

Conservation Assessment
for
Alpine Bilberry
(Vaccinium uliginosum)L.



Photo credit: Susan R. Crispin

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and
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This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service - Threatened and Endangered Species Program at 626 East Wisconsin Avenue, Milwaukee, Wisconsin 53203.

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EXECUTIVE SUMMARY

Vaccinium uliginosum L., otherwise known as alpine bilberry, is a perennial shrub of the heath family. It is deciduous, with small rounded leaves, pendant pink flowers, and an edible blue berry. Individual plants can become quite large through clonal growth, and may live for many years. Flowers appear in June and July, and are pollinated by bumblebees and other insects.

Vaccinium uliginosum has a number of synonyms, and plants have been divided into varieties and subspecies by different researchers. There appear to be two very similar subspecies present in the Northeast, though Natural Heritage programs track plants as simply *Vaccinium uliginosum*. For present conservation purposes, this approach is satisfactory.

The species is relatively common in the alpine communities of Maine, New Hampshire, and New York. It is less common in Vermont, reflecting that state's limited alpine habitat. It is known from more than twenty different community types, though it is not an important species in many of them. Most of these communities are rare at the state level.

Vaccinium uliginosum is a circumboreal species, and is found in the mountains of the western United States as well as in Minnesota and Michigan and the Northeast. It is ranked S3 and is known from at least 43 extant occurrences in New Hampshire, most of which lie within the White Mountain National Forest. The species is no longer tracked in New Hampshire. It is not tracked in Maine, where it is ranked SR. In Vermont, it is ranked S1 and there are 7 extant occurrences, one of which is from the Green Mountain National Forest. It is on the Green Mountain National Forest's Regional Forester's Sensitive Species list. It is ranked S3 in New York and is known from 26 extant occurrences, all of which may be within Adirondack Park.

The main threat to *Vaccinium uliginosum* is loss of individual plants and suitable habitat due to recreational activities. Direct trampling, soil compaction, and soil erosion all result from hiker foot traffic and off-trail wandering. Air pollution, acid rain, and global warming may have long-term effects on the viability of the species and its alpine habitats. Current regulations are not effective at controlling threats from recreational use or from environmental changes due to human activities.

Currently, only the populations on Vermont's alpine peaks are managed under active conservation programs. The Green Mountain Club is responsible for summit stewardship programs and revegetation projects on a few mountains. Management plans are in place for some of the lands on which *Vaccinium uliginosum* occurs, but there is little in the way of active conservation in Maine, New Hampshire, and New York. Since *Vaccinium uliginosum* is widespread in alpine habitats, it may be a good indicator species that can reflect the overall health and integrity of the alpine system in the Northeast.

ACKNOWLEDGEMENTS

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INTRODUCTION

Vaccinium uliginosum is a deciduous perennial shrub of the heath family. Plants may live for many years, and reproduce sexually through flowers and fruit and asexually through clonal growth. The species is relatively common in the alpine communities of Maine, New Hampshire, and New York. It is less common in Vermont, reflecting that state's limited alpine habitat. *Vaccinium uliginosum* has a number of synonyms, and there appear to be two very similar subspecies present in the Northeast, though Natural Heritage programs track plants as simply *Vaccinium uliginosum*. For present conservation purposes, this approach is satisfactory.

Vaccinium uliginosum is a circumboreal species, and is found in the mountains of the western United States as well as in Minnesota and Michigan. It is ranked S3 in New Hampshire, SR in Maine, S1 in Vermont, and S3 in New York. It is on the Green Mountain National Forest's Regional Forester's Sensitive Species list. It is not tracked in Maine, New Hampshire, and New York.

This assessment includes sections on taxonomy, life history, and population biology. There is an extensive section that describes alpine and subalpine habitats in the Northeast. Occurrence information for Maine, New Hampshire, Vermont, and New York is included in the Distribution and Status section. The last sections cover threats to the species, conservation and management activities, land ownership and habitat protection, and research and monitoring activities.

This assessment is designed to concentrate on occurrences within the Green Mountain National Forest and the White Mountain National Forest, National Forests in Region 9 with *Vaccinium uliginosum* populations. Since the alpine zone in the Northeast is found in New York and parts of Maine, New Hampshire, and Vermont that are not within the Forests, those areas are included as well. Similar assessments are being written for

Juncus trifidus, *Agrostis mertensii*, and *Carex bigelowii* as well. These species share similar habitats in the Northeast and are widespread enough to serve as good indicators of the overall health of the alpine system.

NOMENCLATURE AND TAXONOMY

Vaccinium uliginosum was named by Linnaeus in 1753. Synonyms include *Vaccinium occidentale* Gray, *Vaccinium uliginosum* ssp. *alpinum* (Bigelow) Hultén, *Vaccinium uliginosum* ssp. *microphyllum* Lange, *Vaccinium uliginosum* ssp. *occidentale* (Gray) Hultén, *Vaccinium uliginosum* ssp. *pedris* (Harshberger) S. B. Young, *Vaccinium uliginosum* var. *alpinum* Bigelow, *Vaccinium uliginosum* var. *occidentale* (Gray) Hara, *Vaccinium uliginosum* var. *salicinum* (Cham.) Hultén, *Vaccinium gaultherioides* Bigelow, *Vaccinium pedris* (Harshberger) Holub, *Vaccinium pubescens* Wormsk. ex Hornem., *Vaccinium uliginosum* var. *pedris* Harshb. (BNAP 1998, MOBOT 2001).

A number of subspecies and varieties have been named over the years on the basis of morphological variations, as indicated by the above list of synonyms. The plants in the Northeast have been considered to belong to *Vaccinium uliginosum* var. *alpinum* Bigelow (Fernald 1923), *Vaccinium uliginosum* ssp. *pubescens* (Wormsk. ex Hornem.) Young, and *Vaccinium uliginosum* ssp. *gaultherioides* (Bigelow) Young (Young 1970). In his article, Young (1970) indicates that subspecies *pubescens* and *gaultherioides* have different chromosome numbers, but may still be part of one reproducing metapopulation. Though Young differentiates his subspecies based primarily on leaf pubescence and indicates that they have different chromosome numbers, they are sufficiently similar that they can be referred to as *Vaccinium uliginosum* for conservation purposes. New Hampshire Natural Heritage Bureau treats all New Hampshire plants as *Vaccinium uliginosum* var. *alpinum*.

DESCRIPTION OF SPECIES

Vaccinium uliginosum is a member of the Ericaceae (heath family). It is a low, spreading woody shrub that grows from 0.2 to 60 dm high (Fernald 1950). It is stoloniferous, with its lowest branches rooting into the ground at the nodes. It is a deciduous plant, with small alternate elliptic to oblong-obovate leaves (Gleason and Cronquist 1991). The leaves are firm and entire, with a blunt or rounded tip, and are 5-25 mm long. Leaves may be pubescent or glabrous, and are pale and reticulate below (Fernald 1950). They turn purple in the fall (Slack and Bell 1995). The species is easily distinguished from other members of *Vaccinium* by its distinctive leaves – no other species in the Northeast has the same combination of characteristics. Flowers are pink, 4-petaled, and are borne singly or in groups (2-4) in the axils of bud-scales. The corolla is urceolate and is 1 to 3.5 mm long (Fernald 1950). The fruit is a fleshy berry that ripens from green to blue or black and ranges from 2 to 6 mm (Gleason and Cronquist 1991). It frequently has a waxy bloom that can be rubbed off (Fernald 1950). The seeds are quite small and range from 1 or 2 to approximately 24 per fruit (Jacquemart 1996).

LIFE HISTORY

Vaccinium uliginosum is a perennial shrub. It reproduces both sexually and asexually. Sexual reproduction is important for genetic diversity, dispersal to new habitats, and persistence in the presence of severe disturbance. However, vegetative reproduction appears to be the primary strategy for this species (Jacquemart 1996). *Vaccinium uliginosum* reproduces vegetatively through layering. Prostrate stems become covered by leaf litter, decomposing organic material, and moss, and are slowly buried (Calmes and Zasada 1982). After the stem is buried, it roots into the ground and can be considered a rhizome. Individual plants may live for sixty or more years, though it is difficult to pinpoint an exact age since older parts of the plant may disintegrate while daughter clones continue to grow outward (Jacquemart 1996).

Vaccinium uliginosum has many root characteristics that are typical of the heath family. It is shallowly rooted, with horizontal rhizomes that extend down to 3 cm, and roots that reach depths of 20 cm (Bliss 1966). The roots lack root hairs and are very fine (Korcak 1989 in Jacquemart 1996), and relatively few are produced each year (Bliss 1966). The roots have been found to have ericoid mycorrhizae (Treu *et al.* 1996). Mycorrhizae help their host plant acquire nutrients, especially nitrogen (Read and Kerley 1995 in Jacquemart 1996), and a higher degree of mycorrhizal infection in *Vaccinium uliginosum* corresponds to increased host vigor (Haselwandter 1979).

Vaccinium uliginosum competes well in dwarf shrub communities due to its leaf adaptations. Its upper leaves are larger and are held almost vertically, efficiently capturing sunlight from low solar angles. The lower leaves are small and held horizontally, which maximizes the absorption of diffused light (Sonesson and Callaghan 1991). It also tends to grow taller than surrounding shrubs, which helps it avoid being shaded (Gerdol *et al.* 2000), though this may not be the case in all community types. In protected heath communities, *Vaccinium uliginosum* averaged 6 to 8 cm of shoot growth in a season, with 10-12 leaves per shoot. In more exposed heath-rush communities, shoot growth averaged 1.5 to 2.5 cm with 9 to 10 leaves per shoot (Bliss 1966). Older plants grow at a slightly slower rate than younger plants (Shevtsova *et al.* 1995).

In the spring, temperatures may need to reach 5°C before *Vaccinium uliginosum* begins active growth (Calmes and Zasada 1982). In the fall, *Vaccinium uliginosum* acquires freezing resistance at -15°C, and can withstand winter temperatures of -50°C (Sakai and Otsuka 1970 in Tiffney 1972).

A number of chromosome counts have been reported for *Vaccinium uliginosum*, and are associated with specific subspecies. The basal chromosome number is 12. According to Young (1970), plants from New England have been found with two different chromosome counts. Diploid plants with $2n = 12$ belong to *Vaccinium uliginosum* ssp. *gaultherioides*, and tetraploid plants with $2n = 24$ belong to *Vaccinium uliginosum* ssp.

pubescens. Despite chromosome differences, these plants may still be able to cross-pollinate and exchange genetic information (Young 1970).

Vaccinium uliginosum flowers from June to July (Gleason and Cronquist 1991). At lower altitudes, it blooms earlier and for a shorter duration (Lundberg 1974 in Jacquemart 1996). It is pollinated by bumblebees on Mt. Washington (Bliss 1966), and is also visited by other insects like syrphid flies and solitary bees (Jacquemart 1993). A study in Sweden found that *Vaccinium uliginosum* was less self-fertile than *Vaccinium vitis-idaea* and *Vaccinium oxycoccos* (Fröborg 1996), but another study in Belgium suggested that the polyploid *Vaccinium uliginosum* was more self-fertile than the diploid *Vaccinium vitis-idaea* and *Vaccinium oxycoccos*, though none exhibited high levels of self-compatibility (Jacquemart and Thompson 1996). In any case, it seems safe to say that *Vaccinium uliginosum* is primarily insect-pollinated, but has some ability to self-pollinate in the absence of pollinators.

If flowers are successfully pollinated and fertilized, they set fruit. A study in Newfoundland reported an interval of 35 days from anther dehiscence to fruit ripening (Vander Kloet and Hill 2000), though Jacquemart (1996) reports a longer interval of 5 to 8 weeks. Fruit are mature in September (Young 1992). Fruits usually contain at least several small seeds, and a plant may produce thousands of seeds one year, and none another year (Vander Kloet and Hill 1994). The berries are borne singly or in pairs, and may be eaten by birds or mammals. Spruce grouse, migrating songbirds, black bears, chipmunks, and white-footed mice may eat the fruits (Martin *et al.* 1951). Animals may act as dispersers, but a few adaptations suggest that *Vaccinium uliginosum* tries to bypass animal predation. Its fruits tend to be concealed among its leaves, which turn purple in the fall, and the berries fall off the plant quickly after they ripen (Vander Kloet and Hill 2000). In general, though, shrubs with berries attract birds and mammals and rely on them as dispersers (van der Pijl 1972 in Vander Kloet and Hill 2000), and seeds of *Vaccinium uliginosum* have been found in bird droppings. Seeds of *Vaccinium uliginosum* may be a common part of the seedbank (Vieno *et al.* 1993), or they may be absent from the seedbank (Vander Kloet and Hill 1994). Where they are present, seeds can remain viable for at least six years (Vander Kloet and Hill 2000).

One study found that seeds from scat germinated at rates similar to seeds that had not been eaten. The rates were lower than the rates for cleaned seed, but were still over 50%, though the seedlings were likely to be attacked by fungi. Regardless of animal interaction, *Vaccinium uliginosum* seeds show a much higher rate of germination after they have undergone cold stratification, demonstrating that they have a dormancy period (Vander Kloet and Hill 1994, Vander Kloet and Hill 2000). Seeds may germinate rapidly in the spring, when snow cover is gone and the temperature rises (Calmes and Zasada 1982). Seedling growth is slow, and at the end of its first season, a seedling may only be 3.5 cm tall. Seedlings are rarely observed in natural populations (Jacquemart 1996). This may be due to competition for light and resources from mature plants (Howe 1986 in Vander Kloet and Hill 1994), or it may be due to climatic conditions such as early frost or frost heaving.

Mature plants may be browsed by deer and rabbits (Martin *et al.* 1951), and may be attacked by smaller organisms. Various insects eat the leaves of *Vaccinium uliginosum*, and fungi may attack roots or leaves (Jacquemart 1996). However, it is not clear how many of the insects and fungi are found in northeastern North America, since most of the studies done have been in Europe.

HABITAT

Vaccinium uliginosum is found in many alpine communities. It is a shrub of tundra and muskeg in boreal, arctic, and alpine regions (Young 1970). It is also found on rocky barrens and mountain slopes (Haines and Vining 1998). It requires open habitats and only seems to grow in soils with low pH values, especially poorly drained peat soils (Jacquemart 1996). *Vaccinium uliginosum* is well-suited to the soils on Mt. Washington, New Hampshire, since they are quite acidic, with a low availability of exchangeable cations, and are deficient in nitrogen (Bliss 1966). It is likely that most of the soils in alpine regions in the Northeast share these characteristics. These soils tend to have good drainage, but stay moist due to fog and precipitation (Bliss 1966).

In New Hampshire, *Vaccinium uliginosum* occurs primarily in the dry/mesic heath meadow system of alpine communities, which includes an array of *Carex* meadows, strong heaths, *Diapensia*, fell fields, and barren rock (SVE Panel 2002). The dry/mesic heath meadow system is located on unconsolidated gravel-stony soils, is associated with stony areas and convex landforms that are more exposed, and is limited by elevation (SVE Panel 2002). The dry/mesic heath meadow system forms a large and widespread patch matrix in the Presidential Range. Lesser summits have these systems in small patches (SVE Panel 2002). *Vaccinium uliginosum* is typically found on flatter areas of this association that are wetter, have thicker soils, or are somewhat sheltered versus areas that are more exposed. *Vaccinium uliginosum* is also found in the snowbank/wet meadow/streamside community system, bare subalpine rock summits, subalpine heath/krummholz, and alpine/subalpine bogs, but is not usually found in snowbanks or very wet or exposed areas (SVE Panel 2002). It is found in alpine meadows and in krummholz communities in Vermont and New York, and is found in alpine and subalpine communities in Maine. Many of these community types are ranked S1 or S2 in New England states (see St. Hilaire 2002 for more details on ranks). Over 20 community types are listed below.

1) The alpine herbaceous snowbank meadow is a type of snowbank meadow community that may be associated with seepage zones and that has more herbs than heaths (Sperduto and Cogbill 1999). Snowbank meadow communities are characterized by deep accumulations of snow that melt late and are typically adjacent to krummholz clumps on east and southeast facing slopes, as well as in the lee of rocks. They are usually found below 5800 feet and are floristically richer than those found at higher elevation but may lack some true alpine species. These communities tend to have thick organic soils, and well-decomposed peat provides an important source of nutrients (SVE Panel 2002). Soil pH values range from 4.0 to 4.6 (Bliss 1963). Lower elevation snowbank communities

may include *Dryopteris spinulosa*, *Rubus pubescens*, *Amelanchier bartramiana*, *Spiraea latifolia*, *Streptopus roseus*, *Betula minor*, and *Betula nana* (Bliss 1963, 1966; Sperduto 1993). Plants of higher elevation snowbank communities (5300-6100 feet) include *Vahlodea atropurpurea*, *Salix herbacea*, *Geum peckii*, *Vaccinium uliginosum*, *Carex bigelowii*, *Solidago macrophylla*, *Houstonia caerulea*, *Phyllodoce caerulea*, *Harrimanella hypnoides*, *Castilleja septentrionalis*, *Phleum alpinum*, *Oxyria digyna*, *Luzula spicata*, *Luzula parviflora*, *Viola palustris*, *Veronica alpina* var. *unalaschensis*, *Vaccinium cespitosum*, *Maianthemum canadense*, *Coptis groenlandica*, *Clintonia borealis*, *Cornus canadensis*, and *Veratrum viride*. Total plant cover in snowbank communities averages 91-94%, (Bliss 1966).

2) The moist alpine herb-heath meadow is found only in the Alpine Garden on Mt. Washington. It was formerly included in the streamside community. It is a moist tundra found near streams or snowbanks that is dominated by a variety of herbs, sedges, and heath shrubs (Sperduto and Cogbill 1999). Shrub and heath species include *Salix planifolia*, *Salix uva-ursi*, *Alnus crispa*, *Salix argyrocarpa*, *Vaccinium cespitosum*, *Vaccinium vitis-idaea*, and *Vaccinium uliginosum*. *Cardamine bellidifolia*, *Carex scirpoidea*, *Saxifraga rivularis*, *Houstonia caerulea*, *Polygonum viviparum*, *Potentilla tridentata*, *Prenanthes nana*, *Scirpus cespitosus*, *Agropyron trachycaulon*, *Trisetum spicatum*, *Veronica alpina*, *Achillea borealis*, *Euphrasia oakesii*, *Epilobium alpinum*, *Viola palustris*, and *Carex capillaris* may all occur (Bliss 1963; Sperduto 1993). Plant cover is typically 90% (Bliss 1963). Soil pH ranges from 4.7 to 4.9 (Bliss 1963).

3) The Diapensia-azalea-rosebay dwarf shrubland of New Hampshire is found on exposed wind blown situations with considerable bare ground where winter snow cover is slight or absent (4400-5500 feet elevation). *Diapensia* communities are characterized by the lowest percent plant cover of alpine communities (48-51%), a dominance of cushion plants, and a limited cover of lichens and mosses. Freeze-thaw cycles are prevalent, as are active soil polygons (patterned soil movement due to freeze-thaw cycles) (Bliss 1963). Dominant species include *Diapensia lapponica*, *Juncus trifidus*, *Rhododendron lapponicum*, *Loiseleuria procumbens*, and *Vaccinium uliginosum*. Other species may include *Solidago cutleri*, *Salix uva-ursi*, *Agrostis mertensii*, and *Minuartia groenlandica*.

4) The Diapensia-bilberry heath community represents less diverse *Diapensia* heaths and is found at lower elevations (4000-4600 feet) (Sperduto and Cogbill 1999). Both *Diapensia* communities have soil pHs between 4.2 and 4.6 (Bliss 1963).

5) The alpine heath snowbank community is located in the lee of rocks and ledges or just above continuous krummholz where snow accumulates and typically does not melt until May. Soils in this community tend to be well-drained, with a pH from 4.0 to 4.6 (Bliss 1963). The community is characterized by *Vaccinium uliginosum*, *Vaccinium angustifolium*, *Vaccinium vitis-idaea*, *Carex bigelowii*, and *Juncus trifidus*, supports *Ledum groenlandicum*, *Empetrum nigrum*, *Vaccinium cespitosum*, *Loiseleuria procumbens*, and occasionally *Arctostaphylos alpina* (Sperduto 1993). *Phyllodoce caerulea* and *Harrimanella hypnoides* can be found in this community (Sperduto and Cogbill 1999). Herbaceous associates include *Cornus canadensis*, *Maianthemum*

canadense, and *Trientalis borealis*, and *Cetraria islandica* is frequently present. These communities form dense mats 4 to 12 inches deep, with 91-96% plant cover (Bliss 1963, 1966).

6) Bigelow's sedge meadow is generally the dominant but variable alpine meadow community of higher alpine peaks. Krummholz is sparse or absent. The community is dominated by *Carex bigelowii*, with small amounts of *Minuartia groenlandica* and dwarf heaths, and is found at 4300-6000 feet.

7) The sedge-rush-heath meadow is typically found on west and north exposures from 4800-5500 feet and is characterized by mixtures of *Carex bigelowii*, *Juncus trifidus*, dwarf heath and other shrubs (Sperduto 1993). *Minuartia groenlandica* and *Vaccinium vitis-idaea* are present, and total plant cover averages 72% (Bliss 1963). At lower elevations rush-heath mixtures with less sedge are a prominent variant (Sperduto and Cogbill 1999). *Carex bigelowii* is more prominent at higher elevations, while *Juncus trifidus* is more prominent at lower elevations. Other species present include *Potentilla tridentata* and *Cetraria islandica*. Some examples have much exposed rock and may grade into a fellfield community (Sperduto 1993). At elevations above 5600 feet on Mt. Washington, the community is characterized by *Juncus trifidus*, *Vaccinium vitis-idaea*, and *Potentilla tridentata*, with *Carex bigelowii* and *Minuartia groenlandica* decreased in importance. In more exposed areas, *Diapensia lapponica* is common, while *Vaccinium uliginosum* is more prevalent in areas with greater snow cover (Bliss 1963). Soils in this habitat have pHs ranging from 4.1 to 4.7 (Bliss 1963).

8) The dwarf shrub-bilberry-rush barren is found in exposed situations, from 3400 to 4800 feet. It is the most common alpine community type in the Presidential Range in New Hampshire, covering extensive areas. This community is usually located within a few hundred feet of timberline (Bliss 1963). Some winter snow may accumulate, but it melts early (Sperduto 1993). It is dominated by *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, *Juncus trifidus*, with scattered dwarf shrubs, particularly *Empetrum atropurpureum*, *Potentilla tridentata*, and the occasional *Diapensia lapponica* and *Betula minor*. *Carex bigelowii* and *Juncus trifidus* have a lower abundance here than in sedge-rush-heath meadows (Sperduto and Cogbill 1999). This community type has local variations. On the upper solifluction terraces at higher elevations, like Mt. Washington's Alpine Garden, *Minuartia groenlandica*, *Scirpus cespitosus*, and *Agrostis mertensii* are important. On nearby Boott Spur and Bigelow Lawn, large stone rings with wind-exposed diapensia communities at their centers are surrounded with dwarf shrub heath-rush or sedge-rush-dwarf shrub heath on the more stable and protected flanks. In areas where the soils are moister in summer, there is an increase in the importance of *Carex bigelowii*, so that it dominates, or is co-dominant with *Juncus trifidus* (Bliss 1963). Soils in this community have pHs that range from 4.1 to 4.6 (Bliss 1963).

9) In New Hampshire, the wet alpine/subalpine level and sloping bog community is included in the broader classification of subalpine bogs and subalpine heath snowbanks, which are sloping and level peatlands from 2900 to 4000 feet, occurring in concavities on ridges and on slopes where a combination of poor drainage and abundant precipitation,

and/or self-maintaining *Sphagnum* mats contribute to peat accumulation. The soil is a thick organic layer, with a pH between 4.2 and 4.7 (Bliss 1963). Lowland bog plants are the primary species, but subalpine or alpine species can also be found (Sperduto and Cogbill 1999). *Carex bigelowii* is prevalent, with lesser amounts of *Scirpus cespitosus*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, *Vaccinium oxycoccos*, *Eriophorum spissum*, and *Kalmia polifolia*. Moss species include *Dicranum bergeri*, *Sphagnum fuscum*, *Sphagnum girgensohnii*, *Aulacomnium turgidum*, and *Drepanocladus uncinatus* (Bliss 1963). Wet alpine/subalpine level and sloping bog communities are usually level or slightly sloping peatlands and occur above 3500 feet. They have a patchy distribution, and are restricted to little strips on major subalpine ridges (SVE panel 2002). They tend to be permanently saturated. *Sphagnum capillifolium*, *Sphagnum fuscum*, *Sphagnum rubellum*, *Sphagnum russowii*, and *Sphagnum lescurii* dominate, with subalpine species such as *Empetrum nigrum*, *Vaccinium uliginosum*, and *Rubus chamaemorus*. *Vaccinium oxycoccos* and *Eriophorum vaginatum* are also present (Sperduto and Cogbill 1999). In sites with more alpine exposures at higher elevations, *Carex bigelowii*, *Geum peckii*, and *Betula glandulosa* may be present (Sperduto 1993).

10) In the Labrador tea heath/krummholz community, stunted *Abies balsamea* and *Betula papyrifera* var. *cordifolia* are common, with *Picea rubens* occasional near 3500 feet and *Picea mariana* near 4900 feet. Dwarf shrubs include *Ledum groenlandicum*, *Empetrum atropurpureum*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, and occasionally *Vaccinium boreale*. *Cladina rangiferina*, *Cetraria islandica*, and *Cladina alpestris* are common and abundant. This krummholz community type ranges from nearly pure dwarf shrublands (<15 cm tall) to mixtures with up to 60% krummholz (<2 meter tall trees) (Sperduto and Cogbill 1999).

11) The sheep laurel-Labrador tea heath/krummholz community is found primarily between 3000 and 3500 feet, and is characterized by a mixture of *Kalmia angustifolia* and *Ledum groenlandicum*, with *Vaccinium uliginosum* and *Vaccinium vitis-idaea*. Dwarfed *Betula papyrifera* var. *cordifolia* and *Abies balsamea* are common, and *Picea rubens* is more frequent than *Picea mariana*. Occasional species include *Rhododendron canadense* and *Nemopanthus mucronatus*, with *Vaccinium angustifolium* more common than at higher elevations. This krummholz community type ranges from nearly pure dwarf shrublands (<15 cm tall) to mixtures with up to 60% krummholz (<2 meter tall trees) (Sperduto and Cogbill 1999).

12) The bilberry-mountain heath alpine snowbank in Maine is composed of low mats of dwarfed shrubs interspersed with herbs, and is usually found in protected areas above treeline on upper mountain slopes. *Vaccinium uliginosum* and *Vaccinium cespitosum* are dominant, and *Harrimanella hypnoides*, *Loiseleuria procumbens*, and *Phyllodoce caerulea* are characteristic. Lower elevation species can also be found, including *Maianthemum canadense*, *Cornus canadensis*, *Dryopteris campyloptera*, *Clintonia borealis*, *Solidago macrophylla*, and *Deschampsia flexuosa* (Gawler 2001).

13) The Diapensia alpine ridge in Maine has patchy alpine vegetation in which matted evergreen shrubs and a few herbs are scattered among boulders or in bedrock pockets.

Cushions of *Diapensia* are the dominant feature, but *Vaccinium uliginosum* is also common. The cover of herb species is usually less than 20%, and graminoids such as *Carex bigelowii* and *Juncus trifidus* are typically more abundant than forbs. This community is found in very exposed and windswept areas above treeline, with plants growing in gravelly substrate among fractured rocks (Gawler 2001).

14) The dwarf heath-graminoid alpine ridge is the most common community type above treeline in Maine. It occurs on exposed windswept ridges, and ranges from dry in exposed areas to moist in protected patches. The vegetation is a mixture of dwarf evergreen shrubs and herbs, with total cover from 35-65%. The most abundant herbs are *Carex bigelowii* and *Juncus trifidus*. In one variant, *Carex bigelowii* forms carpets and is dominant, with sparse heath shrubs and herbaceous species. *Vaccinium uliginosum* and *Diapensia lapponica* are both present in this community (Gawler 2001).

15) The subalpine heath-krummholz community is dominated by dwarf shrubs and stunted spruce and fir in Maine. It is found on upper slopes and ridges, usually above 2000 feet, but also occurs near the coast. On mountains, it is frequently the transitional community between treeline and the alpine zone. It is characterized by thin, acidic, well drained soils, and patchy vegetation. Tree species include *Picea mariana*, *Abies balsamea*, and *Sorbus americana*. Shrub species include *Ledum groenlandicum*, *Kalmia angustifolia*, *Vaccinium angustifolium*, and *Vaccinium uliginosum*. *Potentilla tridentata* is also common (Gawler 2001).

16) The spruce-fir-birch krummholz community has dense thickets of stunted matted black spruce, balsam fir, and the occasional birch. Other plants do poorly directly under the krummholz, but species such as *Potentilla tridentata* can be found in openings. The krummholz community occurs between subalpine forests and alpine areas on Maine's higher mountains (Gawler 2001).

17) The three-toothed cinquefoil-blueberry low summit bald community in Maine is characterized by a mosaic of blueberry, lichens, low herbs, and bare rock patches. Elevations range from 600 to 1500 feet, and the balds are mostly found near the coast. Diversity tends to be low, with cover that ranges from 25-55%. *Potentilla tridentata*, *Vaccinium angustifolium*, and *Deschampsia flexuosa* are common, with lichens interspersed in rock crevices. The soils of this community are thin, dry, and acidic, and are in patches over the bedrock (Gawler 2001).

18) The crowberry-bilberry summit bald community in Maine is typically found on acidic bedrock summits or near-summits above 1800 feet. There is usually more exposed rock than vegetation, which consists of a patchy cover of subalpine to alpine species. The dominant species are *Empetrum nigrum* and *Vaccinium uliginosum*. *Empetrum atropurpureum* may occasionally be found, and short trees of *Picea rubens*, *Nemopanthus mucronatus*, and *Betula papyrifera* var. *cordifolia* may be present at lower elevations (Gawler 2001).

19) Alpine meadows are found on open, exposed ridgetops at elevations above 3500 feet in Vermont. In these locations, high winds, frequent fog, abundant precipitation, low temperatures, and frequently intense solar radiation are prevalent. The soils are thin and primarily organic, in low pockets and in areas where the bedrock breaks into small fragments through freezing and thawing, allowing soil accumulation. The plant associations in this community are determined by environmental stresses, soil depth, and moisture. Sedge meadows form a mosaic with low shrub communities, areas of lichen-covered bedrock, and occasional trees in protected pockets. This community is characterized by many arctic species. *Vaccinium uliginosum*, *Empetrum nigrum*, and *Vaccinium boreale* are the dominant shrubs, with *Salix uva-ursi* and *Salix pyrifolia* also present. Herbaceous species may include *Agrostis mertensii*, *Asplenium viride*, *Carex atratiformis*, *Carex bigelowii*, *Deschampsia flexuosa*, *Diapensia lapponica*, *Dryopteris fragrans*, *Empetrum nigrum*, *Hierochloe alpina*, *Huperzia appalachiana*, *Juncus trifidus*, *Luzula parviflora*, *Maianthemum canadense*, *Minuartia groenlandica*, *Poa fernaldiana*, *Potentilla tridentata*, *Prenanthes boottii*, *Smilacina trifoliata*, and *Solidago cutleri* (Thompson and Sorenson 2000).

20) The subalpine krummholz community of Vermont is characterized by stunted trees that are shaped by harsh winds, rime ice, and heavy snowfall. Soils are thin undecomposed organic layers that are near saturation most of the year. The dominant species are *Abies balsamea* and *Picea mariana*, with occasional plants of *Sorbus decora*, *Betula papyrifera* var. *cordifolia*, *Picea rubens*, *Acer spicatum*, and *Sorbus americana* as well. Shrubs include *Vaccinium boreale*, *Vaccinium myrtilloides*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, *Ledum groenlandicum*, *Amelanchier bartramiana*, and *Viburnum edule*. The herb layer can include *Maianthemum canadense*, *Cornus canadensis*, *Carex brunnescens*, *Carex canescens*, *Clintonia borealis*, *Oxalis montana*, *Coptis trifolia*, *Potentilla tridentata*, *Pyrola minor*, and *Huperzia appalachiana* (Thompson and Sorenson 2000).

21) The serpentine outcrop community is sparsely vegetated with low diversity due to the scarcity of soil and the mineral content of the soil. The bedrock may be serpentinite or dunite. Serpentine rock has a high content of iron, magnesium, nickel, and chromium, and a low content of calcium, nitrogen, phosphorus, potassium, and molybdenum. Most of the species found in this habitat are grasses and herbs, though shrubs and occasional trees may be present. Species found in the serpentine outcrop community include *Picea rubens*, *Betula populifolia*, *Juniperus communis* var. *depressa*, *Campanula rotundifolia*, *Cerastium arvense*, *Deschampsia flexuosa*, *Arenaria stricta*, *Dryopteris marginalis*, *Danthonia spicata*, *Poa compressa*, and rarities like *Adiantum viridimontanum*, *Adiantum aleuticum*, *Arenaria macrophylla*, and *Arenaria marcescens* (Thompson and Sorenson 2000).

In New York, the Natural Heritage Program (2004) lists its habitat as alpine ridges, meadows, and openings in krummholz. The three community types that correspond to these descriptions according to Edinger et al. (2002) are alpine meadow, alpine krummholz, and spruce-fir rocky summit, and they are described below.

22) The alpine meadow is a meadow community that is similar to arctic tundra. Alpine meadows occur above timberline (about 4900 ft or 1620 m) on the higher mountain summits and exposed ledges of the Adirondacks. This community consists of a mosaic of small grassy meadows, dwarf shrublands, small boggy depressions, and exposed bedrock covered with lichens and mosses. The flora includes arctic-alpine species that are restricted (in New York) to these meadows, as well as boreal species that occur in forests and bogs at lower elevations. The soils are thin and organic, primarily composed of sphagnum peat or black muck. The soils are often thoroughly wet because they can be saturated by atmospheric moisture from fog. Characteristic species of the grassy meadows include *Scirpus cespitosus*, *Carex bigelowii*, *Calamagrostis canadensis*, *Hierochloa alpina*, *Deschampsia flexuosa*, *Luzula parviflora*, *Juncus trifidus*, *Potentilla tridentata*, *Cornus canadensis*, *Minuartia groenlandica*, and *Prenanthes nana*. Characteristic species of the low shrublands are *Vaccinium uliginosum*, *Chamaedaphne calyculata*, *Ledum groenlandicum*, *Betula glandulosa*, *Empetrum nigrum*, *Rhododendron lapponicum*, *Diapensia lapponica*, and *Salix uva-ursi*. On a few mountains there are distinctive patches of low shrublands consisting of dwarf birches including *Betula glandulosa*, *Betula minor*, and stunted *Betula cordifolia*. Characteristic species of the small boggy depressions include the peat mosses *Sphagnum nemoreum* and *Sphagnum fuscum*, *Eriophorum vaginatum* var. *spissum*, *Kalmia polifolia*, and *Vaccinium oxycoccos*. Rock outcrops that are relatively undisturbed by trampling are covered with arctic-alpine lichens such as map lichen (*Rhizocarpon geographicum*) and may have scattered cushions of diapensia. This community is very sensitive to trampling because of the thin, often saturated soils and the very slow growth rate of the vegetation in the stressful alpine environment.

23) The alpine krummholz community is a dwarf woodland dominated by *Abies balsamea* that occurs at or near the summits of the high peaks of the Adirondacks at elevations of 3500 to 4900 ft (1067 to 1494 m). Approximately 85% of the canopy consists of *Abies balsamea*; common associates include *Betula cordifolia* and *Picea mariana*. Less common are *Picea rubens*, *Juniperus communis*, *Larix laricina*, and *Thuja occidentalis*. The trees form dense stands of stunted trees; at the uppermost elevations below timberline the trees are under 5 ft (1.5 m) tall, with branches extending to the ground (i.e., there is no self-pruning of lower branches), and an average dbh of 3 in (7.6 cm). The groundlayer is densely shaded; the groundcover consists of a thick carpet of mosses, with scattered lichens and herbs. Characteristic herbs include *Cornus canadensis*, *Solidago macrophylla*, *Oxalis acetosella*, *Coptis trifolia*, and *Maianthemum canadense*.

24) The spruce-fir rocky summit is a community that occurs on cool, dry, rocky ridgetops and summits where the bedrock is non-calcareous (such as anorthosite, quartzite, or sandstone), and the soils are more or less acidic. The vegetation may be sparse or patchy, with numerous rock outcrops and rock slides. The species have predominantly boreal distributions. Characteristic trees include *Picea rubens*, *Abies balsamea*, *Sorbus americana*, and *Betula cordifolia*. *Tsuga canadensis* may be an associate in examples in the Catskill Mountains. The shrub layer includes sapling canopy trees along with *Vaccinium angustifolium* and *Vaccinium myrtilloides*. Characteristic herbs include *Campanula rotundifolia*, *Potentilla tridentata*, *Solidago spathulata* ssp. *randii*, *Solidago*

macrophylla, *Deschampsia flexuosa*, *Cornus canadensis*, *Aster acuminatus*, and *Oryzopsis pungens*. There are usually many mosses and crustose lichens growing on rock outcrops. This community type is not fully understood and more data are needed.

The alpine and subalpine habitats in which *Vaccinium uliginosum* occurs overlap with the habitats of *Juncus trifidus*, *Carex bigelowii*, and *Agrostis mertensii*, for which conservation assessments have also been written. Surveys in the alpine zone should include these species as well, since they are likely to be found with *Vaccinium uliginosum*.

DISTRIBUTION AND ABUNDANCE

Vaccinium uliginosum is a circumboreal species. It is found across Canada, Europe, and Asia (Gleason and Cronquist 1991). In the United States it occurs in Maine, New Hampshire, Vermont, New York, Minnesota, Michigan, and in Montana, Idaho, Utah, Nevada, Wyoming, Oregon, Washington, California, and Alaska (NatureServe 2001).

It occurs in alpine and subalpine areas, and reaches the southern limit of its range in northern New England and New York. It is a characteristic shrub of muskeg and tundra, and is common and abundant throughout the central part of its range (Young 1970). In New Hampshire, Maine, and New York, *Vaccinium uliginosum* is a fairly common shrub of alpine and subalpine communities. Vermont, which has a limited alpine area, has fewer occurrences of the species. The White Mountain National Forest has all but five of New Hampshire's occurrences, while only one of Vermont's occurrences is within the Green Mountain National Forest.

Status of Maine Occurrences

Vaccinium uliginosum is not tracked in Maine. It is reported as an associate of other rare species at the following locations (Maine Natural Areas Program 2001). It is unknown whether these populations still exist.

T3 R10 WELS, Piscataquis County – *Vaccinium uliginosum* was seen here on July 17, 1984. It grew at 3260 feet on an open slide. Associated species included *Empetrum nigrum*, *Minuartia groenlandica*, *Juncus trifidus*, and *Agrostis mertensii*. This occurrence is in Baxter State Park.

Dead River Township, Somerset County – *Vaccinium uliginosum* was seen growing on the summit on September 4, 2002. The elevation ranged from 4060 to 4100 feet. Plants grew in gravel along with *Carex bigelowii*, *Agrostis mertensii*, *Juncus trifidus*, *Hierochloa alpina*, *Vaccinium boreale*, and *Sibbaldiopsis tridentata*. Trails are well-marked and scree walls are present, but hikers still impact the vegetation. The area is in the Appalachian Trail Corridor and is part of an eco-reserve owned by the Bureau of Parks and Land.

Sandy River Pkt., Franklin County – *Vaccinium uliginosum* was seen here on June 8, 1985 and July 10, 1996. It was a characteristic species, along with *Empetrum nigrum*, *Vaccinium angustifolium*, *Ledum groenlandicum*, *Minuartia groenlandica*, *Diapensia lapponica*, *Juncus trifidus*, and *Carex bigelowii*. The elevation ranged from 3500 to 4116 feet. The Appalachian Trail passes through this site.

Mt. Abram Township, Franklin County – *Vaccinium uliginosum* was seen here on August 14, 1985, and July 28, 1997. Plants occurred in a dwarf shrub community with *Ledum groenlandicum* and *Vaccinium angustifolium*, and in a krummholz community with *Picea mariana*, *Abies balsamea*, *Betula cordifolia*, and *Vaccinium angustifolium*. The elevation ranged from 3500 to 4049 feet. The area is owned by a paper company, but trails are maintained by hiking organizations.

Grafton, Oxford County – *Vaccinium uliginosum* was seen here on June 25, 2001. Plants grew at 3800 feet in association with *Vaccinium vitis-idaea*, *Kalmia angustifolia*, *Empetrum nigrum*, *Ledum groenlandicum*, and *Vaccinium angustifolium*. This site is in the Appalachian Trail Corridor and is owned by the Bureau of Parks and Land. Trampling by hikers threatens the vegetation.

Riley Township, Oxford County – *Vaccinium uliginosum* was seen here in 1990. Plants grew in an alpine heath at approximately 3000 feet in association with *Empetrum nigrum*, *Ledum groenlandicum*, *Kalmia angustifolia*, *Vaccinium vitis-idaea*, *Potentilla tridentata*, *Juncus trifidus*, *Scirpus cespitosus*, and *Minuartia groenlandica*. The Appalachian Trail passes through part of this site. The area is owned by the Bureau of Parks and Land.

It has also been reported from Aroostook, Penobscot, and Hancock Counties (Josselyn Botanical Society 1995).

Status of New Hampshire Occurrences

New Hampshire Natural Heritage Bureau stopped mapping *Vaccinium uliginosum* in 1993. They still collect data on occurrences, but are preparing to use a new mapping system and treat all occurrences in the Presidential Mountains as one metapopulation.

There are at least 43 occurrences that are considered to be extant (New Hampshire Natural Heritage Inventory 2001). There are 10 historical occurrences. Five occurrences are from private land, the rest are within the White Mountain National Forest. Occurrences may be ranked from A to D (A being best) based on population size, available habitat size, population quality, and population defensibility.

NH .001 (Lincoln, Grafton County) – McKenzie made a specimen from this occurrence on August 1, 1975, from 4000 feet. The specimen is at Plymouth State College. The site is located in the Pemigewasset Wilderness of the White Mountain National Forest.

NH .002 (Sargents Purchase, Coos County) – This historical occurrence was collected on Mt. Washington at 5900 feet on August 10, 1921 by Rehder. The specimen is at GH. Specimens from Greenman (#1159, MO) in 1898, Flint & Huntington (#6724 MO) in 1876, and Englemann (MO) in 1856 are also known. The site is located within Mt. Washington State Park in the White Mountain National Forest.

NH .003 (Sargents Purchase, Coos County) – Specimens have been collected by Faxon in 1887, and Hodgdon and Harrington (#6311.1900) in 1949. Pease cited this population in 1964. It was seen in 1990, and was last observed on July 22, 1996. It was growing all along the trail. This site is in the White Mountain National Forest.

NH .004 (Beans Purchase, Coos County) – In 1989, hundreds of vegetative plants were observed. This population is ranked B. This occurrence was observed on June 17, 1997 by M. Tetreault, and was also observed in 1999. It is located in the White Mountain National Forest, near an Appalachian Mountain Club hut. This location is an open forest with large boulders and talus. Elevation ranges from 3250 to 3400 feet. Associated species include *Picea rubens*, *Abies balsamea*, *Betula papyrifera* var. *cordifolia*, *Ledum groenlandicum*, *Vaccinium vitis-idaea*, and *Empetrum atropurpureum*. Hiker traffic threatens plants in this location.

NH .005 (Pinkham's Grant, Coos County) – This occurrence was observed on August 15, 1989, at 2850-3000 feet. The population consisted of nearly 50 vegetative plants, covering an area of 5 to 10 square yards. The plants were mature and of normal vigor, but showed no evidence of reproduction. Associated species included *Vaccinium vitis-idaea*, *Empetrum nigrum*, *Ledum groenlandicum*, and *Betula cordifolia*. The occurrence is ranked C due to its quality, condition, and defensibility. It is in the White Mountain National Forest and may be threatened by hiker traffic.

NH .006 (Franconia, Grafton County) – This occurrence was observed on July 25, 1990, and noted as common and widespread between two peaks. It is ranked A, and is in the White Mountain National Forest. The elevation is 5200 feet and hiker traffic is a threat.

NH .007 (Franconia, Grafton County) – This occurrence was observed on July 26, 1990, and was noted as being widespread and common. It is ranked A. It is in the White Mountain National Forest, at 5080 feet, and is threatened by hiking traffic.

There are six unprocessed field reports at New Hampshire Natural Heritage Bureau that mention more recent occurrences of *Vaccinium uliginosum* from three mountains and three ridges in the same area as NH .006 and .007.

NH .008 (Benton, Grafton County) – This population was first seen on July 31, 1990, and the species was noted as being throughout the alpine area and in a subalpine bog, but no details were recorded. The population is small but in excellent condition, and is ranked B. It was observed on October 15, 1999. Five plants were observed right along a trail. A visit on October 6, 2002, listed *Vaccinium uliginosum* as well as *Carex bigelowii*,

Potentilla tridentata, *Minuartia groenlandica*, *Deschampsia flexuosa*, *Vaccinium vitis-idaea*, *Agrostis mertensii*, *Juncus trifidus*, and *Achillea millefolium*. It is on a popular mountain that is partly within the White Mountain National Forest. The elevation is 4802 feet. There is an unprocessed field report on this location at New Hampshire Natural Heritage Bureau.

NH .009 (Franconia, Grafton County) – This occurrence was observed on August 7, 1990. The site is on a mountain in the White Mountain National Forest. The population is ranked C and limited habitat area prevents a better rank. The elevation is 4360 feet, and hiker traffic is a threat.

NH .010 (Franconia, Grafton County) – This occurrence was first seen in 1990 and was observed on July 24, 1997 by M. Tetreault. The population is ranked CD and the available habitat is noted as a small rocky summit. It is from a mountain in the White Mountain National Forest. Elevation is 4900 feet and hiker traffic may be a threat.

NH .011 (Lincoln, Grafton County) – In 1990, over 1000 ramets were seen in a 2+ acre area. The population is ranked B and it is noted that *Vaccinium uliginosum* is abundant and of normal vigor in available habitat, but that habitat is limited. This occurrence was observed again on July 25, 1997 by M. Tetreault. This occurrence is from a mountain in the White Mountain National Forest. The elevation is 4500 feet. Associated species include *Diapensia lapponica*, *Empetrum nigrum*, and *Minuartia groenlandica*.

NH .012 (Franconia, Grafton County) – This occurrence was first seen in 1990, and was observed again on June 24, 1997 by M. Tetreault. It is ranked C. It is at a lower elevation (4165 feet) by a lake and an Appalachian Mountain Club hut, and is in the White Mountain National Forest. It occurs just above treeline on the trail along with *Prenanthes* sp., *Scirpus cespitosus*, *Potentilla tridentata*, *Diapensia lapponica*, and *Carex bigelowii*. It is also in a heath meadow with *Geum peckii*, *Scirpus cespitosus*, *Salix uva-ursi*, *Betula minor*, *Prenanthes* sp., and *Hierochloa alpina*. Hiker traffic is a threat.

NH .013 (Beans Purchase, Coos County) – This occurrence was observed on July 22, 1990, but no details were noted. The habitat is a subalpine heathland, at 3400 feet. It is on a mountain in the White Mountain National Forest.

NH .014 (Beans Purchase, Coos County) – This occurrence was observed on July 22, 1990, but no details were noted. The habitat is a northern exposed shoulder with *Empetrum atropurpureum* and *Empetrum nigrum*, at 4580 feet. It is from a mountain in the White Mountain National Forest. There is an unprocessed field report from this location at New Hampshire Natural Heritage Bureau.

NH .015 (Beans Purchase, Coos County) – This occurrence was observed on July 21, 1990. It is located on the summit of a mountain in the White Mountain National Forest. Associated species include *Empetrum atropurpureum* and *Vaccinium vitis-idaea*. The elevation is 3900 feet. There is an unprocessed field report from this location at New Hampshire Natural Heritage Bureau.

NH .016 (Success, Coos County) – This occurrence was first recorded on June 19, 1990; the population was 90% in leaf, 10% in flower. There were 101-1000 plants on 2+ acres. Most plants were mature and of normal vigor, and showed good sexual reproductive success. This occurrence is ranked B. In 1995, the population was observed but no details are available. Associated species included *Vaccinium boreale*, *Vaccinium angustifolium*, *Vaccinium vitis-idaea*, *Ledum groenlandicum*, *Empetrum nigrum*, *Abies balsamea*, *Picea mariana*, *Minuartia groenlandica*, and *Betula cordifolia*. This occurrence was last observed on September 3, 1999. Hundreds to thousands of plants were observed as a major component of the summit community, and appeared healthy. It is within the Appalachian Trail Corridor. Hiker traffic can present a threat. The elevation is 3500 feet.

NH. 017 (Success, Coos County) – This occurrence was first recorded on June 18, 1990; fewer than 10 plants were seen on a rock outcrop less than 5 square meters in area, growing with *Rhododendron canadense*, *Ledum groenlandicum*, *Chamaedaphne calyculata*, *Vaccinium vitis-idaea*, and *Vaccinium corymbosum*. This occurrence is ranked D based on its quality. It was searched for but not found in 2000. The elevation is 2400 feet. It is within the Appalachian Trail Corridor.

NH .018 (Beans Grant, Coos County) – This occurrence was observed on September 2, 1990, and noted as an excellent occurrence. It is ranked A. It is from a mountain in the White Mountain National Forest. Associated species include *Diapensia lapponica*, *Juncus trifidus*, *Agrostis mertensii*, and *Carex bigelowii*. The elevation is 4185 feet.

NH .019 (Chandlers Purchase, Coos County) – This occurrence was observed on September 2, 1990. Plants were found to be numerous and abundant on the summit of a mountain, along a trail, and near a pond. Associated species included *Diapensia lapponica*, *Carex bigelowii*, *Juncus trifidus*, *Viola palustris*, and *Vaccinium cespitosum*. This population is ranked A and is in the White Mountain National Forest. Hiker traffic is heavy and has resulted in some erosion. Elevation ranges from 4300 to 4600 feet.

NH .020 (Beans Grant, Coos County) – This occurrence was observed on September 2, 1990. Plants were observed in limited habitat on the summit and along cliffs south of the summit of a mountain. This occurrence is ranked BC and is in the White Mountain National Forest. Associated species include *Diapensia lapponica*, *Juncus trifidus*, *Potentilla tridentata*, *Empetrum nigrum*, *Minuartia stricta*, *Solidago cutleri*, *Agrostis mertensii*, and *Carex bigelowii*. The elevation is 3910 feet.

NH .021 (Beans Grant, Coos County) – This occurrence was observed in 1989, and again on September 2, 1990. In 1989 it was noted as mature plants of normal vigor covering an area 10 to 100 square yards. The habitat is a subalpine bog at 4052 feet. Associated species included *Rubus chamaemorus* and *Empetrum nigrum*. This occurrence is ranked B and is from a mountain in the White Mountain National Forest. There is a more recent, unprocessed field report from this location at New Hampshire Natural Heritage Bureau.

NH .022 (Low & Burbanks, Coos County) – This occurrence was observed on July 16, 1990. It is in a ravine in the White Mountain National Forest, at 3250 feet. There is an unprocessed field report from this location at New Hampshire Natural Heritage Bureau, and *Vaccinium uliginosum* is listed as an associated species on a report from an adjacent mountain.

NH .023 (Thompson & Meserve, Coos County) – This occurrence was first observed in 1990. It was observed again on July 1, 1997 by M. Tetreault. It was in a dwarf shrub heath-rush community, along with *Hierochloa alpina* (Element Occurrence .018), *Vaccinium vitis-idaea*, *Juncus trifidus*, *Diapensia lapponica*, and *Deschampsia flexuosa*. It is from a mountain in the White Mountain National Forest.

NH .024 (Thompson & Meserve, Coos County) – This occurrence was observed on July 17, 1990. It is from a lawn on the south slope of a mountain in the White Mountain National Forest. The elevation is 5400 feet. *Vaccinium uliginosum* was observed nearby in a gulf in 1994.

NH .025 (Thompson & Meserve, Coos County) – This occurrence was first observed in 1990, and was observed again on July 1, 1997 by M. Tetreault. It is on a mountain in the White Mountain National Forest, at 5220 feet. The mountain has an open lawn, a snowbank community, and supports a number of species, including *Betula minor*, *Betula glandulosa*, *Empetrum nigrum*, *Deschampsia flexuosa*, *Geum peckii*, *Loiseleuria procumbens*, and *Phyllodoce caerulea*. There is an unprocessed field report for this location at New Hampshire Natural Heritage Bureau.

NH .026 (Thompson & Meserve, Coos County) – This occurrence was observed on July 17, 1990. It was noted as being abundant and a dominant species in an alpine bog, along with *Ledum groenlandicum*, *Betula glandulosa*, and *Scirpus cespitosus*. Other associated species included *Eriophorum vaginatum* var. *spissum*, *Vaccinium oxycoccos*, *Geum peckii*, and *Betula minor*. The elevation is 5250 feet. This occurrence is ranked B and is at a lake in the White Mountain National Forest.

NH .027 (Thompson & Meserve, Coos County) – This occurrence was first observed in 1990, and is in the White Mountain National Forest. It was observed again on July 1, 1997 by M. Tetreault. It occurs frequently around a lake and is ranked B. The habitat is a Northeastern Alpine/Subalpine bog, with *Eriophorum spissum*, *Scirpus cespitosus*, *Carex bigelowii*, *Geum peckii*, *Ledum groenlandicum*, *Picea mariana*, and *Juncus trifidus*. The elevation is 4900 feet. Hiker traffic may pose a threat. There is an unprocessed field report on this location at New Hampshire Natural Heritage Bureau.

NH .028 (Sargents Purchase, Coos County) – This occurrence was observed on June 28, 1990. It is from a well-known alpine area in the White Mountain National Forest. There is an unprocessed field report at New Hampshire Natural Heritage Bureau for *Vaccinium uliginosum* from Mt. Washington. It could correspond to this or the following

Element Occurrence from Sargents Purchase. There is also an unprocessed report from a ravine on Mt. Washington.

NH .029 (Sargents Purchase, Coos County) – This occurrence was observed on June 27, 1990, along a trail between the summit of Mt. Washington and an Appalachian Mountain Club hut. The habitat is characterized by boulder talus, and associated species include *Carex bigelowii*, *Diapensia lapponica*, *Loiseleuria procumbens*, *Rhododendron lapponica*, *Betula minor*, and *Betula glandulosa*. This occurrence is in the White Mountain National Forest, at 5900 feet.

NH .030 (Sargents Purchase, Coos County) – This occurrence was observed on June 28, 1990. It was reported as common and widespread on a lawn from a hut to a trail junction. D. Dunlop collected a specimen (#2897, NHA). The area is dominated by low heaths and alpine plants. This occurrence is ranked A and is in the White Mountain National Forest. The elevation is 5400 feet.

NH .031 (Sargents Purchase, Coos County) – This occurrence was observed by M. Tetreault on June 30, 1997. It was also observed in 1990 near an Appalachian Mountain Club hut and at a certain flat in the White Mountain National Forest. The elevation is 5020 feet. There is an unprocessed field report from a nearby mountain at New Hampshire Natural Heritage Bureau. *Vaccinium uliginosum* is mentioned as occurring along a trail from the hut to a gulf in a *Carex bigelowii* report (Element Occurrence .026).

NH .032 (Shelburne, Coos County) – This occurrence was observed on October 7, 1990. It is from a mountain in the White Mountain National Forest. The habitat is a matrix of heath associations, subalpine bogs, and krummholz. The elevation is 3420 feet. Hiker traffic and wandering off-trail is a threat.

NH .033 (Lincoln, Grafton County) – This occurrence was observed on August 28, 1991, and is ranked BC. The habitat is a cold talus slope, and associated species include *Empetrum nigrum*, *Ledum groenlandicum*, *Kalmia angustifolia*, *Picea mariana*, *Chamaedaphne calyculata*, *Vaccinium vitis-idaea*, *Vaccinium myrtilloides*, and *Vaccinium angustifolium*. It is on a mountain in the White Mountain National Forest. This is the lowest station for *Vaccinium uliginosum*, at 2320 feet.

NH .034 (Albany, Carroll County) – This occurrence was observed in 1991 and noted as occupying an area of a few square meters near the trail. It was associated with *Empetrum atropurpureum*, *Betula papyrifera*, *Picea rubens*, *Kalmia angustifolia*, and is ranked D. It is on a mountain in the White Mountain National Forest. The elevation is 2280 feet.

NH .035 (Albany, Carroll County) – This occurrence was observed on August 6, 1991. It is from the same mountain as .034, in the White Mountain National Forest.

NH .036 (Shelburne, Coos County) – This occurrence was observed on July 15-16, 1992. Plants were uncommon on three secondary summits along the trail. The habitat is

approximately 5 acres of a mosaic of moist subalpine heathland and boreal acidic rocky summit communities. The elevation ranges from 2960-3240 feet. Associated species include *Kalmia angustifolia*, *Vaccinium angustifolium*, *Vaccinium vitis-idaea*, *Empetrum atropurpureum*, *Empetrum nigrum*, *Nemopanthus mucronatus*, *Abies balsamea*, *Picea mariana*, and *Amelanchier bartramiana*. The occurrence is ranked B, and is along a trail in the White Mountain National Forest. Foot traffic is a problem, but the trail is fairly remote.

NH .037 (Benton, Grafton County) – This occurrence was observed in 1992. It is from a mountain in the White Mountain National Forest. No other details are available.

NH .038 (Low & Burbanks, Coos County) – This occurrence was observed on September 16, 1993. It was believed to consist of 2 genets of feeble vigor in a 1-5 square yard area. There was no evidence of reproduction, and the population was regarded as a chance introduction. It was ranked CD. A survey to the area in 2000 found hundreds of plants further down the basin on a ridge. *Vaccinium uliginosum* was dominant, and was associated with *Agrostis* sp., *Ledum groenlandicum*, *Kalmia polifolia*, *Salix planifolia*, *Scirpus cyperinus*, *Cornus stolonifera*, and *Streptopus amplexifolius*. The rank has been changed to A. This occurrence is in a brook basin in the White Mountain National Forest. The elevation is 3150 feet.

NH .039 (Albany, Carroll County) – This occurrence was observed on September 9, 1993. The population consisted of 11-50 genets covering an area of 100 square yards. Plants were mature with immature fruit and of normal vigor. Associated plant species included *Vaccinium vacilans*, *Vaccinium angustifolium*, *Vaccinium vitis-idaea*, *Gaylussacia baccata*, *Kalmia angustifolia*, *Empetrum atropurpureum*, *Aronia melanocarpa*, and *Rhododendron canadense*. The terrain was noted as having bedrock exposures, very rocky soil, and a shallow organic layer with boulders and stone. Fire disturbance was identified as a likely reason for the presence of *Vaccinium uliginosum*. This occurrence is ranked C and is from a mountain in the White Mountain National Forest. The elevation is 2760 feet. Succession may threaten this population, as may off-trail hiking.

NH .040 (Low & Burbanks, Coos County) – This occurrence was observed on July 8, 1992. Plants are common are there are hundreds of acres of habitat. Associated species are *Vaccinium vitis-idaea*, *Vaccinium myrtilloides*, *Ledum groenlandicum*, *Picea mariana*, *Abies balsamea*, and *Betula cordifolia*. There were no threats identified and the occurrence is ranked A or B. It is in a ravine in the White Mountain National Forest. The elevation is 3440 feet.

NH .041 (Berlin, Coos County) – This historical occurrence was observed in 1883. The site is privately owned.

NH .042 (Stark, Coos County) – This historical occurrence was observed in 1947. It is on private property.

NH .044 (Randolph, Coos County) – This historical occurrence was observed in 1917. It is on private property.

NH .045 (Martins Location, Coos County) – This historical occurrence was observed in 1950. It is in the White Mountain National Forest, probably near Dolly Copp campground.

NH .046 (Beans Purchase, Coos County) – This historical occurrence was observed in 1921, from a mountain in the White Mountain National Forest.

NH .047 (Beans Purchase, Coos County) – This historical occurrence was observed in 1914, from a mountain in the White Mountain National Forest.

NH .049 (Thompson & Meserve, Coos County) – This historical occurrence was observed in 1895 along a gulf trail in the White Mountain National Forest.

NH .052 (Hadley's Purchase, Coos County) – This historical occurrence was observed in 1908, from a mountain in the White Mountain National Forest.

NH .053 (Beans Purchase, Coos County) – This occurrence was observed on July 7, 1992, on a cliff in the White Mountain National Forest. The cliff is of coarse-grained mica schist and ranges from 2900-3100 feet elevation. Associated species include *Potentilla tridentata*, *Vaccinium myrtilloides*, *Juncus trifidus*, *Abies balsamea*, *Picea rubens*, and *Betula cordifolia*. *Vaccinium uliginosum* grew in two widely separated clumps, one 10 cm in diameter, the other 2 m long by 10 cm wide. There was no evidence of reproduction, and the population was ranked D due to the small size and threat of hiking traffic.

NH .055 (Benton, Grafton County) – This occurrence was observed on August 2, 1995. It is ranked D and is on a mountain in the White Mountain National Forest. The elevation is 2790 feet.

NH .058 (Livermore, Grafton County) – In 1993, plants were observed along the ridge in the krummholtz community. Associated species included *Abies balsamea*, *Picea mariana*, *Empetrum atropurpureum*, *Empetrum nigrum*, *Vaccinium vitis-idaea*, *Vaccinium myrtilloides*, and *Ledum groenlandicum*. This occurrence is ranked B. This occurrence was last observed on September 30, 2000. Plants were noted as scattered along the ridge. The elevation is 4300 feet. The location is a mountain in the White Mountain National Forest.

NH .060 (Bethlehem, Grafton County) – This occurrence from a mountain is based on an unprocessed report at New Hampshire Natural Heritage Bureau. This location is in the White Mountain National Forest.

NH .061 (Chatham, Carroll County) – This occurrence is from an unprocessed New Hampshire Natural Heritage Bureau report from a mountain. This location is in the White Mountain National Forest.

Status of Vermont Occurrences

There are 7 extant occurrences in Vermont, and two historical occurrences (Vermont Natural Heritage Program 2001). One occurrence is from land within the Green Mountain National Forest.

VT .001 (Bolton, Chittenden County) – This occurrence was first observed in 1982. It was observed again on November 4, 1991. It is a small population with three or four major patches and perhaps a few small clumps scattered on a cliff face that is approximately 2000 feet south of the summit. Four patches were measured with dimensions of 5 m by 50 cm, 8 m long on a crest, 1.5 m by 3 m, and 30 cm by 20 cm. The habitat area is described as almost vertical cliff faces 60 feet high that extend for 150 yards at 3200 feet elevation. The cliffs are schist bedrock and have *Vaccinium uliginosum* and *Empetrum nigrum* scattered on the cliff brows and small ledges, along with northern mosses and lichens. There is a dense thicket of *Picea mariana* and *Abies balsamea* at the top of the cliff. This population is ranked CD, in part because of its small size. The area is owned by Bolton Valley, a ski resort.

VT .002 (Duxbury, Washington County) – This occurrence was first reported in 1912. In 1985, plants were found along the summit in crevices with *Carex bigelowii*. On August 17, 1987, plants were observed and reported as more common in areas that did not receive heavy use, and were doing particularly well on the smaller summit north of the trail. This occurrence was observed on August 9, 2001 by R. Popp. Plants were noted as scattered throughout the summit. The site elevation is 4000 feet and the habitat is identified as the second largest New England Alpine Community in Vermont. It is owned by the Vermont Department of Forests, Parks & Recreation.

VT .003 (Underhill, Chittenden County) – Plants were first collected from this site in 1877. In 1990, plants were noted as common and widespread on a summit, ridge, and along a trail. This occurrence was surveyed again in 1994. Four long-term study sites were established, with 10 one-metered quadrats at each site. The first site had *Vaccinium uliginosum* present in all 10 quadrats, with 59% average frequency and 38% average coverage. The second site had the species in all 10 quadrats, with 63% average frequency and 21% average coverage. The third site had plants in all 10 quadrats, with 50% average frequency and 22% average coverage. The fourth site had *Vaccinium uliginosum* in 9 quadrats, with 64% average frequency and 41% average coverage. The habitat is identified as New England Alpine Tundra Community, and is the best and largest example in the state. The elevation of the area is around 4393 feet. The area is owned by the University of Vermont and the Vermont Department of Forests, Parks & Recreation.

VT .004 (Lowell, Orleans County) – This historical occurrence was last observed on September 5, 1967. Plants grew on dunite ledges just below the summit, in a serpentine outcrop community. The elevation was approximately 3200 feet. This site was surveyed in 1981 but no plants were found. The site appears to be privately owned.

VT .006 (Johnson, Lamoille County) – This historical occurrence is based on an herbarium specimen from 1895. A plant was collected from the rocky bank of a river. The river appears to be entirely within privately owned land.

VT .007 (Cambridge, Lamoille County) – This occurrence was seen on October 23, 1989. One plant was seen by M. R. Paul, approximately 1600' south of the peak along the trail. The area was described as a ski trail with an elevation of 3360 feet. The area is assumed to be privately owned.

VT .008 (Worcester, Washington County) – This occurrence was first observed in 1989 as consisting of one plant. It is ranked D. Another survey on July 3, 2000 failed to relocate the population. It was suggested that perhaps the trail had been rerouted or that the area had been posted to keep hikers away. It was surveyed again on August 8, 2000 by R. Popp. The plant(s) occupied a one square foot patch that was approximately 15 feet left of the trail. The habitat was in the area halfway between the start of the krummholz and the summit, at an elevation of 3539 feet. The habitat is identified as exposed rocky summit, reminiscent of alpine tundra, with good montane forests, stunted conifers, mountain holly, and mossy glades. The area is owned by the Vermont Department of Forests, Parks & Recreation.

VT .009 (Lincoln, Addison County) – This occurrence was first observed in 1915. It was observed again on June 25, 1991, when it consisted of one plant, and has a rank of D due to threats from hiker traffic. The plant was growing in a crack in a rock in an area of heavy foot traffic about 20 feet east of the summit. The habitat was identified as alpine tundra community, at about 4000 feet elevation on schist. It is on land owned by the Green Mountain National Forest.

VT .010 (Bolton, Chittenden County) – In 1996, six small clumps were seen on the exposed cliff face and brow. This occurrence was observed again on July 24, 2002. Three clumps were observed through binoculars on an exposed cliff face. The habitat is a boreal acidic cliff community at approximately 2800 feet elevation. The cliff top is a dense thicket of *Picea rubens*, *Betula papyrifera* (or *Betula cordifolia*), and *Nemopanthus mucronatus*, with stunted *Picea mariana* on the cliff brow. This occurrence is ranked D, in part because of its small size. The location is owned by the United States Army.

Status of New York Occurrences

Vaccinium uliginosum is not tracked in New York. However, it was tracked previously and New York Natural Heritage Program (2004) has retained element occurrence records. There are approximately 26 extant occurrences and one historical occurrence, though it is

likely that some of the smaller occurrences have been extirpated since they were last surveyed. Occurrences may be ranked from A to D (A being best) based on population size, available habitat size, population quality, and population defensibility.

NY .002 (North Elba, Essex County) – This occurrence was first surveyed on June 18, 1986, and was last observed on August 8, 1993. Plants occurred in an alpine meadow in a dwarf heath shrubland, with *Empetrum nigrum*, *Diapensia lapponicum*, *Ledum groenlandicum*, and *Vaccinium boreale*. The habitat covered 12 acres at 4950 feet, and the occurrence was ranked A. It was identified as a large population in very good habitat. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .003 (Keene, Essex County) – This occurrence was first surveyed on July 22, 1989, and was last seen on June 20, 1991. Plants occurred above timberline in alpine meadows and in krummholz, with *Vaccinium boreale* and *Empetrum nigrum*. *Agrostis mertensii*, *Carex bigelowii*, *Diapensia lapponica*, and *Scirpus cespitosus* are also associated species. The habitat covers 10 acres at 5000 feet, and the population is ranked B. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .004 (Newcomb, Essex County) – This occurrence was first surveyed on July 28, 1988; it was very common in an alpine meadow at 4760 feet, and was ranked A. It was last observed on August 8, 1993. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .005 (North Elba, Newcomb, Essex County) – This occurrence was first surveyed on July 28, 1988. At the time of the survey, it was the dominant plant in alpine meadows, forming 80% of the *Vaccinium uliginosum*-*Empetrum nigrum*-*Ledum groenlandicum* association. It was last observed on August 8, 1993. The occurrence is ranked Extant and covers 4 acres at 4775 feet. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .006 (Newcomb, Essex County) – This occurrence was first surveyed on July 28, 1988, when it was ranked A. It was last observed on August 8, 1993. It was the dominant plant in an alpine meadow of 5 acres at 4710 feet. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .007 (North Elba, Essex County) – This occurrence was first surveyed on July 21, 1989, when it was ranked B. It was last observed on August 20, 1994. It was common in the alpine area, and it was estimated that 3-4 genets were present. There were 6 acres of habitat at 4475 feet. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .008 (North Elba, Essex County) – This occurrence was surveyed on July 21, 1989, when it was ranked C. Approximately 200 plants formed 20% cover in an alpine meadow at 3820 feet.

NY .009 (North Elba, Essex County) – This occurrence was surveyed on September 3, 1988, and was ranked A. It was the dominant plant in the alpine meadows, forming 50% cover in an association with *Vaccinium angustifolium* and *Kalmia angustifolia*. There is one acre of habitat at 4040 feet. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .010 (Keene, Essex County) – This occurrence was first surveyed on August 23, 1988, when it was ranked A. It was last observed on July 29, 1995. It was a dominant plant in the alpine meadow, forming 60% of the *Vaccinium uliginosum-Ledum groenlandicum-Kalmia angustifolia* association. There is one acre of habitat at 4695 feet. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .011 (Keene, Essex County) – This occurrence was surveyed on August 12, 1988, when it was ranked A. It was the dominant plant in the alpine meadow and formed 95% of the *Vaccinium uliginosum-Ledum groenlandicum* association. There was one acre of habitat at 4575 feet. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .012 (Keene, Essex County) – This occurrence was surveyed on July 27, 1989, when it was ranked B. *Vaccinium uliginosum* formed 70% of the cover in the *Vaccinium uliginosum-Vaccinium boreale-Empetrum nigrum* association, and was dominant over much of the alpine zone. The available habitat was 21 acres at 4775 feet. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .013 (Keene, Essex County) – This occurrence was first surveyed on August 2, 1988, when it was ranked A. It formed 70% cover in an association with *Vaccinium boreale* and *Empetrum nigrum* over 5 acres of habitat at 4870 feet. It was last observed in July 1993. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .014 (Keene, Essex County) – This occurrence was first surveyed on August 23, 1988, when it was ranked AB. It formed 70% cover in a *Vaccinium uliginosum-Ledum groenlandicum- Chamaedaphne calyculata- Kalmia angustifolia* association. It was last observed on July 29, 1995. The habitat is a krummholz and alpine heath at 4530 feet. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .015 (Keene, Essex County) – This occurrence was surveyed on August 12, 1988, and was ranked B. It occurred in alpine meadows and krummholz zones and formed 45% of a *Vaccinium uliginosum-Picea mariana* association. There was one acre of habitat at 4760 feet. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .016 (North Hudson, Keene, Essex County) – This occurrence was first surveyed on August 21, 1988, when it was ranked AB. It formed 90% of the cover in an alpine meadow-krummholz mix. It was last seen on July 9, 1989. The habitat covers 2 acres at 4800 feet. This occurrence is in the Dix Mountain Wilderness Area of Adirondack Park.

NY .017 (Newcomb, Essex County) – This occurrence was surveyed on July 28, 1988, and was ranked AB. It was the dominant plant in the alpine meadow, forming 98% of the cover in a *Vaccinium uliginosum*-*Ledum groenlandicum* association. There was one acre of habitat at 4470 feet. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .018 (Newcomb, Essex County) – This occurrence was surveyed on September 8, 1989 and was ranked C. Fifty plants grew in several tiny alpine areas that were heavily damaged by trails and camping. The elevation was 4550 feet.

NY .019 (Keene, Essex County) – This occurrence was surveyed on July 22, 1989, when it was ranked D. One plant was seen on broad flat anorthosite ledges, with second growth *Abies balsamea* and *Betula papyrifera*. *Agrostis hyemalis* was noted as an associated species. There was one acre of habitat at 3600 feet. The site is near a campground and busy hiking trail and received heavy use. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .020 (Keene, Essex County) – This historical occurrence was last seen in 1920. It was presumably in a bog at 3900 feet, in the High Peaks Wilderness Area of Adirondack Park.

NY .021 (Keene, Essex County) – This occurrence was surveyed on August 13, 1989, and was ranked D. One plant grew on a rocky stream bank in *Abies balsamea* forest at 3250 feet.

NY .022 (Newcomb, Essex County) – This occurrence was surveyed on July 16, 1989, and was ranked C. Approximately 150 plants grew in wet places along a brook and trail between 3050 and 3200 feet elevation.

NY .023 (North Elba, Essex County) – This occurrence was observed on September 5, 1989, when it was ranked D. Three plants grew on wet ledges next to a brook, in a fir, yellow birch, and red spruce forest. Associated species included *Gaultheria hispidula* and *Ledum groenlandicum*. The elevation was 2700 feet.

NY .024 (North Elba, Essex County) – This occurrence was last surveyed on June 26, 1990, when it was ranked D. The population consisted of one large plant in an area of talus, ice caves, and anorthosite boulders in woods with *Abies balsamea*, *Picea*, and *Betula alleghaniensis*. The plant was near a hiking trail at 2700 feet in the High Peaks Wilderness Area of Adirondack Park.

NY .025 (North Elba, Essex County) – This occurrence was surveyed on September 5, 1989, when it was ranked C. Forty plants occurred on a vast anorthosite cliff with scattered intrusives and seeps. Associated species included *Deschampsia flexuosa*, *Alnus crispa*, and *Carex brunnescens*. The elevation was 3580 feet. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .026 (Newcomb, Essex County) – This occurrence was surveyed on September 8, 1989, and was ranked C due to limited habitat and trampling by hikers. The population consisted of 150 plants in a flat rocky alpine area at 4430 feet. Associated species included *Lycopodium selago*, *Arenaria groenlandica*, *Potentilla tridentata*, *Picea mariana*, and *Vaccinium boreale*. This occurrence is in the High Peaks Wilderness Area of Adirondack Park.

NY .027 (Keene, Essex County) – This occurrence was surveyed on July 30, 1989, when it was ranked C due to a small population in limited habitat next to a busy hiking trail. The population consisted of 50-100 clumps on a rocky alpine summit, growing with *Solidago cutleri*, *Agrostis mertensii*, *Scirpus cespitosus*, and *Empetrum nigrum*. The elevation was 3550 feet. This occurrence is in the Dix Mountain Wilderness Area of Adirondack Park.

The following occurrence comes from a New York Natural Heritage (2004) data sheet on *Agrostis mertensii* and was not in the New York Natural Heritage Program data provided for *Vaccinium*:

Wilmington, Essex County. This location is a mix of alpine krummholz and open areas on Whiteface Mountain. The target species is *Agrostis mertensii*. *Vaccinium uliginosum* is an associated species, along with *Minuartia groenlandica* and *Abies balsamea*. The area was surveyed in 1986. The elevation is 4700 feet.

STATUS

Vaccinium uliginosum has a global status of G5. It is considered globally secure. It is ranked S1 in Vermont, S3 in New Hampshire and New York, and is considered secure or is unranked in the rest of its North American range. Table 1 shows ranks from NatureServe (2001).

Table 1. Status of *Vaccinium uliginosum* in North America.

RANKED as S1, S2 or LISTED as T or E by State	RANKED as S3-S5 OR S?	RANKED as SR or SRF	RANKED as SH or SX
Vermont (S1): 7 extant and 2 historical occurrences	New Hampshire (S3, T); 43+ extant and 10 historical occurrences	Maine (SR): occurrences reported from 7 counties	
Michigan (S2)	New York (S3): 26 extant occurrences and 1 historical occurrence	Alaska, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming (SR)	
Minnesota (S2)	California (S?)	British Columbia (SR)	
Alberta (S2)	Manitoba (S5)	Labrador, Newfoundland Island (SR)	
New Brunswick (S1)	Ontario (S5)	Northwest Territories, Nunavut, Yukon Territory (SR)	
Nova Scotia (S2)	Saskatchewan (S4?)	Quebec (SR)	
Prince Edward Island (S1)			

Vaccinium uliginosum was listed as Threatened in New Hampshire, but has been downgraded to the watch list. It is known from 53 occurrences, 10 of which are historic. Forty-eight occurrences are on the White Mountain National Forest, and all but 7 of those are considered extant. In Vermont, *Vaccinium uliginosum* is on the Green Mountain National Forest Regional Forester's Sensitive Species list. One occurrence is on land owned by the Green Mountain National Forest. There are 9 occurrences in Vermont, one of which is historical. This species is not tracked in Maine or New York.

POPULATION BIOLOGY AND VIABILITY

Sexual reproduction is important for genetic diversity, dispersal to new habitats, and persistence in the presence of severe disturbance. However, vegetative reproduction appears to be the primary strategy for this species (Jacquemart 1996). *Vaccinium uliginosum* reproduces vegetatively through layering. Individual plants may live for sixty or more years, though it is difficult to pin-point an exact age since older parts of the plant may disintegrate while daughter clones continue to grow outward (Jacquemart 1996).

Vaccinium uliginosum forms mycorrhizal associations. It has been found that mycorrhizae help their host plant acquire nutrients, especially nitrogen (Read and Kerley 1995 in Jacquemart 1996), and a higher degree of mycorrhizal infection in *Vaccinium uliginosum* corresponds to increased host vigor (Haselwandter 1979). If the fungi on which *Vaccinium uliginosum* depends decrease in abundance or become extirpated, there could be a corresponding decrease in the health of *Vaccinium uliginosum* populations.

Vaccinium uliginosum competes well in dwarf shrub communities, but it can grow slowly, especially in exposed habitats, where shoot growth can average 1.5 to 2.5 cm per year (Bliss 1966). It is widespread enough that its slow growth rate does not limit it, but it may take years to recover after damage.

Vaccinium uliginosum is primarily insect-pollinated, but has some ability to self-pollinate in the absence of pollinators. Plants in the northeast have been found with two different chromosome counts. Diploid plants with $2n = 12$ belong to *Vaccinium uliginosum* ssp. *gaultherioides*, and tetraploid plants with $2n = 24$ belong to *Vaccinium uliginosum* ssp. *pubescens*. Despite chromosome differences, these plants may still be able to cross-pollinate and exchange genetic information (Young 1970).

Fruits usually contain at least several small seeds, and a plant may produce thousands of seeds one year, and none another year (Vander Kloet and Hill 1994). The fruits tend to be concealed among leaves, and the berries fall off the plant quickly after they ripen (Vander Kloet and Hill 2000). Dispersal distance may be limited by this feature, though some berries are eaten by animals, which can be effective dispersers over longer distances. Seeds of *Vaccinium uliginosum* may be a common part of the seedbank (Vieno *et al.* 1993), or they may be absent from the seedbank (Vander Kloet and Hill 1994). Where they are present, seeds can remain viable for at least six years (Vander Kloet and Hill 2000).

Vaccinium uliginosum seeds show a much higher rate of germination after they have undergone cold stratification, demonstrating that they have a dormancy period (Vander Kloet and Hill 1994, Vander Kloet and Hill 2000). Seeds may germinate rapidly in the spring, when snow cover is gone and the temperature rises (Calmes and Zasada 1982). Seedling growth is slow, and at the end of its first season, a seedling may only be 3.5 cm tall. Seedlings are rarely observed in natural populations (Jacquemart 1996). This may be due to competition for light and resources from mature plants (Howe 1986 in Vander Kloet and Hill 1994), or it may be due to climatic conditions such as early frost or frost heaving.

The limiting climatic factor in southern and central regions may be maximum summer temperatures (Jacquemart 1996). A warming experiment in Sweden that also included increased water and nutrients found that *Vaccinium uliginosum* produced more leaves and branches under these conditions (Press *et al.* 1998). However, the experiment did not study the long-term effect of higher temperatures on the species. Air pollution does not appear to greatly affect *Vaccinium uliginosum*, since it is resistant to damage from heavy metal and sulfur dioxide pollution (DiLabio and Rencz 1980; Vaisanen 1986).

POTENTIAL THREATS AND MONITORING

Present or Potential Risks to Habitat or Range

The heath snowbank/wet meadow/streamside/wet shrub ravine system has a patchy linear distribution that may be more vulnerable to disturbance than other alpine communities, and its hydrology may be affected by disturbance (SVE Panel 2002). The snowbank/wet meadow/streamside community system may be negatively affected by hiking, winter camping, and late winter/spring use. Current management allows camping in alpine areas with more than one foot of snow, and areas in the snowbank/wet meadow/streamside community system have the best potential for making snow caves. This draws recreational use to the habitat and may affect the snowbank system. Snow use in general probably has a minor effect, but snow cave digging may have a large effect (SVE Panel 2002).

The dry/mesic heath meadow system is threatened by trampling along trails and on ridges and peaks where hikers wander in search of a good view. The system is widespread, but trampling where habitat patches are smaller may put some species at risk (SVE Panel 2002). Heavy recreational use also threatens alpine plants on Camel's Hump (Zika 1993), and on Mt. Abraham (Thompson 1991). Likewise, hiker traffic has severely degraded habitat on Mt. Marcy (Ketchledge and Leonard 1984).

Global warming and acid deposition may be a threat to the dry/mesic heath meadow system, though the ultimate effects on the success of this species and others of the dry/mesic alpine heath meadow community are uncertain, and some effects may not be negative. Acid rain deposition is not likely to be a big issue since alpine soils are already quite acidic (SVE panel 2002). Air pollution, including ground-level ozone, may damage plants in the alpine zone.

Several sources indicate that *Vaccinium uliginosum* is restricted in its range by summer temperatures. In Newfoundland, *Vaccinium uliginosum* is limited by high summer temperatures (Damman 1965). Maillette (1988) reports that in southern Québec, it is limited to areas with fewer than 60 frost-free days. It is adapted to high altitudes and latitudes and is considered an Arctic-montane species (Conolly and Dahl 1970 in Jacquemart 1996). *Vaccinium uliginosum* is generally confined to areas with a mean annual maximum temperature of 21° C (Rodwell 1991b in Jacquemart 1996). Therefore, it may be threatened by global warming if summer temperatures increase too much.

Commercial, Recreational, Scientific or Educational Over-utilization

Vaccinium uliginosum is not used for commercial, scientific, or educational purposes. Its berries may be picked by hikers, but that probably does not affect population viability. Trampling by hikers is a much greater concern.

Disease or Predation

No disease or predation threats have been identified.

Inadequacy of Existing Regulatory Mechanisms

Vaccinium uliginosum is not a protected species in Maine or New Hampshire. Small populations could easily be lost due to recreational impacts. There are no regulations that restrict recreational impacts, except in Maine's Baxter State Park, where access is somewhat restricted. In Vermont, species that are state listed as Threatened or Endangered are protected from "taking" (picking, digging up, etc.) without a permit (B. Popp, Vermont Nongame and Natural Heritage Program, personal communication). However, *Vaccinium uliginosum* is not state listed, and the protection from taking does not include protection from trampling by hikers. On peaks in the Green Mountain National Forest, there are no regulations that prohibit camping above treeline, an activity which could negatively impact plants and habitat. However, campfires are prohibited on Mt. Abraham (USDA Forest Service 1987). In New York, plants on the state list are protected from "taking" without the landowner's permission (New York Natural Heritage Program 2004).

There are no regulatory mechanisms that protect habitat. Efforts are being made in the White and Green Mountains to educate hikers and limit hiker impacts, but there are very few regulations that are effective at preventing habitat loss. Federal regulations governing air pollution and air quality are also not effective at preventing damage to alpine plants and ecosystems from ozone and other pollutants.

Other Natural or Human Factors Affecting Continued Existence of Species

Vaccinium uliginosum is negatively impacted by hiker trampling, which breaks apart plants (SVE Panel 2002). On Mt. Abraham alpine bilberry is located in a crack in a rock in an area that used to receive a lot of foot traffic, and suffered damage as a result (Thompson 1991). The area it is in is currently roped off, and the plants are recovering (M. Deller, personal communication).

SUMMARY OF LAND OWNERSHIP AND EXISTING HABITAT PROTECTION

In Maine, occurrences are known from lands owned by Baxter State Park, the Bureau of Parks and Land, and private individuals or companies. Habitat in Baxter State Park and in the Appalachian Trail Corridor is protected from development, though not from recreational impacts. Land owned by the Bureau of Parks and Land is managed for multiple uses, including recreation, wildlife, and timber. Their dominant use system is designed to keep intensive management activities away from areas with rare species and backcountry recreational usage (Maine Bureau of Parks and Land 2004). Land owned by private individuals and companies is assumed to be without protection.

All but five of the New Hampshire occurrences of *Vaccinium uliginosum* are within the White Mountain National Forest. The other occurrences are from privately owned property. The White Mountain National Forest is managed for multiple uses, including timber harvesting. Populations that are within the Appalachian Trail Corridor are afforded protection from non-recreational uses. Since *Vaccinium uliginosum* grows above treeline in many locations, in areas where the primary use is recreational, it is relatively protected from non-recreational pressures. Occurrences that are on privately owned lands can be assumed to have no protection.

In Vermont, one occurrence is on land owned by the Green Mountain National Forest. Since *Vaccinium uliginosum* is on the Green Mountain National Forest Regional Forester's Sensitive Species list, any activities near the occurrence should maintain protection for the plants. One occurrence is owned by the United States Army and is assumed to not have any protection. All other occurrences are on land owned or managed by the Vermont Department of Forests, Parks & Recreation. These lands are protected from development. Land classified as natural areas are managed for protection of rare species and habitats and for recreational purposes (Vermont Department of Forests, Parks, and Recreation 2004). One occurrence is partly on land owned by University of Vermont, and one is on land owned by a ski resort. University of Vermont allows multiple uses of its land but cooperates with state agencies to protect the alpine habitat. The ski company does not offer any habitat protection on its land.

Most New York occurrences are in Adirondack Park. Adirondack Park is a combination of public and private lands that is managed for multiple uses, including water conservation and timber management. Some areas are designated as wilderness or as for outdoor recreation. All public lands are managed by the state, and there is a management plan for the whole Park. The Adirondack Park Agency is responsible for managing the Park (Adirondack Park Agency 2004). It is not clear which occurrences in Adirondack Park are on public lands, and it is not clear what the management strategy for the alpine areas is.

SUMMARY OF EXISTING MANAGEMENT ACTIVITIES

There are no existing management activities in Maine, New Hampshire, or the White Mountain National Forest. The National Forests have management plans in place or are in the process of developing them. The Appalachian Trail Conference monitors rare plants within its corridor and tries to protect rare plants during trail work. There may be management activities in Adirondack Park and on lands owned by the Vermont Department of Forests, Parks, & Recreation. There are management plans in place for their lands, but no information on management activities was available through those agencies' websites or through data provided by Natural Heritage Programs. Current management activities in Vermont appear to be restricted to periodic monitoring by the Green Mountain National Forest and the conservation activities of the Green Mountain Club. See below for details.

PAST AND CURRENT CONSERVATION ACTIVITIES

In Vermont, *Vaccinium uliginosum* is tracked by the state Natural Heritage Program. Signs aimed at educating visitors about the fragility of the alpine zone are present on various peaks in Maine, New Hampshire, Vermont, and New York. Alpine revegetation projects have been carried out at a small scale in the Adirondacks (Ketchledge *et al.* 1985), but did not necessarily target *Vaccinium uliginosum*.

The Green Mountain Club is responsible for a number of conservation activities. Summit caretakers are present on Mt. Mansfield, Camel's Hump, and Mt. Abraham from the end of May to mid-October to educate visitors about alpine habitats and plants. Trail crews work to keep trails well-defined with blazes and cairns, and construct scree walls to protect vegetation. Summit caretakers also use string to mark off areas that are being revegetated, and position wooden signs that ask people to stay off revegetated areas at ground level, where they can be easily seen. Illegal trails and areas used repeatedly for picnicking or view seeking are revegetated. The Green Mountain Club's conservation activities are limited by a lack of funds to pay caretakers and varying regulations for lands owned by different agencies.

RESEARCH AND MONITORING

Existing Surveys, Monitoring and Research

Vaccinium uliginosum is not actively surveyed or monitored in Maine, New Hampshire, the White Mountain National Forest, or New York. The Appalachian Mountain Club monitors vegetation and rare species around its huts, but *Vaccinium uliginosum* is not a targeted species. In New Hampshire, other surveys in the alpine area are carried out by New England Plant Conservation Program task force members, although those surveys only target the rarest alpine species, and by Plant Conservation Volunteers, who are overseen by the New England Wild Flower Society. Again, *Vaccinium uliginosum* is not a targeted species. The Appalachian Trail Conference last conducted surveys within its trail corridor in 1990, and *Vaccinium uliginosum* was noted as present or ranked in some areas (A. Schori, Appalachian Trail Conference, personal communication). The species is no longer tracked by New Hampshire Natural Heritage Bureau and New York Natural Heritage Program.

In Vermont, monitoring and surveys are conducted by Vermont Nongame and Natural Heritage Program botanists and by Plant Conservation Volunteers, as well as by New England Plant Conservation Program task force members in coordination with the Green Mountain National Forest. There is no regular scheduling for surveying activities (B. Popp, Vermont Nongame and Natural Heritage Program, personal communication). There are several long-term study transects that have been set up on Mt. Mansfield to monitor vegetation changes.

Survey Protocol

Each state's Natural Heritage Program has its own form for surveys, but all the forms are designed to gather the same basic information. Location, population size, habitat, and threats are all important. New Hampshire's old form asked for detailed information on habitat (community type, associated species, slope, aspect, position, soil hydrology), population data (number of ramets or genets if countable, occurrence area, plant health, population structure, phenology, reproductive evidence), and a map, but the newer form is less complex. Forms generally also ask for ratings of four aspects of the element occurrence – quality, condition, viability, and defensibility.

In New Hampshire and Vermont, Plant Conservation Volunteers, as well as state botanists, may survey plants. Plant Conservation Volunteers are trained to identify plants and are then assigned certain occurrences to survey. They may also send in information about new populations that they discover. New England Plant Conservation Program monitoring groups use state Heritage reporting forms and collect GPS data points for each population. New Hampshire occurrences within the Appalachian Trail corridor were surveyed by members of New Hampshire Natural Heritage Bureau. Maine relies on state botanists, as does New York, but both will accept occurrence data from what Maine terms “rogue botanists.” Reporting forms are available on-line. Ideally, each field report would contain comprehensive data, but detailed observations are frequently lacking. Thoroughly surveying a population is time-consuming and may not be feasible for large populations. Sometimes a botanist does not realize that a species is of particular interest, and so it is only noted in passing. *Vaccinium uliginosum* is too common in New Hampshire to be the target of surveys.

Research Priorities

A study should be conducted to examine subspecies of *Vaccinium uliginosum* in the White Mountains. New Hampshire Natural Heritage Bureau treats all plants as *Vaccinium uliginosum* var. *alpinum*, while Young (1970) treated plants as *Vaccinium uliginosum* ssp. *pubescens* and ssp. *gaultherioides* based on pubescence and chromosome numbers. It is not known whether these subspecies have different habitat preferences or if they are cross-fertile. If the subspecies do not hybridize, and one is much more abundant than the other, it may be worth considering protection for the rarer plants.

Information is needed on the disturbance dynamics of the dry/mesic heath meadow system. Information is needed on the dry/mesic heath meadow system of lower elevation peaks as they may receive heavier recreational impacts (SVE Panel 2002). The patches of alpine communities on the lower elevation peaks are small and isolated, and the percentage of the lower summit areas impacted by recreation is much higher than in the large alpine blocks on the higher summits (S. Lemieux, USDA Forest Service -White Mountain National Forest, personal communication).

Monitoring of the snowbank/wet meadow/streamside/wet shrub ravine system, and specific sites such as the Alpine Garden, is needed to determine the effects of winter

camping and other recreational uses (SVE Panel 2002). Information is available for compilation (SVE Panel 2002).

There is a need for information regarding the processes that distinguish the different community types within this snowbank/wet meadow/streamside/wet shrub ravine system (SVE Panel 2002). There is also a need for information on the patterns of distribution of communities within the snowbank/wet meadow/streamside/wet shrub ravine system (SVE Panel 2002).

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APPENDIX

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Appendix I:

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.