habitat and plants.	
CT		Glastonbury				Search for named site, suitable habitat and plants.



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No action should be undertaken without the review of conservation professionals and the prior consultation and consent of state Natural Heritage Programs.

<b>State</b>	<b>EO #</b>	<b>Town</b>	<b>First Priority</b>	<b>Second Priority</b>	<b>Third Priority</b>	<b>Fourth Priority</b>
CT		Branford				Search for named site, suitable habitat and plants.

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## IV. APPENDICES

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- 1. Personal Communication References**
- 2. Herbarium Specimens for *Liparis liliifolia* Located at Select Regional Herbaria**
- 3. An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe**

## **1. Personal Communication References**

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Snyder, David. New Jersey Natural Heritage Program, Office of Natural Lands Management, 22 South Clinton Avenue, PO Box 404, Trenton, New Jersey 08625-0404 USA.

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Whigham, Dennis. Smithsonian Environmental Research Center, PO Box 28, 647 Contees Wharf Road, Edgewater, Maryland 21037 USA.



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New York 12233-4757 USA.

**2. Herbarium Specimens for *Liparis liliifolia* Located at Select Regional Herbaria**

State	County	Township	Primary Collector	Collection Number	Herbarium Acronym	Collection Notes	Collection Date	Label Data	Location Notes	Primary Determination
NH	Hillsborough	Manchester	Batchelder, F.		NHA		20 Sep 1909	Fruiting	Manchester City	
VT	Addison	Middlebury	Brainerd, E.		VT		30 Jun 1883			<i>Liparis liliifolia</i>
VT	Addison	Middlebury	Brainerd, E.		VT		26 Jun 1882			<i>Liparis liliifolia</i>
VT	Addison	Middlebury	Brainerd, E.		VT		30 Jun 1883	Moist woods.		<i>Liparis liliifolia</i>
VT	Addison	Middlebury	Brainerd, E.		GH		26 Jun 1880			<i>Liparis liliifolia</i>
VT	Bennington	Pownal	Flynn, N.		VT		2 Jul 1907	Krigger Rocks. No. Pownal.		<i>Liparis liliifolia</i>
VT	Bennington	Pownal	Carpenter, D.		VT		3 Jul 1907			<i>Liparis liliifolia</i>
VT	Chittenden	Colchester	Eggleston, W.		VT	Third collector listed as "Jones".	3 Jul 1906	Sandy bluff off Ft. Ethan Allen.		<i>Liparis liliifolia</i>
VT	Rutland	Wells	Weatherby, C.	7214	NEBC		28 Jun 1936	Disintegrating slate outcrops in thin woods.		<i>Liparis liliifolia</i>
VT	Windsor	Sharon	Dutton, D.		VT	Day stated as 6-11 on label. It is likely collected on the 9th, based on a duplicate (photo) at VT.	Jul 1925	Edge of woods. Alt. 1400 ft.		<i>Liparis liliifolia</i>
VT	Windsor	Sharon	Dutton, D.		VT	Collection is a black and white photograph. The year of collection is likely 1925 based on a duplicate at VT.	9 Jul	Under trees at edge of woods.		<i>Liparis liliifolia</i>
VT	Windsor	Sharon	Ridlon, H.		VT	Collector's name followed by a question mark on label.	7 Jul 1925	Downer State Forest.		<i>Liparis liliifolia</i>
MA	Berkshire	Alford	Hoffman, R.		NEBC	Two collections on sheet. This label for right. Left by Hoffman.	20 Aug 1904	Rich woods.		<i>Liparis liliifolia</i>
MA	Berkshire	Mount Washington	Walters, F.		NHA		10 Jul 1915	Rocky woods.		<i>Liparis liliifolia</i>

**2. Herbarium Specimens for *Liparis liliifolia* Located at Select Regional Herbaria**

State	County	Township	Primary Collector	Collection Number	Herbarium Acronym	Collection Notes	Collection Date	Label Data	Location Notes	Primary Determination
MA	Berkshire	West Stockbridge	Hoffman, R.		NEBC	Two collections on sheet. This label for left. Right by Hoffman.	22 Aug 1902	Pine woods.		<i>Liparis liliifolia</i>
MA	Essex (ma)	Amesbury	Eaton, A.		AMES		10 Jul 1896	Great Swamp.		<i>Liparis liliifolia</i>
MA	Essex (ma)	Amesbury	Huntington, J.		AMES	J. Warren Huntington.	Jun 1896	Great Swamp.		<i>Liparis liliifolia</i>
MA	Essex (ma)	Amesbury	Eaton, A.	1136	NEBC		Jul 1896			<i>Leptorchis liliifolia</i>
MA	Franklin (ma)	Deerfield (ma)	Poland, R.	1159	MASS	Two collections on sheet. This label for upper (#1).	13 Jul 1952	Pocumtuck, East off Pine Nook Rd. near S end of wooded area on east. N. of Hilltop orchard. Down a stream bed. 15 plants in bloom along stream in June 1955.		<i>Liparis liliifolia</i>
MA	Franklin (ma)	Deerfield (ma)	Poland, R.	113	MASS		2 Jun 1953	Pocumtuck, East off Pine Nook Rd. near S end of wooded area on E (N of Hilltop orchard). Down a stream bed. East of woods road to my apthitheather. 15 plants in bloom along stream 18 Jun 1955.		<i>Liparis liliifolia</i>

**2. Herbarium Specimens for *Liparis liliifolia* Located at Select Regional Herbaria**

State	County	Township	Primary Collector	Collection Number	Herbarium Acronym	Collection Notes	Collection Date	Label Data	Location Notes	Primary Determination
MA	Franklin (ma)	Deerfield (ma)	Peirce, G.	155-1	NEBC	Printed label states plant collected about 1840-1850. Handwritten note states date is 1842.	1842	Mt. Sugarloaf.		<i>Liparis liliifolia</i>
MA	Franklin (ma)	Greenfield (ma)	Williams, E.		GH	Two collections on sheet. This label for lower. Upper by Thacher.	17 Jun 1910	Rocky Hill.		<i>Liparis liliifolia</i>
MA	Franklin (ma)	Greenfield (ma)	Thacher, G.		GH	Mrs. G. W. Thacher.	16 Jun 1910	Rocky Hill.		<i>Liparis liliifolia</i>
MA	Franklin (ma)	Leverett	Torrey, R.		MASS		18 Jun 1910	No. Leverett.		<i>Liparis liliifolia</i>
MA	Franklin (ma)	Sunderland	Boutwell, W.		MASS		Jun 1881	Mt. Toby.		<i>Liparis liliifolia</i>
MA	Franklin (ma)	Sunderland	Boutwell, W.		MASS		Jun	Mount Toby.		<i>Liparis liliifolia</i>
MA	Franklin (ma)	Sunderland	Ruhfel, R.		MASS		22 Sep 1984	Deciduous woods, among <i>Betula papyrifera</i> , on plateau between two slopes, west side of Mt. Toby, 11 plants seen, 4 had flowered, no fruit set, one fruit present from previous year.		<i>Liparis liliifolia</i>

**2. Herbarium Specimens for *Liparis liliifolia* Located at Select Regional Herbaria**

State	County	Township	Primary Collector	Collection Number	Herbarium Acronym	Collection Notes	Collection Date	Label Data	Location Notes	Primary Determination
MA	Hampden	East Longmeadow	Zebryk, T.	1672	MASS		17 Aug 1994	Pine Quarry Conservation Area, south of Chestnut St., near intersection with Rt. 83. On sandstone ledge near abandoned quarry working, in mesic mixed hardwood-white pine forest. Substrate: thin, sandy loam over sandstone. Associated	Label continued (1): taxa: <i>Acer saccharum</i> , <i>Pinus strobus</i> , <i>Acer rubrum</i> , <i>Betula alleghaniensis</i> , <i>Betula papyrifera</i> , <i>Populus deltoides</i> , <i>Fagus grandifolia</i> , <i>Mitchella repens</i> , <i>Carex swanii</i> , <i>Viburnum recognitum</i> , <i>Pyrola elliptica</i> , <i>Smilacina racemosa</i> . Rare,	<i>Liparis liliifolia</i>
MA	Hampden	Holyoke City	Sorrie, B.	2542	NEBC		20 Jul 1984	Mt. Tom - 25+ plants at head of low slope laced with vernal seeps. Young forest of <i>Acer saccharum</i> , <i>Carya</i> spp., <i>Ostrya</i> , <i>Quercus rubra</i> . No shrub layer. With <i>Hystrix</i> , <i>Viola triloba</i> , <i>Uvularia perfoliata</i> , <i>Carex</i> spp.		<i>Liparis liliifolia</i>

**2. Herbarium Specimens for *Liparis liliifolia* Located at Select Regional Herbaria**

State	County	Township	Primary Collector	Collection Number	Herbarium Acronym	Collection Notes	Collection Date	Label Data	Location Notes	Primary Determination
MA	Hampden	West Springfield	Sorrie, B.	5216	MASS		23 Aug 1990	Low wall of former sandstone quarry off Millville Rd. 35 plants, with <i>Selaginella ruprestris</i> , <i>Polygonum tenue</i> , <i>Juniperus virginiana</i> .		<i>Liparis liliifolia</i>
MA	Hampden	West Springfield	Owen, M.		NEBC	M.L. Owen. Plant cultivated, taken from a wild population.	Jun 1879	Plant brought from West Springfield woods June 1876.		<i>Liparis liliifolia</i>
MA	Hampden	Westfield City	Sorrie, B.	3600	NEBC		29 Aug 1986	East Mtn. - N of Mass. Pike -- 30 plants on thin soil of ledge under <i>Betula lenta</i> , <i>Ostrya virginiana</i> , <i>Celastrus scandens</i> .		<i>Liparis liliifolia</i>
MA	Hampshire	Amherst	Jesup, H.		NHA		2 Jun 1874	Mt. Holyoke.	A fruiting stem also on sheet.	<i>Liparis liliifolia</i>
MA	Hampshire	Amherst	unknown		MASS	Collector not stated on original handwritten label, but may be Dr. C.G. Trow, who donated this specimen A.C. 1870.				<i>Liparis liliifolia</i>
MA	Hampshire	Amherst	unknown		MASS					<i>Liparis liliifolia</i>
MA	Hampshire	Amherst	Clark, B.		MASS		1881	Rich hill sides. Vic. of Amherst.		<i>Liparis liliifolia</i>

**2. Herbarium Specimens for *Liparis liliifolia* Located at Select Regional Herbaria**

State	County	Township	Primary Collector	Collection Number	Herbarium Acronym	Collection Notes	Collection Date	Label Data	Location Notes	Primary Determination
MA	Hampshire	Amherst	Clark, B.	2812	NEBC	Two collections on sheet. This label for upper. Lower by Perkins.	30 Jun 1881	Hillside, near Amherst.		<i>Liparis liliifolia</i>
MA	Hampshire	Amherst	Sorrie, B.	2529	NEBC		19 Jul 1984	Bare Mt. - uncommon and scattered in small colonies on low knolls, in oak-hickory forest.		<i>Liparis liliifolia</i>
MA	Hampshire	Belchertown	Pease, A.	20694	MASS		19 Aug 1930	Shaded roadside.		<i>Liparis liliifolia</i>
MA	Hampshire	Goshen	Churchill, J.		AMES		1905	In bed of a shallow, swampy brook in moss somewhat open situation. Bloomed June 1.		<i>Liparis liliifolia</i>
MA	Hampshire	Goshen	Leavitt, R.		AMES		8 Jun 1905			<i>Liparis liliifolia</i>
MA	Hampshire	Granby	Poland, R.	1160	MASS	Two collections on sheet. This label for lower (#2).	6 May 1947	The Notch.		<i>Liparis liliifolia</i>
MA	Hampshire	Granby	Hunnewell, F.	12115	NEBC		30 May 1931	Woods.		<i>Liparis liliifolia</i>
MA	Hampshire	South Hadley	Pease, A.	19664	MASS		17 Sep 1925	Rocky woods, Bear Mt.		<i>Liparis liliifolia</i>
MA	Hampshire	South Hadley	Perkins, C.		NEBC	Collected in first week of May according to label. Two collections on sheet. This label for lower. Upper by Clark.	May 1880	Brought from S. Hadley Falls in Autumn of 1879 by C.A.P. Fl'd in house May (1st week) 1880.	This specimen is a transplant.	<i>Liparis liliifolia</i>
MA	Hampshire	Williamsburg	St. John, H.	99	NEBC	Two collections on sheet. This label for lower. Upper by Jesup.	17 Jun 1908	Petticoat Hill, Park Williamsburg.		<i>Liparis liliifolia</i>

**2. Herbarium Specimens for *Liparis liliifolia* Located at Select Regional Herbaria**

State	County	Township	Primary Collector	Collection Number	Herbarium Acronym	Collection Notes	Collection Date	Label Data	Location Notes	Primary Determination
MA	Hampshire		Jesup, H.		MASS		20 Jun 1874	Mt. Holyoke.	Town not provided on label.	<i>Liparis liliifolia</i>
MA	Hampshire		unknown		MASS	Ex. Herb. Edward Hitchcock.		[...] not a distinct variety [...] Mt. Holyoke.	Label has been placed on sheet in such a way that some of label data is obscured by specimen. Town and County not provided on label.	<i>Malaxis liliifolia</i>
MA	Hampshire		Jesup, H.		NEBC		Jun 1873	Swamp near Mt. Holyoke.	Town is likely near Amherst.	<i>Liparis liliifolia</i>
MA	Middlesex (ma)	Ashland	Morong, T.		NEBC	Two collections on sheet. This label for left. Right by Eaton.	28 Jun 1878			<i>Liparis liliifolia</i>
MA	Middlesex (ma)	Concord	Eaton, R.		NEBC	Two collections on sheet. This label for right. Left by Morong.	16 Jun 1961	Steep rocky slope, east facing, in deciduous woods in moist sandy leaf mold. Three plants only. [Conantum] near base of cliff rising behind house at 24 Valley Road. (Discovered by Wilber Y. Walworth in 1959).		<i>Liparis liliifolia</i>



**2. Herbarium Specimens for *Liparis liliifolia* Located at Select Regional Herbaria**

State	County	Township	Primary Collector	Collection Number	Herbarium Acronym	Collection Notes	Collection Date	Label Data	Location Notes	Primary Determination
MA	Middlesex (ma)	Lexington	Tryon, R.		NEBC		8 Jul 1971	Appeared spontaneously in open site near <i>Pinus strobus</i> , at 100 Pleasant Street. First observed in flower in 1970. The original plant and offset developed in 1971, no seeds were produced. In Pine Needles.		<i>Liparis liliifolia</i>
MA	Norfolk	Canton	Fuller, T.		NEBC	A black and white photo on page is from 11 May 1895. A flower on sheet from Needham (15 Jun 1885) is from a transplanted individual from the Canton location.	15 Jun 1884	Little Blue Hill.		<i>Liparis liliifolia</i>
MA	Norfolk	Canton	Churchill, J.		GH	Three collections on sheet. This label for upper right. Lower right by Hitchings and left by Hitchings.	9 Sep 1905	Ledges, Great Blue Hill. Blue Hills Reservation.		<i>Liparis liliifolia</i>
MA	Norfolk	Milton	Faxon, C.		VT		15 Jun 1876	Blue Hill.		<i>Liparis liliifolia</i>
MA	Norfolk	Milton	Kidder, N.		NEBC		6 Jul 1894	[Forest nt].	Bracketed word may refer to "Forest St."	<i>Liparis liliifolia</i>

2. Herbarium Specimens for <i>Liparis liliifolia</i> Located at Select Regional Herbaria										
State	County	Township	Primary Collector	Collection Number	Herbarium Acronym	Collection Notes	Collection Date	Label Data	Location Notes	Primary Determination
MA	Norfolk	Milton	Hitchings, E.		GH	Three collections on sheet. This label for lower right. Upper right by Churchill and left by Hitchings.	Jun 1887			<i>Liparis liliifolia</i>
MA	Norfolk	Milton	Hitchings, E.		AMES		11 Jun 1876			<i>Liparis liliifolia</i>
MA	Norfolk	Milton	Williams, E.		NEBC		10 Jun 1900	Blue Hill. Blue Hills Reservation.	Town not provided on label.	<i>Liparis liliifolia</i>
MA	Norfolk	Milton	Hitchings, E.		GH	Three collections on sheet. This label for left. Upper right by Churchill and lower right by Hitchings.	8 Jun 1890			<i>Liparis liliifolia</i>
MA	Norfolk		Hitchings, E.		NEBC		8 Jun 1889	Blue Hills in Readville.	Readville is a village in Boston City, Suffolk County.	<i>Liparis</i>
MA	Worcester	Millbury	unknown		CUW	Ex herbarium of Joseph Jackson, Worcester, MA.	1879			<i>Liparis liliifolia</i>
MA			Goodale, A.		MASS		13 Aug 1931	Prescott. Flora of the Swift River Watershed.	Prescott is likely an historic village flooded by the Quabbin Reservoir. Many occurrences of place names with the word "Prescott" in them are now in New Salem, Franklin County, MA.	<i>Orchis spectabilis</i>

**2. Herbarium Specimens for *Liparis liliifolia* Located at Select Regional Herbaria**

State	County	Township	Primary Collector	Collection Number	Herbarium Acronym	Collection Notes	Collection Date	Label Data	Location Notes	Primary Determination
MA			Goodale, A.		MASS		13 Aug 1931	Prescott. Flora of the Swift River Watershed.	Prescott is likely an historic village flooded by the Quabbin Reservoir. Many occurrences of place names with the word "Prescott" in them are now in New Salem, Franklin County, MA.	<i>Orchis spectabilis</i>
RI	Providence	Glocester	Champlin, R.		NEBC		29 Jun 1967	With <i>Uvularia perfoliata</i> , under maples, hickories. Brook south of Keech Hill.		<i>Liparis liliifolia</i>
RI	Providence	Lincoln	Collins, J.		NEBC		7 Jul 1928	Woods.		<i>Liparis liliifolia</i>
CT	Fairfield	Bridgeport	Eames, E.		VT	Two collections on sheet. This label for lower (flowering and vegetative).	12 Jun 1894			<i>Liparis liliifolia</i>
CT	Fairfield	Greenwich	Cushman, J.	1051	NEBC		7 Jul 1907	Rocky wooded slopes.		<i>Liparis liliifolia</i>
CT	Fairfield	Greenwich	Cushman, J.	1051	NEBC		7 Jul 1907	Rocky wooded slopes.		<i>Liparis liliifolia</i>
CT	Fairfield	Monroe)	Eames, E.	8515	NEBC		18 Jun 1911	Moist rocky bank.		<i>Liparis liliifolia</i>
CT	Fairfield	Trumbull	Eames, E.		GH		7 Jun 1897	Shrubby bank.		<i>Liparis liliifolia</i>
CT	Hartford	Southington	Bissell, C.	580	NEBC	Two collections on sheet. This label for right. Left by Weatherby.	18 Jul 1893	Moist thickets. Rare.		<i>Liparis liliifolia</i>

**2. Herbarium Specimens for *Liparis liliifolia* Located at Select Regional Herbaria**

State	County	Township	Primary Collector	Collection Number	Herbarium Acronym	Collection Notes	Collection Date	Label Data	Location Notes	Primary Determination
CT	Hartford	West Hartford	Weatherby, C.		NEBC	Two collections on sheet. This label for left. Right by Bissell.	4 Jul 1896	Conn Reservoirs.		<i>Liparis liliifolia</i>
CT	Hartford	Windsor	Winslow, E.		NEBC		17 Jun 1911			<i>Liparis liliifolia</i>
CT	Litchfield	Woodbury	Blewitt, A.	618	NEBC		23 Jun 1911	In dry trap woods.		<i>Liparis liliifolia</i>
CT	Middlesex (ct)	Killingworth	Hall, F.	56	NEBC		23 Aug 1876			<i>Liparis liliifolia</i>
CT	New Haven	Hampden	Blewitt, A.	575	NEBC	Two collections on sheet. This label for right. Left by Allen.	16 Jun 1911	Mt. Carmel.		<i>Liparis liliifolia</i>
CT	New Haven	Milford	unknown		AMES	Collector is Miss [In]ez Winkler.	17 Jun 1934	Devon (Milford). Rocky + sandy soil in shade of trees.		<i>Liparis liliifolia</i>
CT	New Haven	Naugatuck	Blewitt, A.	4510	NEBC		26 Jun 1916	Moist woodland path, Beacon Hill.		<i>Liparis liliifolia</i>
CT	New Haven	New Haven City	unknown	18-1	GH	Collections on sheet also from MA and NY (without any additional label information).				<i>Liparis liliifolia</i>
CT	New Haven	New Haven City	Allen, J.		NEBC	Two collections on sheet. This label for left. Right by Blewitt.	6 Jul 1878			<i>Liparis liliifolia</i>
CT	New Haven	Orange	Eames, E.		VT	Two collections on sheet. This label for upper (fruiting).	28 Sep 1893			<i>Liparis liliifolia</i>
CT	New Haven	Oxford	Harger, E.	4765	NEBC		17 Jun 1905	Dry woods.		<i>Liparis liliifolia</i>
CT	New Haven	Southbury	Denslow, H.		GH	B.J. Buck.	20 Jun 1940			<i>Liparis liliifolia</i>
CT	New London	Franklin (ct)	Woodward, R.		NEBC		19 Jun 1905	Dry rocky woods.		<i>Liparis liliifolia</i>
CT	New London	Norwich (ct)	Mitchell, L.		NEBC		17 Jul 1867			<i>Liparis liliifolia</i>

**2. Herbarium Specimens for *Liparis liliifolia* Located at Select Regional Herbaria**

<b>State</b>	<b>County</b>	<b>Township</b>	<b>Primary Collector</b>	<b>Collection Number</b>	<b>Herbarium Acronym</b>	<b>Collection Notes</b>	<b>Collection Date</b>	<b>Label Data</b>	<b>Location Notes</b>	<b>Primary Determination</b>
CT	Tolland	Somers	Pease, A.	379	NEBC	Cultivated plant.	22 Jun 1902	Cult. at Andover, Mass. Plant brought from Somers, Ct., where collected by A.S.P.		<i>Liparis liliifolia</i>
CT	Windham (ct)	Killingly	Weatherby, C.	5388	NEBC		8 Jun 1925	Thin soil on margin of ledge, in shade.		<i>Liparis liliifolia</i>

### 3. 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 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.