

*Conservation Assessment*  
*for*  
*Small-flowered Woodrush (*Luzula parviflora* (Ehrh.) Desv.)*



PLANTS Database 2001

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*This document is undergoing peer review, comments welcome*

This Conservation Assessment/Approach was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation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

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## EXECUTIVE SUMMARY

*Luzula parviflora* (Ehrh.) Desv. (small-flowered woodrush) is designated as a Regional Forester Sensitive Species on the Hiawatha National Forest (Michigan) in the Eastern Region of the Forest Service. The species occurrence is documented but not listed on the Superior National Forest in Minnesota and Green Mountain National Forest in Vermont. The purpose of this document is to provide the background information necessary to prepare a Conservation Approach, the latter which will include management actions to conserve the species.

*Luzula parviflora* is circumboreal; occurring in Eurasia, Greenland, Canada and the United States. Its range in the United States includes Alaska; portions of the Rocky Mountains, the Cascade Mountains, and northern Appalachian Mountains; and areas close to Lake Superior in Michigan and Minnesota. *L. parviflora* is found in usually wet or damp soil that may be rocky or gravelly. In the contiguous United States, the species usually occurs in montane forests (Clemants, 1990; Weatherbee, 1996; Cronquist *et al.* 1998; Magee and Ahles, 1999; Vermont Nongame and Natural Heritage Program [VNNHP], 2002). In contrast, in Michigan and Minnesota it occurs primarily in low altitude forests (Michigan Natural Features Inventory [MNFI], 2002; Minnesota Heritage and Nongame Research Program, 2002). In the eastern United States (MA, ME, MI, MN, NH, NY, VT), *L. parviflora* often occurs near forest openings or along stream banks, trails, or lakeshores (Weatherbee, 1996; MNFI, 2002; VNNHP, 2001; Appendix). *L. parviflora* also occurs in open habitats such as tundra, meadows, bogs, thickets and heathlands (Welsh, 1974; Swab, 2000).

Like other woodrushes, *L. parviflora* has a grass-like aspect, three seeds per capsule, and perfect flowers with six small tepals. It can be distinguished from other *Luzula* species by flowers that are usually solitary (rarely in small clusters), a decomposed inflorescence, tepals that are straw-colored, brown, or black, and an inconspicuous or absent appendage on the seed (Gleason and Cronquist, 1991; Swab, 2000). *L. parviflora* reproduces vegetatively with rhizomes and by seed. Evidence suggests that the species has a persistent seed bank that may allow the species to endure after even severe disturbances (McGraw *et al.* 1991; del Moral *et al.* 1995). Although seeds are dormant immediately after dispersal, a portion of seeds germinate after a ripening period (Bell and Amen, 1970).

Although *L. parviflora* is widespread and common in areas of its range, it is rare in parts of the eastern United States. Natural heritage programs have listed it as Endangered in Massachusetts, Threatened in Michigan, Rare in Vermont, and Special Concern in Minnesota. *L. parviflora* may be rare in these areas naturally as it is at the southern edge of its range. Potential threats to populations include small population sizes; global warming; and human disturbances such as logging, dredging a creek, and ski hill expansion.

## ACKNOWLEDGEMENTS

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**Herbarium and Heritage Data** – We appreciate the sharing of occurrence information for this species from Heritage personnel both in the United States and Canada, along with the helpful assistance of Herbarium personnel. See Contacts section at end of report for a complete list.

### **Editorial Committee**

- We thank Jan Schultz, of the Hiawatha National Forest, for her suggestions and patience through numerous revisions.
- Also appreciated was the editorial assistance of the following contract employees working with the Hiawatha National Forest: Beverly Braden, contract botanist.

### **Literature Search**

- We thank Laura Hutchinson of the North Central Research Library for performing initial species inquiries and sending us relevant research articles.
- We thank Jan Schultz, of the Hiawatha National Forest, for use of her extensive library of materials to begin to compile information on this species.
- We thank Beverly Braden, a contract botanist, for additional literature searches at Northern Michigan University in Marquette, Michigan State University in East Lansing, and the University of Michigan in Ann Arbor.
- We also thank Ramona Shackleford, a contract botanist, for additional literature searches at the University of Wisconsin at Madison.

## NOMENCLATURE AND TAXONOMY

The Juncaceae family consists of only two genera in North America, the *Luzula* (woodrush) genus and the *Juncus* (rush) genus (Brooks & Clemants 2000). *L. parviflora* (Ehrh.) Desv (small-flowered woodrush) is further categorized into the subgenus *Anthelaea* (Grisebach) Buchenau (Table 1).

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**Table 1.** Current taxonomic placement and nomenclature of *Luzula parviflora* (Swab, 2000).

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<b>Family:</b>	Juncaceae Jussieu
<b>Genus:</b>	<i>Luzula</i> de Candolle
<b>Subgenus:</b>	<i>Anthelaea</i> (Grisebach) Buchenau
<b>Scientific name:</b>	<i>Luzula parviflora</i> (Ehrhart) Desvauz
<b>Common name:</b>	Small-flowered woodrush
<b>USDA Symbol:</b>	LUPA4 (PLANTS, 2001)
<b>Synonymy:</b>	<i>Juncus parviflorus</i> Ehrhart <i>Luzula parviflora</i> (Ehrhart) Desvauz var. <i>fastigiata</i> (Mey.) Buch var. <i>melanocarpa</i> (Michx.) Buch. var. <i>parviflora</i> ssp. <i>fastigiata</i> (Mey.) Hämet-Ahti ssp. <i>melanocarpa</i> (Michx.) Hämet-Ahti ssp. <i>parviflora</i>

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Physical characters vary in *Luzula parviflora* to such a degree that many authorities recognize varieties or subspecies (Table 2). Characters such as stem height; color of leaves, perianths, seeds, and capsules; and size of inflorescences tend to differ between specimens of the different intraspecific taxa. *L. parviflora* (Ehrh.) Desv. var. *melanocarpa* (Michx.) Buch. or *L. parviflora* (Ehrh.) Desv. ssp. *melanocarpa* (Michx.) Hämet-Ahti is often recognized predominantly in eastern North America, while two other intraspecific epithets (*fastigiata* and *parviflora*) are often used to distinguish plants in western North America (Table 2). The Integrated Taxonomic Information System (ITIS) (2001) and PLANTS Database (2001) recognize *L. fastigiata* E. Mey. as a distinct species. ITIS also recognizes *L. parviflora* (Ehrh.) Desv. ssp. *parviflora*. The Flora of North America (Swab 2000) does not recognize varieties, subspecies, or *L. fastigiata* as a distinct species. Consequently, this conservation assessment does not formally distinguish the described varieties or subspecies of *L. parviflora* (Ehrh.) Desv.

**Table 2.** Recognized name of *L. parviflora* (Ehrh.)Desv. in literature by the given authors.

Species name given by source	Sources
<i>L. parviflora</i> (Ehrh.)Desv. (no varieties or subspecies mentioned; <i>L. fastigiata</i> is included in species)	Hitchcock, <i>et al.</i> 1969; Voss, 1972; Welsh, 1974; Cronquist <i>et al.</i> 1977; Great Plains Flora Ass. 1986; Budd, 1987; Swab, 2000; Michigan Natural Features Inventory, 2001.
<i>L. parviflora</i> Ehrh.)Desv. var. <i>fastigiata</i> (Mey.) Buch var. <i>melanocarpa</i> (Michx.)Buch. var. <i>parviflora</i> (any or all the above varieties mentioned)	Hultén, 1968; Roland and Smith, 1983; Clemants, 1990; Ownbey and Morley, 1991; Gleason and Cronquist, 1991; Swab, 1993.
<i>L. parviflora</i> (Ehrh.)Desv. ssp. <i>fastigiata</i> (Mey.)L. Hämet-Ahti ssp. <i>melanocarpa</i> (Michx.)Hämet-Ahti ssp. <i>parviflora</i> (any or all of the above subspecies mentioned)	Hultén, 1968; Hämet-Ahti, 1971; Scoggan, 1974; Moss, 1983; Hinds, 1986; Kartesz, 1994; Cody 1996; Weatherbee, 1996; Magee and Ahles, 1999; Minnesota Heritage and Nongame Research Program, 2002; Massachusetts Natural Heritage and Endangered Species Program, 2001, ITIS, 2001.
<i>L. fastigiata</i> E. Mey. <i>L. parviflora</i> (Ehrh.)Desv.	ITIS, 2001; Plants database 2001; Ceska and Kirschner, 2001.

## DESCRIPTION OF SPECIES

Table 3 displays details of technical characteristics of *L. parviflora* throughout North America. Superficially, *Juncus* species may be confused with *Luzula* species as both genera have six persistent tepals, superior ovaries with three stigmas, loculicidal capsules, and a grass-like appearance. *Juncus* species, however, have more than three seeds per capsule, no hairs along the leaf margins or at the throat of sheaths, and open sheaths (Brooks & Clemants 2000).

*L. parviflora* is the only native *Luzula* species in the eastern North America within the subgenus *Anthelaea* (Swab, 2000). *L. luzuloides*, however, is a species within *Anthelaea* that has been introduced from Europe. Distinguishing characters of this subgenus include solitary or small clusters of flowers, decompound inflorescences, and an inconspicuous or absent appendage on the seed (Fig 1.). These two species can be easily distinguished from one another by the color of their tepals. *L. luzuloides* has pink or white tepals, while *L. parviflora* has tepals varying from straw-colored to brown or black (Swab, 2000). *L. acuminata* (subgenus *Pterodes*), like *L. parviflora*, has solitary flowers; but it has a simple inflorescence, and a conspicuous appendage on the seed. Other species of *Luzula* in eastern North America are part of the subgenus *Luzula*. Unlike *L. parviflora*, species of this subgenus have flowers in dense clusters (Swab, 2000). *L. parviflora*, in addition,

tends to be taller than other *Luzula* species in eastern North America (Gleason and Cronquist, 1991; Judziewicz, 1995).

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**Table 3.** Technical characteristics of *Luzula parviflora* (Ehrh.) Desv. throughout North America. References for descriptions: Hämet-Ahti, 1971; Roland and Smith, 1983; Hinds, 1986; Clemants, 1990; Gleason and Cronquist, 1991; Swab, 2000.

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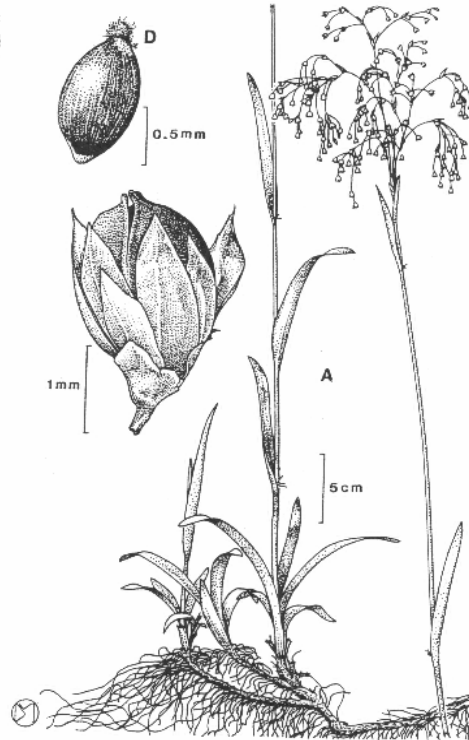
<b>Culms:</b>	Perennial, usually clustered culms connected by stolons or rhizomes; 3 dm to 12 dm tall.
<b>Leaves:</b>	Flat, usually glabrous, sometimes ciliate along margins; 4-13 mm broad, 3-29 cm long; hairs along throat of sheath; open sheaths; acute to acuminate apex; 2-6 cauline leaves, 4-8 basal leaves.
<b>Inflorescence:</b>	Cymose; 4-20 cm long, 3-12 cm broad; branches that are long, slender, and arching; flowers terminal and usually solitary (rarely paired). <b>Tepals:</b> Six tepals (2 whorls of 3); persistent during fruiting; 1.5-2.5 mm long; apex acute or mucronulate; lanceolate to ovate; margins can be scarious. <b>Stamen:</b> Six; anthers slightly shorter or longer than filaments. <b>Fruit:</b> Three seeded capsule; equal with to distinctly exerting perianth; ovoid to ellipsoid; 1.6-2.7 mm; apex acute or mucronate; beak absent or up to 0.5 mm; straw-colored to pale, dark, or purplish brown, to black. <b>Seeds:</b> No appendages; "tuft of hairs at placental end" (Gleason and Cronquist, 1991); 1.0 - 1.5 mm long; ellipsoid.
<b>Chromosome:</b>	2n=24, [2n = 22, 24, 36 (Moss, 1983); 2n = 24, 22 (Swab, 1993)]

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### Characteristics specific to *L. parviflora* in eastern North America

Hämet-Ahti (1971) distinguished *Luzula parviflora* plants in eastern North America (as far west as Minnesota) from those of western North America. Although the subspecies recognized in eastern North America (*L. parviflora* ssp. *melanocarpa*) is not recognized in this document, the characteristics that distinguish the eastern plants are useful. In general, eastern plants are taller than western plants and occasionally they have a reddish tinge at the stem base (which is more prominent in western plants) (Hämet-Ahti, 1971). The inflorescence is few flowered with long branchlets. Leaves of the eastern plants are described as "bluish to grayish green, dull, broadly lanceolate" (Hämet-Ahti, 1971) and are in general wider than leaves of the western plants. Tepals of the eastern plants vary from brown to pale brown, are nearly translucent, and have a faint middle nerve. Capsules tend to be dark brown shades and are distinctly longer than the tepals. Seeds are dark brown (Hämet-Ahti, 1971).





**Fig. 1.** *Luzula parviflora* (Ehrh.) Desv.

From "Juncaceae" by Clemants, 1990.

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### **Chromosomes and speciation**

*Luzula* species are believed to have a unique speciation history. Like most genera of Cyperaceae and Juncaceae, *Luzula* species have a wide range of chromosome numbers and polyploidy (Ebinger, 1964; Briggs and Walter, 1997). Species of these families have unusual (diffuse) centromeres that result in a different orientation of chromosomes during cell division than most living things. These centromeres allow cells to be viable even if chromosomes fragment. Chromosomes in *Luzula* species tend to be smaller in species that have greater polyploidy (Nordenskiöld, 1951; cited in Ebinger, 1964; Briggs and Walter, 1997). In addition, Mukherjee *et al.* (1993) found that the total DNA content of eight *Luzula* species that have a wide range of chromosome numbers does not differ greatly. Such evidence suggests that speciation may be associated with fragmentation of the chromosomes. Most other polyploid species are believed to have speciated by chromosomal duplication or hybridization (Mukherjee *et al.* 1993; Briggs and Walter, 1997).

Research suggests that subgenus *Anthelaea* is oldest of the three *Luzula* subgenera, by the fact that many of the species of *Anthelaea* are diploid or have lower chromosomal numbers (Ebinger, 1964). The simplistic inflorescences and a more restricted range of this subgenus compared to the other subgenera are other indications that *Anthelaea* is the oldest subgenus (Ebinger, 1964).

## LIFE HISTORY

### Reproduction

*L. parviflora* is a self-compatible (Keighery, 1985; Bennington *et al.* 1991) perennial with perfect flowers (Gleason and Cronquist, 1991; Swab, 2000). Flowers and fruits are produced from spring to late summer (Gleason and Cronquist, 1991; Swab, 2000) and flowers are wind-pollinated (Cronquist, 1988). Bell and Amen (1970) determined that *L. parviflora* seeds are temporarily dormant after dispersal and do not readily germinate unless the inhibitor system is removed by scarification of the micropyle (after scarification 66% germination was obtained). After storing seeds at room temperature for eight months, 36% of seeds germinated in the lab without scarification (Bell and Amen, 1970), while 100% germinated after micropyle scarification. *L. parviflora* also reproduces asexually through vegetative growth of rhizomes and culms (Gleason and Cronquist, 1991; Swab, 2000). Hämet-ahti (1971) did not find evidence of hybridization between *L. parviflora* and other *Luzula* species in the eastern United States.

### Ecology

A few studies have revealed that viable seeds from *Luzula* species may persist in seed banks for decades or even centuries (Bakker *et al.* 1996; Hendry *et al.* 1995; Granström, 1981). At Eagle Summit, Alaska, McGraw *et al.* (1991) sampled a buried seed bank along a "time transect." Given the geography of the location, McGraw expected the age of seeds would increase with distance along the transect. Germination assays were performed for 12 intervals along the transect. Most species that germinated were only present in the first 3 soil intervals (the youngest intervals), while *L. parviflora* was found in 9 of the first 10 intervals. Seeds that germinated from the 10th interval were estimated to be approximately 197±80 years old by radiocarbon dating of seed coats. Seeds from only one species (*Carex bigelowii*) germinated in the intervals beyond the 10th interval. The study by McGraw *et al.* (1991) suggests that a portion of *L. parviflora* seeds may maintain their dormancy each year and become part of a persistent seed pool.

Species that have persistent seed pools often occur in unpredictable habitats (Barbour *et al.* 1987). As conditions suddenly improve, seeds germinate. Perennial herbs that have a persistent seed pools are often found in later successional communities (Barbour *et al.* 1987). Persistent seed banks may have genetic variability not present in the current population. Such variability may allow a species to adapt to a greater variety of conditions. Bennington *et al.* (1991) in an extension of the study by McGraw *et al.* (1991) in Eagle Summit, Alaska, found some evidence that *L. parviflora* plants grown from old seed banks are genetically unique compared to the plants grown from younger seed banks.

A study of plant communities on the Pumice Plain of Mount St. Helens by del Moral *et al.* (1995) demonstrates the capacity of *L. parviflora* to respond to severe disturbance. *L. parviflora* is a "relict species" of Mount St. Helens as it occurred in forested areas on the volcano prior to the eruption in 1981 (del Moral *et al.* 1995). Areas on Mount St. Helens

described as "refugia" were extremely disturbed with no surviving trees, although "some soil, seeds, buried plant organs or, possibly, stems" (del Moral *et al.* 1995) survived the eruption. Eleven years after the eruption, *L. parviflora* had a mean percent cover in refugia of 160% and only four other species were found as frequently as *L. parviflora* in refugia (del Moral *et al.* 1995); two of these species invaded the habitat after the eruption. The successful re-establishment of *L. parviflora* in refugia may be related to its persistent seed banks.

The study at Mount St. Helens also indicates that *L. parviflora* has the capacity to establish in harsh habitats. The volcano's eruption eliminated all vegetation from areas described as "barren." *L. parviflora* was one of the most notable relict species that established in these barren areas 11 years after the eruption (del Moral *et al.* 1995).

### **Dispersal/Migration**

*L. parviflora* may have no specialized method to disperse seeds. The seed is not adapted to wind dispersal or attaching to animals. Many herbs of temperate forests, including a few documented *Luzula* species, are dispersed by ants (Handel 1978, Gaddy 1986). Most seeds that are dispersed by ants have a "caruncle" that ants consume after they move the seeds (Handel 1978). Except for a tuft of hairs, seeds of *L. parviflora* have no appendage or caruncle, and are therefore probably not attractive to ants. In the study by del Moral *et al.* (1995) describing plant communities on Mount St. Helens, *L. parviflora* seeds must have dispersed from refugia into barren areas since barren areas were devoid of plant material after the volcano's eruption. The plants were confined to barrens that were within 20 meters of the refugia 11 years after the volcano.

Most pollen from wind-pollinated herbs disperses to nearby plants. With distance from the pollen source, pollination decreases rapidly (Levin and Kerster, 1974). Recent studies of outcrossing plants in open areas indicate that a small fraction of pollen may potentially pollinate plants over 200 meters from a given source (Rognli *et al.*, 2000; Luna V. *et al.* 2001). Evidence suggests that forest herbs have lower dispersal than herbs in open habitats. In an experiment of ragweed pollen dispersed into a forest, data suggested that only 10% of pollen would still be airborne 100 meters from the source (Raynor, 1967; cited in Levin and Kerster, 1974).

### **HABITAT**

#### **Range-wide**

*L. parviflora* is usually found in wet or damp soil that may be rocky or gravelly. In the contiguous United States, the species usually occurs in montane forests (Table 4; Clemants, 1990; Weatherbee, 1996; Cronquist *et al.* 1998; Magee and Ahles, 1999; VNNHP, 2002). In Michigan and Minnesota, however, it occurs primarily in low altitude forests near Lake Superior (Table 4; MNFI, 2002; Minnesota Heritage and Nongame Research Program, 2002). In the eastern United States (MA, ME, MI, MN, NH, NY and VT), *L. parviflora* often occurs near forest openings or along stream banks, trails, or lakeshores (Weatherbee, 1996; MNFI, 2002; VNNHP, 2001; Appendix). *L. parviflora*

also occurs in open habitats such as tundra, meadows, bogs, thickets and heathlands primarily north of the contiguous U.S. (Welsh, 1974; Swab, 2000).

Other than one population that is 20 miles from Lake Superior, populations of *L. parviflora* in Michigan and Minnesota are within seven miles of the Lake. The proximity of these Midwestern occurrences to Lake Superior suggests that *L. parviflora* is dependent on the cooler summer temperatures found near the Lake or possibly a combination of other lake effect conditions. Such conditions may be similar to the alpine habitat that the species is typically found in the contiguous U.S. The occurrence of arctic or alpine flora occurring disjunct from their primary distributions in the Lake Superior drainage basin is not unusual. Given and Soper (1981) documented 48 plant species from arctic or alpine habitats that occur in the Lake Superior drainage basin.

**Table 4.** Habitat descriptions quoted primarily from technical manuals rangewide and from North America.

**Range wide**

Arctic	"Inhabits damp, sheltered situations including thickets and grassy slopes" (Polunin, 1959).
Eurasia	"At the forest limit in the tundra and in the alpine zone" (Komarov & Shishkin, 1935). "Tundra, damp grassland and wood-margins " (Tutin <i>et al.</i> 1980).
Norway	"Humid mountains... moss-lichen heath, alpine mire, flushed snowbed meadow, low <i>Salix</i> scrub and birch wood..." on acidic soil (Skogen, 1981).

**North America**

"Meadows in temperate to subalpine boreal forest. Wet grasslands and tundra, willow copses, herb slopes; 0-3300 m" (Swab, 2000).

**a) Canada** "Damp woods, thickets, slopes" (Scoggan, 1978).

<u>Canadian prairie:</u>	"Infertile soil, open forests; Boreal forest, Rocky Mountains" (Budd, 1987).
<u>Alberta:</u>	"Moist forests and marshy areas" (Moss, 1983).
<u>British Columbia:</u>	"Dry to moist meadows, shrubby slopes and streambanks in montane and subalpine zones; frequent in mountains" (Ceska & Kirschner 2001).
<u>Manitoba:</u>	"Damp to wet clearings and woods throughout the northern four fifths of province" (Scoggan, 1957).
<u>New Brunswick:</u>	"Damp coniferous or mixed woods, cool ravines and banks" (Hinds, 1986).
<u>Nova Scotia:</u>	"Scattered in intervale forests, along rocky stream-banks..." (Roland & Smith 1983).

**Table 4.** Habitat descriptions quoted primarily from technical manuals rangewide and from North America.

<u>Yukon:</u>	"Open woods, willow thickets, sheltered ravines, herb-mat slopes" (Cody, 1996).
<b>b.) United States</b>	
<u>Alaska:</u>	"Moist places in forest and tundra" (Hultén, 1968). "Lake shores, streambanks, bogs, thickets, meadows and open woods, in tundra, heathlands, and forests" (Welsh, 1974).
<u>California:</u>	"Moist places in coniferous woodlands at 1000-3300 m" (Swab, 1993).
Eastern U.S.	"Moist or wet, wooded or open, often rocky places" (Gleason and Cronquist, 1991).
<u>Intermountain Region:</u>	"Along streams and in woodlands at middle and upper-middle altitudes in the mountains, not extending above timberline" (Cronquist <i>et al.</i> 1998).
<u>Michigan:</u>	"Moist somewhat open woods, sheltered gravelly shores" (Voss, 1972). Eight of the nine populations are on islands in Lake Superior. The single mainland population is within five miles of Lake Superior (MNFI 2002).
<u>Minnesota:</u>	"Rocky, wooded stream banks in the coniferous forest region..." conditions near Lake Superior may be most suitable (Coffin and Pfanmuller, 1988). Occurrences are within seven miles of Lake Superior, with the exception of one population that is 20 miles from the Lake.
<u>New England:</u>	"Mountains, in thickets and in the open" (Magee and Ahles, 1999).
<u>New York:</u>	"Cool, montane woods" (Clemants, 1990).
<u>Massachusetts</u> :	"Rare. In moist spruce-fir forest above 2800' ... often in openings along trails" (Weatherbee, 1996). See Appendix for a detailed description.
<u>Pacific Northwest:</u>	"Moist to fairly dry areas, coastal rain-forest to alpine slopes" (Hitchcock <i>et al.</i> 1969).
<u>South Dakota:</u>	"In montane forests" (Great Plains Flora Assoc., 1986).

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**Table 4.** Habitat descriptions quoted primarily from technical manuals rangewide and from North America.

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Vermont: Vermont Nongame and Natural Heritage Program (VNNHP, 2001) has habitat descriptions for 13 of the 21 known populations. The elevation of populations range from 2300 feet to 4020 feet, with most located higher than 3500 feet. Nine of the descriptions mention that populations are in forested areas, eight mention the forest consists of a combination of *Picea rubens* (red spruce), *Abies balsamea* (balsam fir) or *Betula papyrifera* (paper birch). Eight of the populations are located along trails and forest openings. (VNNHP, 2001; Green Mountain National Forest, 2002; see Appendix)

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### **National Forests**

Superior National Forest, Minnesota: This National Forest contains 10 of the 13 known populations in Minnesota. Eight populations are located in white cedar swamps or in a transition zone between conifer swamps of *Thuja occidentalis* (white cedar), *Picea mariana* (black spruce), and *Abies balsamea* (balsam fir) and upland forests of *Betula papyrifera* (paper birch), *Populus tremuloides* (quaking aspen), and *Picea glauca* (white spruce) (Minnesota Heritage and Nongame Research Program, 2002; Appendix). The other two populations are near lake shores. Four populations are in at least partially disturbed areas; two are along trails and two are near a clear-cut (Minnesota Heritage and Nongame Research Program, 2002; Appendix).

Associated species listed in at least two populations (number of occurrences):

Herbs: *Carex* spp. (5), *Clintonia borealis* (4), *Coptis groenlandica* (3), *Cornus canadensis* (7), *Dryopteris carthusiana* (5), *Gymnocarpium dryopteris* (2), *Linnaea borealis* (3), *Lycopodium annotinum* (3), *Maianthemum canadensis* (2), *Oxalis montana* (2), *Rubus pubescens* (6), *Sphagnum* spp. (5), *Thelypteris phegopteris* (2). Shrubs: *Acer spicatum* (2), *Alnus rugosa* (3), *Rubus* spp. (2), *Ribes* spp. (2), *Sorbus* spp. (2).

Hiawatha National Forest, Michigan: A single population was discovered in 1994. Habitat was described as “mesic northern forest with hardwood-conifer swamp, along creek” (MNFI, 2002).

Associated species: *Prunus serotina*, *Bromus inermis*, *Cirsium palustre*, *Viola* spp, *Epilobium* spp, *Carex intumescens* (MNFI, 2002; Appendix).

Green Mountain National Forest, Vermont: Of the nine populations occurring on this National Forest, three have not been located since before 1940 (VNNHP, 2001; Green Mountain National Forest, 2002; Appendix). The six extant populations are located in mid to high altitude forests consisting of a combination of *Abies balsamea*, *Picea rubens*, and *Betula papyrifera*. Two populations are located in moist or wet soil. Portions of five populations are located along trails (VNNHP, 2001; Appendix).

## National Parks

Isle Royale National Park, Michigan: Isle Royale National Park has eight populations of *L. parviflora* recognized by the Michigan Natural Features Inventory (MNFI). A few of these populations consist of multiple "sub-populations" that are scattered in different habitats. Seven populations occur in forests (four of which are dominated by *Abies balsamea*). Five populations occur along forested trails, one near a cabin, and one at the edge of a pond. Two occur in meadows and one occurs on a gravelly beach. Three populations occur on smaller islands near Isle Royale (MNFI, 2002).

Associated species (listed at least once):

Herbs: *Aster macrophyllus*, *Caltha palustris*, *Carex rugosperma*, *Carex trisperma*, *Chimaphila umbellata*, *Clintonia borealis*, *Coptis trifolia* [*C. groenlandica*], *Cornus canadensis*, *Dryopteris expansa*, *Dryopteris fragrans*, *Gymnocarpium dryopteris*, *Linnaea borealis*, *Lycopodium* spp., *Maianthemum canadense*, *Oplopanax horridus*, *Rubus parviflorus*, *Streptopus roseus*, *Symplocarpus foetidus*, *Taraxacum officinale*.  
Shrubs: *Juniperus communis*, *Diervilla lonicera* (MNFI, 2002; Appendix).

## DISTRIBUTION

### Range-wide Distribution

*L. parviflora* is a circumboreal species occurring primarily in northern latitudes of Asia, Europe and North America. *L. parviflora* is known to occur in the following locations:

**Asia**: Mongolia; Russian Federation (GRIN, 2002).

**Europe**: Finland; Norway; Russian Federation; Sweden (GRIN, 2002).

**North America**: Greenland; St. Pierre and Miquelon;

**Canada** (Alberta, British Columbia, Labrador, Manitoba, New Brunswick, Newfoundland Island, Northwest Territories, Nova Scotia, Nunavut, Ontario, Quebec, Saskatchewan, Yukon Territory);

**United States** (Alaska, Arizona, California, Colorado, Idaho, Maine, Massachusetts, Michigan, Minnesota, Montana, Nevada, New Hampshire, New Mexico, New York, Oregon, South Dakota, Utah, Vermont, Washington, Wyoming). (Swab, 2000<sup>\*</sup>)

### Region-wide Distribution

In the Eastern Region of the USDA Forest Service, *L. parviflora* occurs in northern New England (MA, ME, NH, VT), eastern New York, and near Lake Superior in Minnesota and Michigan (Coffin and Pfanmuller, 1988; Clemants, 1990; Chadde, 1999; Magee and

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<sup>\*</sup> Swab (2000) includes Wisconsin in the range of *L. parviflora*. Wisconsin State Herbarium (2002), however, indicates that *L. parviflora* does not occur in Wisconsin.

Ahles, 1999). In Michigan it occurs in Isle Royale National Park and a single population occurs on the Hiawatha National Forest in the Upper Peninsula.

## RANGEWIDE STATUS AND ABUNDANCE

### The Nature Conservancy's Ranking

Rangewide status can be assessed by a ranking system developed by The Nature Conservancy, NatureServe, and the Natural Heritage Network (NatureServe Explorer, 2001). This ranking system uses information on species that are tracked by The Nature Conservancy and Natural Heritage Programs throughout the world. The global ranking (G-rank) gives the status of a species throughout its range. Each country where the species occurs has a national ranking (N-rank) that indicates the species vulnerability within that country. If the species occurs within the boundaries of provinces, states, or other divisions within a country, the species is given a subnational ranking (S-rank) for that area (NatureServe Explorer, 2001).

The number or letter following G, N, or S is the ranking of current vulnerability of the species within the given geographical boundary (Nature Serve Explorer, 2001). Numeral ratings range from 1 to 5. The more vulnerable a species is to extirpation within the given geographical boundary, the lower the numeral rating. If a letter or punctuation follows the G, N, or S, the current status has not been determined; the letter indicates what is known about the species (Nature Serve Explorer, 2001).

**Table 5.** Subnational rank (S) of *L. parviflora* by states in which it occurs as listed by NatureServe (2001). Western states are those states west of Minnesota. (S1=Critically imperiled, S2=Imperiled, S4=Apparently secure, SR=Reported, SU=Unrankable, S?=Unranked).

Western U.S. State (west of Minnesota)	S-Rank	Eastern U.S. State	S-Rank	State Status
Alaska	SR	Maine	SR	
Arizona	SR	Massachusetts	S?	Endangered
California	SR	Michigan	S1	Threatened
Colorado	SR	Minnesota	SR	Special concern
Idaho	SR	New York	S4	
Montana	SR	New Hampshire	SR	
Nevada	SR	Vermont	S2	Rare
New Mexico	SR			
Oregon	SR			
South Dakota	SU			
Utah	SR			
Washington	SR			
Wyoming	S4			



**Table 6.** Subnational rank (S) of *L. parviflora* in provinces of Canada where it occurs as listed by NatureServe (2001). (S2S3=Imperiled to Vulnerable, S3S5=Vulnerable to Secure, S5=Secure, SR=Reported, S?=Unranked).

Western Canada Province (west of Minnesota)	Subnational Rank	Eastern Canada Province	Subnational Rank
Alberta	S5	Labrador	S3S5
British Columbia	SR	New Brunswick	SR
Manitoba	S5	Newfoundland Island	S3S5
Northwest Territories	SR	Nova Scotia	S2S3
Nunavut	SR	Ontario	S5
Saskatchewan	S?	Quebec	SR
Yukon	SR		

The global ranking for *L. parviflora* is "G5" or "secure" throughout most of its range (Nature Serve Explorer, 2001). The national rank in the United States is "N?" (01 Aug 1993) indicating that it has not been ranked. The status of *L. parviflora* is "reported" (SR), "unranked" (S?) or "unrankable" (SU) in 16 of the 20 U.S. states that it occurs (Table 5). New York and Wyoming ranked the species as "apparently secure" (S4). In Michigan the species is ranked as "critically imperiled" (S1), while in Vermont it is "imperiled" (S2) (NatureServe Explorer, 2001).

In Canada, the National Heritage Status Rank of *L. parviflora* is unranked N? (09 Aug 1993). *L. parviflora* is "reported" (SR) or "unranked" (S?) in seven of the 13 Canadian provinces that it occurs (Table 6). The status is "secure" (S5) in Alberta, Manitoba, and Ontario. *L. parviflora* has a range rank between "vulnerable" and "secure" in Labrador and Newfoundland Island, while the status is between "imperiled" and "vulnerable" in Nova Scotia (Table 6).

### Ranking by States and the U.S. Forest Service

*L. parviflora* is listed as Endangered in Massachusetts with only one known element occurrence (Massachusetts - NHESP, 2002), while it is listed as Threatened in Michigan with nine occurrences (MNFI, 2002). In Minnesota it is listed as a Special Concern species with 13 known occurrences, although 3 of these have not been located for more than 50 years (Minnesota Heritage and Nongame Research Program, 2002; Appendix). It is listed as Rare in Vermont with 21 known occurrences, although 8 of these have not been relocated for over 60 years (VNNHP, 2002; Green Mountain National Forest, 2002; Appendix).

The Eastern Region (Region 9) of the U.S. Forest Service has listed *L. parviflora* as a Regional Forester Sensitive Species on the Hiawatha National Forest in Michigan (Eastern Region, 2000). The Risk Evaluation from the Hiawatha National Forest indicates that the rationale for the listing is due to viability concerns for the single population that occurs on the forest (Hiawatha National Forest, 1999). In the Eastern Region, the species also occurs on the Superior National Forest in Minnesota and the Green Mountain National Forest in Vermont. No Risk Evaluation has been filed by the

Superior National Forest for this species. The Risk Evaluation on *L. parviflora* completed by the Green Mountain National Forest indicates that the number of known populations has increased three-fold on the forest in the past 10 years (from 3 to 9 occurrences) and historical populations seem to be resilient (Green Mountain National Forest, 2000). Diane Harlow Burbank (per. comm. 2002) indicates that the forest has not listed the species in part because new populations are often located when it is targeted during surveys. Given the inconspicuous nature of *L. parviflora*, one might expect that newly discovered populations may have been previously overlooked.

## **POPULATION BIOLOGY AND VIABILITY**

### **General population biology**

Populations of *L. parviflora* in Vermont, Minnesota, and Michigan tend to consist of scattered "patches" or "clumps" of culms (Appendix). Many patches occur near a variety of forest openings including trails, creeks, a cabin, lakes shores, and pond shores. Populations described as being in shade tend to be quite small. In Minnesota, for example, the three smallest populations had less than nine flowering culms and were in undisturbed forests (Minnesota Heritage and Nongame Research Program, 2002; Appendix). One might expect, therefore, that this species (at least in the eastern U.S.) tends to be a forest herb that is dependent on occasional disturbances. Although forest herbs have many different adaptations to live in the shade, some forest plants persist by asexual vegetative growth when they are in heavy shade (Hughes *et al.* 1988; Kudoh *et al.* 1999). One would expect that *L. parviflora* has such a capacity since it is rhizomal. A small or large opening allows such species to reproduce sexually (Hughes *et al.* 1988; Kudoh *et al.* 1999). Possibly non-flowering patches of *L. parviflora* are not noticed very often, as the leaves are grass-like and not too distinctive. The persistent seed bank that *L. parviflora* apparently has, may allow this species to respond to disturbances by seed germination in addition to vegetative growth.

### **Site specific population viability**

The size of populations may give some indication of population viability. Populations of *L. parviflora* in Minnesota, Michigan and Vermont were given an estimated population size (Table 7) based on descriptions of the populations found in the Appendix. "Small-sized" populations are expected to have one to several patches with <30 flowering or fruiting culms. "Medium-sized" populations are expected to have between 30 and 100 flowering or fruiting culms in one to several patches. "Large-sized" populations are expected to have >100 flowering or fruiting culms in many patches. When considering population size, one must keep in mind that *L. parviflora* is a rhizomal species and as such, each genet (genetically distinct individual) may consist of multiple culms. The actual number of sexually-active genets, therefore, is probably less than the number of flowering or fruiting culms.

**Table 7.** Rough estimates of population sizes in Minnesota, Michigan and Vermont based on population descriptions (See Element Occurrences Appendix). Small-sized: <30 reproductive culms. Medium-sized: >30, <100 reproductive culms. Large-sized: >100 reproductive culms. "H" indicates the number of historical populations or populations that have not been re-visited for more than 50 years.

State	Estimated Population Size				
	Unknown	Small-sized	Medium-sized	Large-sized	Total
Michigan	3	2	2	2	9
Minnesota	3 (3H)	6	4		13
Vermont	13 (7H)	2	3	2	20

Small population sizes may be a concern in 6 of the 10 described populations in Minnesota, 2 of the 7 described populations in Vermont, and 2 of the 6 described populations in Michigan. Small size may especially be a concern for the population on the Hiawatha National Forest where only one culm made up the entire population and no other population is known in the area. Small populations tend to be more vulnerable to extirpation than larger populations (Ellstrand and Elam, 1993; Primack, 1993, pp. 253-376). Small populations tend to have less genetic variation possibly due to genetic drift and population bottlenecks (Primack, 1993, pp. 253-376). Loss of genetic variation may decrease the population's ability to adapt to changes in the environment. In addition inbreeding depression may affect the fecundity of small populations. Populations rated as "small" in literature have sometimes up to 50 or even 100 individuals (Ellstrand and Elam, 1993; Primack, 1993, pp. 253-376). Therefore, populations rated, as "medium-sized" in Table 7 are relatively small and may in fact have viability problems.

The actual viability of populations depends on more than just the population size. Given that *L. parviflora* is self-compatible, the small population sizes may not noticeably affect seed production. Seed or pollen movement between neighboring populations may also decrease the negative effects of the small population size (Ellstrand and Elam, 1993; Primack, 1993, pp. 253-376). Six of the Minnesota populations are relatively close to one another (within a few miles of at least one other population). Gene flow (via pollen or seeds) among these populations may maintain the genetic variability of the populations. In addition, populations may have more patches of culms that were not observed. Occasional forest disturbances may also increase the number of flowering culms within a population from one year to the next. As noted in the "Ecology" section of this Conservation Assessment, *L. parviflora* can have persistent seed banks. The genetic variability within small populations of this species may be maintained, by the occasional recruitment of plants from past generations from the seed bank. Individual genets of *L. parviflora*, like other rhizomal (clonal) species, may be long-lived and may persist through disturbances (Ellstrand and Roose, 1987; Standley, 1991). Such abilities may buffer the species from the effects of small population sizes.

## POTENTIAL THREATS

Although *L. parviflora* is rare in areas of the eastern United States, the importance of its rarity may be depreciated by biologists because this species is at the edge of its range and common in other areas of the world. In fact, according to the Natural Heritage's Ranking, *L. parviflora* is abundant, widespread, and common in Ontario, Canada (ranked S5) which borders the United States from Minnesota to New York (NatureServe, 2001). This species, in addition, was probably never common in the eastern United States and no evidence suggests that the numbers of populations are declining.

*L. parviflora*, nevertheless, is part of the local flora of each area that it occurs. Given the rarity of *L. parviflora* in Minnesota, Michigan, Massachusetts, and Vermont, monitoring and protecting populations may be appropriate. All of these states have low numbers of populations and a majority of populations apparently consist of <100 flowering culms. This species, in addition, has quite variable physical characteristics that have influenced some taxonomists to recognize different subspecies and varieties. Such distinctions suggest that populations in eastern North America may be quite genetically unique compared to populations in other areas of the world.

One threat to populations of *L. parviflora* in Minnesota, Michigan and Vermont is the small size of populations. Each of these states has at least a few small populations. If such populations are isolated from one another, the persistence of these populations may be threatened (see "Population Biology and Viability"). Some populations in these states have not been observed in over half a century suggesting that these populations may be extirpated.

Human disturbances are other potential threats to populations. Maintaining hiking paths may threaten some of the populations. Periodic dredging of the creek that borders the population on the Hiawatha National Forest may be a threat to that population (Jan Schultz, pers. comm. 2002). Timber harvest and road construction are other potential threats to populations. The risk of logging areas that *L. parviflora* occurs in Minnesota is evident as two of the known populations on the Superior National Forest (occurrences five and nine) were discovered within or near recent clear-cuts (Appendix). Logging and construction threats may be less likely in Vermont where populations are at high altitudes making logging activities difficult and less cost effective. However, ski area expansion may be a threat to populations in Vermont (Burbank, 2000).

Since *L. parviflora* may be dependent on occasional intermediate disturbances, dredging a creek and maintaining hiking trails may allow sunlight to penetrate the forest canopy and permit culms of *L. parviflora* to flower. On the other hand, the effect of severe disturbances such as clear-cut harvesting of trees could be detrimental. Although *L. parviflora* tends to occur in disturbed areas, it also tends to occur in forested areas. The loss of humidity, increased temperatures, and intrusion of weedy species associated with large canopy openings could make the habitat unsuitable. Such disturbances may not only destroy portions of populations, but also may fragment populations and prevent natural gene flow within and between populations. Such factors may augment negative

effects of small population sizes. Research is needed to determine what types of disturbances may be beneficial to populations and what ones are detrimental.

Climate change is another potential threat especially for Midwestern populations. Scientists throughout the world have predicted that a worldwide warming trend (Global Warming) is beginning to occur and will continue to increase during the coming century (Primack, 1993, pp 157-161; Levitus *et al.* 2001). Global Warming is an expected effect of the increase in carbon dioxide and other "greenhouse gases" in the atmosphere from human activities (Primack, 1993, pp 157-161; Levitus *et al.* 2001). The populations of *L. parviflora* in Michigan and Minnesota are unique in that they occur at low altitudes compared to populations in other areas of the contiguous U.S. These populations may persist at these altitudes due to the cooling effect of being within 20 miles of Lake Superior. The rarity of *L. parviflora* in the Midwest and the proximity of populations to Lake Superior suggest that a slightly warmer climate could make the habitat unsuitable.

### SUMMARY OF LAND OWNERSHIP AND PROTECTION

Table 8 displays the known land ownership for populations of *L. parviflora* in Massachusetts, Minnesota, Michigan, and Vermont. These states track *L. parviflora* occurrences due to the species' rarity. In these states, a higher proportion of the known populations are on public land (state, university, or federal) than on private land or land with unidentified ownership.

The species is localized on federal land in Michigan occurring only on Isle Royale National Park and the Hiawatha National Forest. All of the known populations in Michigan are, therefore, protected to some degree by the State's listing of the species as Threatened, in addition to the species being listed as a Regional Forester Sensitive Species on the Hiawatha National Forest. The single element occurrence in Massachusetts may be relatively well protected as it consists of multiple populations that are located in a State Managed Natural Area and the State has listed it as Endangered.

**Table 8.** Land ownership of element occurrences of *Luzula parviflora* in Massachusetts, Vermont, Minnesota, and Michigan. Historical populations (H), listed in parentheses, are the portion of the listed occurrences that have not been re-located for over 50 years.

Ownership	Massachusetts	Michigan	Minnesota	Vermont
Unknown/private	0	0	2 (2 H)	7 (5 H)
State	1	0	1	4
U.S. Forest Service	0	1	10 (1 H)	9 (3 H)
University	0	0	0	1
U.S. Park Service	0	8	0	0
Total occurrences	1	9	13 (3 H)	21 (8 H)
% on public land	100	100	85	67

In Minnesota and Vermont, populations that do not occur on public land are primarily historical populations (Table 8). Most of Minnesota's populations are on the Superior National Forest (some of which are managed with the State). Almost half of the populations in Vermont occur on the Green Mountain National Forest. Since *L. parviflora* is not listed as a Regional Forester Sensitive Species on the Superior or Green Mountain National Forest, the protection of the species may be considered less during management activities than species with such a listing. *L. parviflora* may, however, be protected to some degree on these Forests since the States in which these National Forests occur (Vermont and Minnesota) have listed the species as Rare or a Special Concern. One of the Minnesota populations is protected from logging as it occurs in a Wilderness Area of the Superior National Forest. Populations in Vermont may have some intrinsic protection due to their occurrence in mid to high elevations.

## RESEARCH AND MONITORING

### Existing Surveys, Monitoring, and Research

The study of the seed bank in Eagle Summit Alaska (McGraw *et al.*, 1991; Bennington *et al.*, 1991) and the study of plants establishing in the Mount St. Helens area after the volcano's eruption (see "Life History" section) are two plant community studies that have increased the information base of *L. parviflora*. Both of these studies monitored *L. parviflora* due to its incidental presence at these locations. Studies of plant community succession probably will continue to be carried out in the area surrounding Mount St. Helens. Such studies will probably continue to incidentally monitor *L. parviflora* populations given the species' presence around the volcano.

The only known monitoring of *L. parviflora* in the eastern U.S. is in Isle Royale National Park. A portion of one of the eight populations in the park is in a permanent monitoring plot (Jack Oelfke, pers. comm. 2002). Since being discovered on the Hiawatha National Forest in 1994, *L. parviflora* is searched for during rare plants surveys prior to timber harvests or other management activities. These surveys are performed annually in different areas of the National Forest. New populations have not yet been located despite these efforts.

### Survey Protocol

#### 1. Re-visit the Known Population on the Hiawatha National Forest

The population of *L. parviflora* that was discovered in 1994 on the Hiawatha National Forest has not been re-visited (Jan Schultz, pers. comm. 2002). A thorough search and description of the population's current size and structure would inform biologists of this population's vulnerability to extirpation. Although only one culm was originally located in 1994, the population may consist of other undiscovered patches or new patches may have grown since that time.

#### 2. Locate undiscovered populations

Like any rare species, undiscovered populations of *L. parviflora* may exist. Moreover, species such as *L. parviflora* may be overlooked more often than other rare species due to

its grass-like aspect and inconspicuous flowers. On the Hiawatha National Forest, rare plant surveys are often done in connection with planned timber sales and little funding is available to specifically look for rare plants; thus the most suitable habitat may not have been searched for this species. A search specifically targeting *L. parviflora* would be the most effective method in locating undiscovered populations on the Hiawatha National Forest. Since only one population is known in the Upper Peninsula, such a search is appropriate. By using habitat descriptions from Minnesota and Michigan, the most likely habitat could be identified and searched. If habitat descriptions from Ontario could be obtained, this could improve identifying the most promising habitat.

## **Future Research Suggestions**

### *1. Life History Study*

Annual monitoring of any population would clarify the population biology of this species. Descriptions of populations are from only one or two temporally spaced visits. Annual surveys of any population in the eastern United States might reveal how long each flowering patch persists and where or when new patches begin flowering. Such data would indicate if the species is dependent on occasional forest disturbances. If *L. parviflora* requires more light to flower than forested areas provide, research could determine why populations tend to be located in forests. One might expect, given its circumboreal range, that *L. parviflora* requires the cool temperatures or the moist soil found in forests. Possibly germination requirements depend on certain conditions of forests. Three of the eight populations in Isle Royale National Park grow in meadows and other open areas. Research could determine if seeds from these populations germinate and grow into mature plants, or if the populations persist by asexual rhizomal growth.

### *2. Taxonomy Study*

Given that recent sources vary in their recognition of distinct species, subspecies, or varieties of *L. parviflora*, a genetic analysis of plants throughout its range would justify or refute the intra- and inter-specific divisions. This seems especially urgent since quite respectable and recent sources such as the PLANTS database (2001), ITIS (2001), and Ceska and Kirschner (2001) recognize *L. fastigiata* as a distinct species from *L. parviflora*, while Swab in Flora of North America (2000) does not even recognize *L. parviflora* var. *fastigiata*.

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## APPENDIX

### Element Occurrences of *Luzula parviflora*

Known occurrences of *Luzula parviflora* (Ehrh.) Desv. in states of the eastern United States that track this species. States included are: Massachusetts (1 occurrence), Michigan (9 occurrences), Minnesota (13 occurrences), and Vermont (21 occurrences). Descriptions are in alphabetical order by location (state, county, and then town or site).

#### Massachusetts

Location:	Massachusetts, Berkshire County
Year(s) Observed:	1906, 1978, 1982, 1983, 1997, 1999, June 2000 (Massachusetts Natural Heritage and Endangered Species Program (NHESP), 2002)
Ownership:	State
Size of Population:	Site 1: Six small patches, 74 culms, 37 with fruit (2000). Site 2: Two patches, 22 culms, 2 with fruit (2000). Site 3: 6 small patches, 80 culms, 18 with fruit (2000).
Habitat:	"In moist spruce-fir forest above 2800' often in the openings along trails" (Weatherbee, 1996).
Associated species:	<i>Oxalis montana</i> , <i>Clintonia borealis</i> , <i>Solidago arguta</i> (?), <i>Dryopteris camploptera</i> , <i>Deschampsia flexuosa</i> , <i>Aralia nudicaulis</i> , <i>Carex</i> spp., <i>Rubus</i> spp., <i>Sorbus americana</i> , <i>Viburnum lantanoides</i> , <i>Aster acuminatus</i> , <i>Streptopus rosius</i> , <i>Acer spicatum</i> , <i>Picea rubens</i> , <i>Abies balsamea</i> , <i>Betula alleghaniensis</i> , <i>Prunus serotina</i> .
Source of information:	(Weatherbee, 1996; Massachusetts NHESP, 2002)

#### Michigan

Location:	Michigan, Alger County
Year(s) Observed:	July 1994
Ownership:	U.S. Forest Service
Size of Population:	"1 plant"
Habitat:	"Growing on sandy spill site where sediment from the creek was deposited in the past. Mesic northern forest with hardwood-conifer swamp, along creek."
Associated species	<i>Prunus serotina</i> , <i>Bromus inermis</i> , <i>Cirsium palustre</i> , <i>Viola</i> spp, <i>Epilobium</i> spp, <i>Carex intemescens</i> .
Source of Information:	MNFI, 2002 (Occurrence number 6).

Location:	Michigan, Keweenaw County, Isle Royale
Year(s) Observed:	June 1994
Ownership:	National Park Service
Size of Population:	Patch 1: "30 plants" Patch 2: "25 plants"

Habitat: Patch 1: "Under shaded eaves of cabin where rain falls off."  
Patch 2: "Along trail near dock ... in shade of even-aged 6" *Abies balsamea* stand."  
Associated species Patch 2: *Hylocomium splendens*, *Maianthemum canadense*, *Coptis trifolia* [*groenlandica*], and *Lycopodium clavatum*.  
Source of Information: MNFI, 2002 (Occurrence number 7); Judziewicz, 1995.

Location: Michigan, Keweenaw County, Isle Royale  
Year(s) Observed: June 1985, June 1994  
Ownership: National Park Service  
Size of Population: Patch 1 (1985): "8 plants..."  
Habitat: Patch 1: "along trail...in white cedar-yellow birch woods."  
Patch 2 (1994): "Along...[t]rail"  
Associated species Patch 1: "...with alder, *Caltha palustris*, and *Symplocarpus foetidus*."  
Source of Information: MNFI, 2002 (Occurrence number 5); Judziewicz, 1995.

Location: Michigan, Keweenaw County, Isle Royale  
Year(s) Observed: Patch 1: 1961, June 1994  
Patch 2: June 1994  
Ownership: National Park Service  
Size of Population: Patch 1 (1994): "16 flowering plants."  
Patch 2: "20 plants"  
Habitat: Patch 1 (1994): "..within 1 m of trail, in open old aspen stand..."  
Patch 2: "...on rocky trailside forest margin"  
Associated species Patch 1(1994): "with *Aster macrophyllus* dominant, also *Rubus parviflorus* and *Taraxacum officinale*..."  
Patch 2: *Juniperus communis* & *Carex rugosperma*  
Source of Information: MNFI, 2002 (Occurrence number 3); Judziewicz, 1995.

Location: Michigan, Keweenaw County, Isle Royale  
Year(s) Observed: 1930, June 1959 (June 1965?)  
Ownership: National Park Service  
Habitat: "Beach."  
Source of Information: MNFI, 2002 (Occurrence number 1); Judziewicz, 1995.

Location: Michigan, Keweenaw County, Isle Royale  
Year(s) Observed: June 1965  
Ownership: National Park Service  
Habitat: "Moist woodland."  
Source of Information: MNFI, 2002 (Occurrence number 2)

Location: Michigan, Keweenaw County, Isle Royale  
Year(s) Observed: 1984, July 1985  
Ownership: National Park Service  
Size of Population: "Colonies small (5-50 plants)."

Habitat: "In open to filtered light, moist humus; in herb-dominated disturbance openings, esp. near edges. Forest openings (e.g., trail cut, windthrow) and meadow with scattered trees. In moist soil with an overstory of *Abies balsamea* and *Sorbus decora*. Also opening in *Abies* forest; dominated by *Oplopanax* and *Dryopteris assimilis*."

Associated species *Gymnocarpium dryopteris*, *Dryopteris expansa*, *Lycopodium* spp, *Cornus canadensis*, *Clintonia borealis*, *Diervilla lonocera*, *Linnaea borealis*, *Dicranium*, *Coptis groenlandia*

Source of Information: MNFI, 2002 (Occurrence number 4).

Location: Michigan, Keweenaw County, Isle Royale

Year(s) Observed: June 1994

Ownership: National Park Service

Size of Population: 1: "scattered plants"  
 2: "4 vigorous clumps... with 42, 6, 47, and 22 flowering stems respectively in each clump" (monitoring plot)  
 3: unknown  
 4: "a few plants"  
 5: unknown  
 6: "large colonies "  
 7: "5 plants"

Habitat: 1: "meadow...moist swales"  
 2: "...in dense fir forest with devil's club dominant in understory"...next to trail..."  
 3: "successional meadow"  
 4: "near 'saddle' of boreal forest ridge... growing on edge of boggy pool dominated by *Carex trisperma*"  
 5: "in dense balsam-fir forest"  
 6: "successional meadow"  
 7: "balsam-fir forest."

Source of Information: MNFI, 2002 (Occurrence number 8); Judziewicz, 1995.

Location: Michigan, Keweenaw County, Isle Royale

Year(s) Observed: June 1994

Ownership: National Park Service

Size of Population: 20 sterile plants

Habitat: "Under *Abies*...on mossy 40 degree N-facing slope..."

Associated species "with *Dryopteris fragrans*, *Cornus canadensis*, *Chimaphila umbellata*, *Gymnocarpium dryopteris*, *Streptopus roseus*, *Lycopodium annotinum*..."

Source of Information: MNFI, 2002 (Occurrence number 9); Judziewicz, 1995.

## Minnesota

Location: Minnesota, Cook County

Year(s) Observed: August, 2000



Ownership: State (Managed with U.S. Forest Service)  
 Size of Population: "3 patches of fruiting plants and basal rosettes."  
 Habitat: "...along hiking trail...3 plants in shady area about 20 m from trail...25 plants+ many rosettes w/in 1 m of trail...third patch.. approx. 13 m N of trail on crest of slope. Open canopy of mixed boreal hardwoods, old conifer forest; little shrub cover."  
 Associated species "Dense herb layer of *Aster macrophyllus*, *Clintonia borealis*, *Cornus canadensis*, etc."  
 Source of Information: Minnesota Heritage and Nongame Research Program, 2002, (Occurrence number 11).

Location: Minnesota, Cook County  
 Year(s) Observed: July, 1998  
 Ownership: U.S. Forest Service (managed with State)  
 Size of Population: "13 fruiting stems and 3 clumps (approx. 1 ft sq.)"  
 Habitat: "Located at edge of clearcut aspen/ birch conifer association and mixed conifer swamp (Cedar, spruce, tamarack). Moist soil with Sphagnum moss. Partly sloping to west, shaded by sapling black spruce and paper birch."  
 Associated Species *Cornus canadensis*, *Maianthemum canadense*, *Lycopodium annotinum*, *Linnaea borealis*, *Dryopteris carthusiana*, *Gaultheria hispidula*, *Clintonia borealis*, *Sorbus decora*, seedling white cedar.  
 Source of Information: Minnesota Heritage and Nongame Research Program, 2002, (Occurrence number 9).

Location: Minnesota, Cook County  
 Year(s) Observed: June, 1998  
 Ownership: U.S. Forest Service (managed with State)  
 Size of Population: "Approx. 39 flowering and fruiting stems located in 3 X 6 ft area."  
 Habitat: "...in white cedar forest on soil, *Carex* hummocks, and on decomposing logs. Found on moist soil in partial shade of cedar and various shrubs (*Alnus rugosa*, *Acer spicatum*, *Sorbus* spp., *Abies balsamea*)."  
 Associated Species *Lycopodium annotinum*, *Cornus canadensis*, *Dryopteris carthusiana*, *Coptis groenlandica*, *Carex* spp., *Oxalis montana*, *Clintonia borealis*, *Rubus pubescens*.  
 Source of Information: Minnesota Heritage and Nongame Research Program, (Occurrence number 7).

Location: Minnesota, Cook County  
 Year(s) Observed: August, 1998  
 Ownership: U.S. Forest Service (managed with State)  
 Size of Population: "9 small clumps (2 sterile) with approx. 60 fruiting stems..."  
 Habitat: "...located at edge of upland and lowland forest. Growing in Sphagnum moss. Area recently clearcut, some logging debris on plants. "

Associated Species *Calamagrostis canadensis, Rubus pubescens, R. strigosus, Scirpus cyperinus, Carex intumescens, C. leptonevia, C. disperma, Viola* spp., *Aster puniceus, Ribes triste, Cornus canadensis, Dryopteris carthusiana, Alnus incana ssp. rugosa, Betula papyrifera* saplings, *Thuja occidentalis, Picea glauca, Abies balsamea.*

Source of Information: Minnesota Heritage and Nongame Research Program, 2002, (Occurrence number 5).

Location: Minnesota, Cook County  
 Year(s) Observed: June, 1998  
 Ownership: U.S. Forest Service  
 Size of Population: "8 fruiting stems scattered in a 10 X 15 ft area.."  
 Habitat: "In white cedar swamp forest."  
 Associated Species *Trientalis borealis, Cornus canadensis, Clintonia borealis, Linnaea borealis, Maianthemum canadense, Dryopteris spinulosa, Lycopodium clavatum, Acer spicatum, Abies balsamea.*

Source of Information: Minnesota Heritage and Nongame Research Program, 2002, (Occurrence number 8).

Location: Minnesota, Cook County  
 Year(s) Observed: June, 1998  
 Ownership: U.S. Forest Service  
 Size of Population: "1 small plant with 2 flowering shoots..."  
 Habitat: "Observed in transition zone between white cedar and black spruce swamp forests. Located in heavy shade on soil and sphagnum hummocks formed over cedar roots."  
 Associated Species *Gymnocarpum dryopteris, Clintonia borealis, Huperzia selago, Rubus pubescens, Linnaea borealis, Cornus canadensis, Schizachne purpurascens, Alnus rugosa, Amelanchier bartramiana, Ledum groenlandica, Coptis groenlandica, Carex leptalea, C. trisperma, C. leptonevia.*

Source of Information: Minnesota Heritage and Nongame Research Program, 2002, (Occurrence number 6).

Location: Minnesota, Cook County  
 Year(s) Observed: July, 1998  
 Ownership: U.S. Forest Service  
 Size of Population: "5 fruiting stems in 10-inch clump and 3 smaller sterile clumps..."  
 Habitat: "Located at edge of small depression in Sphagnum under shade of black spruce. Close to transition zones with upland aspen stand and mixed conifer swamp in heavy shade."  
 Associated Species *Rubus pubescens, Cornus canadensis, Gymnocarpum dryopteris, Carex trisperma.*

Source of Information: Minnesota Heritage and Nongame Research Program, 2002, (Occurrence number 10).

Location: Minnesota, Cook County  
Year(s) Observed: July, 1891  
Ownership: Unknown  
Source of Information: Minnesota Heritage and Nongame Research Program, 2002,  
(Occurrence number 2).

Location: Minnesota, Cook County  
Year(s) Observed: 1947  
Ownership: U.S. Forest Service  
Habitat: "On a trail through mossy woods, along the shore."  
Source of Information: Minnesota Heritage and Nongame Research Program, 2002,  
(Occurrence number 14).

Location: Minnesota, Cook County  
Year(s) Observed: June, 2000  
Ownership: U.S. Forest Service  
Size of Population: "Three small populations with 3-6 flowering culms each and sterile rosettes."  
Habitat: "On edge of conifer swamp... *Picea mariana* swamp w/ Sphagnum cover 50-60% and patchy, mixed shrubs; Microsite is lower edge of water-filled hollows under *P. mariana*."  
Source of Information: Minnesota Heritage and Nongame Research Program, 2002,  
(Occurrence number 12).

Location: Minnesota, Cook County  
Year(s) Observed: August, 1997  
Ownership: US Forest Service  
Size of Population: "7 fruiting clumps"  
Habitat: "...at base of hill where forest grades into wetland. Wetland is mix of fir, spruce, balsam, poplar, tamarack aspen and birch."  
Associated species "Overstory: balsam fir, black spruce with quaking aspen and paper birch. Other spp: *Lycopodium annotinum*, *Cornus canadensis*, *Vaccinium angustifolium*, *Dryopteris spinulosa*, *Coptis groenlandica*, *Oxalis montana*, *Thelypteris phegopteris*, *Ribes* spp, *Rubus pubescens*, *R. strigosus*."  
Source of Information: Minnesota Heritage and Nongame Research Program, 2002,  
(Occurrence number 3).

Location: Minnesota, Cook County  
Year(s) Observed: August, 1998  
Ownership: U.S. Forest Service  
Size of Population: "3+ dozen plants some of which were single, sterile basal leaves. At least 12 other plants in full fruit, several larger clumps of multiple basal rosettes."

Habitat: "Occur on both sides of portage within +/- 3 m of trail center. Some plants adjacent to tread area, other fruiting culms on portage. Moist soils."  
Associated Species "Woods of *Thuja occidentalis*, *Betula*, *Abies balsamea*, *Petasites palatus*, *Rubus pubescens*, *Thelypteris phegopteris*, *Aster macrophyllus*, *Carex anst*, *Poa* spp, *Fragaria*, Etc."  
Source of Information: Minnesota Heritage and Nongame Research Program, 2002, (Occurrence number 4).

Location: Minnesota, Lake County  
Year(s) Observed: July, 1941  
Ownership: Unknown  
Habitat: "Rocky, wooded wall of a stream."  
Source of Information: Minnesota Heritage and Nongame Research Program, 2002, (Occurrence number 1).

## Vermont

Location: Vermont, Addison County  
Year(s) Observed: July 1878  
Ownership: U.S. Forest Service (USDA Forest Service, 2002)  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002, (Occurrence number 4).

Location: Vermont, Addison County  
Year(s) Observed: July 1878  
Ownership: Unknown  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002, (Occurrence number 8).

Location: Vermont, Bennington County  
Year(s) Observed: June 1990  
Elevation (feet): approx. 3500 ft to 3720  
Ownership: U.S. Forest Service  
State Rank: Excellent estimated viability  
Size of Population: Large population-hundreds of plants, all vigorous.  
Habitat: "Plants concentrated along trail growing in filtered light generally associated with canopy openings in an area dominated by balsam fir and red spruce. Ground layer is dense with *Dryopteris campyloptera*, *Oxalis montana*, *Clintonia borealis*, *Lycopodium lucidulum*."  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002, (Occurrence number 14).

Location: Vermont, Bennington County  
Year(s) Observed: July 1903  
Ownership: Unknown

Source of Information: Vermont Nongame and Natural Heritage Program, 2002,  
(Occurrence number 10).

Location: Vermont, Caledonia County  
Year(s) Observed: July 1889  
Ownership: Unknown  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002,  
(Occurrence number 7).

Location: Vermont, Caledonia County  
Year(s) Observed: August 1991, August 1992  
Elevation (feet): 3200  
Ownership: State  
State Rank: Fair Estimated Viability  
Size of Population: "Several small groups of plants were observed but no large patches;  
each group consisted of two or three fruiting culms and three or four  
sterile rosettes. Fruiting culms were vigorous and fertile seed was  
set."  
Habitat: "All plants observed occur along the edges of the footpath...  
montane mixed (i.e. red spruce - paper birch - mountain maple)  
forest. No plants were observed in wholly 'natural' undisturbed  
woodland..."  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002,  
(Occurrence number 18).

Location: Vermont, Chittenden County  
Year(s) Observed: August 1981  
Elevation (feet): 3700  
Ownership: State  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002,  
(Occurrence number 12).

Location: Vermont, Lamoille County  
Year(s) Observed: July 1990  
Elevation (feet): 3100  
Ownership: Unknown  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002,  
(Occurrence number 13).

Location: Vermont, Lamoille County  
Year(s) Observed: August 1989  
Elevation (feet): 2300  
Ownership: Unknown  
State Rank: Viability not assessed  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002,  
(Occurrence number 17).

Location: Vermont, Lamoille County  
Year(s) Observed: 1857, July 1990  
Elevation (feet): 4000  
Ownership: University of Vermont  
State Rank: Fair Estimated Viability  
Habitat: "In grassy margins along road in low spruce-fir" (1990).  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002,  
(Occurrence number 2).

Location: Vermont, Orleans County  
Year(s) Observed: May 1987  
Elevation (feet): 3223  
Ownership: State  
Habitat: "One place along trail."  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002,  
(Occurrence number 1).

Location: Vermont, Orleans County  
Year(s) Observed: June 1895  
Ownership: Unknown  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002,  
(Occurrence number 11).

Location: Vermont, Rutland County  
Year(s) Observed: 1891, July 1910  
Ownership: Unknown  
Habitat: "Mountain cliffs." (Eggelston)  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002,  
(Occurrence number 6).

Location: Vermont, Rutland County  
Year(s) Observed: June 1990  
Ownership: State & U.S. Forest Service (USDA Forest Service, 2002)  
State Rank: Good Estimated Viability  
Size of Population: "27 clumps total counted."  
Habitat: "Widely scattered along ... trail... Associated natural community is  
a spruce/fir forest."  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002,  
(Occurrence number 16).

Location: Vermont, Washington County  
Year(s) Observed: 1926, June 1976  
Elevation (feet): 3800  
Ownership: State

Habitat: "Growing in stunted *Abies balsamea*/*Betula cordifolia* scrub."(1976); "woods." (1926)  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002, (Occurrence number 5).

Location: Vermont, Washington County  
Year(s) Observed: July 1993  
Elevation (feet): 3900  
Ownership: U.S. Forest Service  
State Rank: Good Estimated Viability  
Size of Population: "35 flowering culms."  
Habitat: "Along trail in moist mineral soil in high-elevation, montane spruce-fir forest."  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002, (Occurrence number 20).

Location: Vermont, Washington County  
Year(s) Observed: July 1993  
Elevation (feet): 3700  
Ownership: U.S. Forest Service  
State Rank: Excellent Estimated Viability  
Size of Population: "Found in 3-4 scattered locations along the trail; the largest concentration was 223 flowering culms."  
Habitat: "All plants were found along the edge of [trail] in wet or moist mineral soil. No plants were found in undisturbed forest away from the trails where ground cover plants or duff layer prevailed."  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002, (Occurrence number 19).

Location: Vermont, Windham County  
Year(s) Observed: 1912, July 1913  
Ownership: U.S. Forest Service (USDA Forest Service, 2002)  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002, (Occurrence number 9).

Location: Vermont, Windham County  
Year(s) Observed: June 1990  
Elevation (feet): 3600 ft  
Ownership: U.S. Forest Service  
State Rank: Fair Estimated Viability  
Size of Population: "Small population ( 50-100 plants)."  
Habitat: "Stunted spruce-fir forest with openings... along a ... trail."  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002, (Occurrence number 15).

Location: Vermont, Windham County

Year(s) Observed: 1936  
Owner: U.S. Forest Service  
Source: USDA Forest Service, 2002

Location: Vermont, Windsor and Addison Counties  
Year(s) Observed: July 1924, June 1992  
Elevation (feet): 2920  
Ownership: U.S. Forest Service  
State Rank: Poor Estimate Viability  
Size of Population: "One clump (1992)".  
Habitat: "Area dominated by 30 foot high white birch."  
Source of Information: Vermont Nongame and Natural Heritage Program, 2002,  
(Occurrence number 3).



## **LIST OF CONTACTS**

### **Information Requests**

#### Michigan

Jack Oelfke; Branch Chief, Natural Resource Management; Isle Royale National Park  
Jan Schultz; Forest Plant Ecologist; Hiawatha National Forest; Marquette  
Phyllis Higman, Michael Kost, Rebecca Boehm; Michigan Natural Features Inventory;  
Lansing  
Beverly Braden; Contract Botanist; Hiawatha National Forest, Marquette

#### Minnesota

Sharron Nelson; Minnesota Heritage and Nongame Research Program  
Jack Greenlee; Forest Plant Ecologist; Superior National Forest

#### Vermont

Bob Popp; Botanist; Vermont Nongame and Natural Heritage Program  
Anne Turner; Botanical Assistant; Vermont Nongame and Natural Heritage Program  
Diane Harlow Burbank, Ecologist; Green Mountain & Finger Lakes National Forest

### **Review Requests**

Emmet J. Judziewicz; Assistant Professor of Biology; University of Wisconsin-Stevens  
Point

### **Other**

Permission to Print Drawing:  
John B. Skiba; Manager; Office of Cartography and Publication, New York State  
Museum