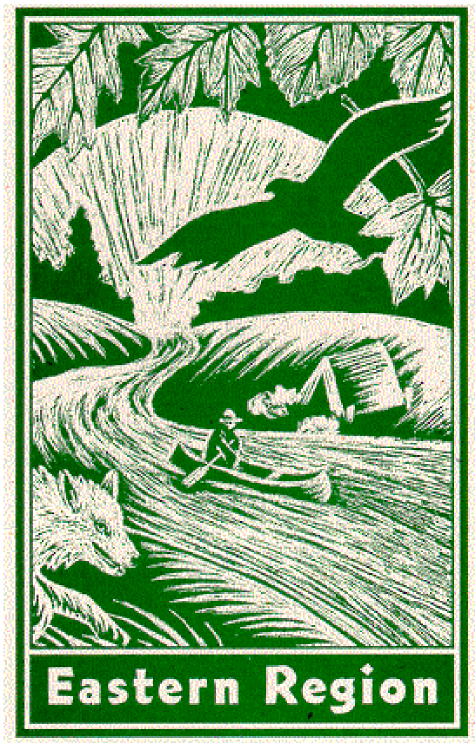
Community Conservation Assessment for White Mountain Alpine Community



USDA Forest Service, Eastern Region

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Catherine Rees
719 Main St.
Laconia, NH 03247
603-528-8721

WHITE MOUNTAIN NATIONAL FOREST

This document was prepared to compile the published and unpublished information on the subject community to serve as a Conservation Assessment for the Eastern Region of the Forest Service.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 community, please contact the Eastern Region of the Forest Service Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee. Wisconsin 53203.

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EXECUTIVE SUMMARY

The purpose of this document is to provide background information necessary to prepare a Conservation Strategy, including management actions to conserve species discussed in this assessment. It is based on information presented in individual species Conservation Assessments, community occurrence data obtained from State Natural Heritage Programs, and information available in the literature.

The Alpine Community of the White Mountains National Forest is limited in its extent and distribution by available of high elevation habitat. The alpine zone is generally recognized as the area above tree line. In New Hampshire, climatic tree line occurs at approximately 4900 ft, but alpine vegetation is found below this elevation due to conditions such as landscape position, exposure, soil condition, and water and nutrient availability that combine to simulate more severe conditions normally found at higher elevations.

The harsh conditions of the alpine zone have served to create a number of more narrowly defined plant communities. These communities tend to arrange themselves along gradients of elevation, moisture (both soil and atmospheric), exposure, slope and snow cover. These finer-resolution communities often have species in common, but the relative abundance of each changes with environmental conditions.

Fifteen Regional Forester Sensitive Species occur within this community, however, all are not found exclusively in alpine environments. The species are; *Arnica lanceolata, Betula minor, Calamagrostis stricta, Cardamine bellidifolia, Euphrasia oakesii, Festuca prolifera, Geocaulon lividum, Geum peckii, Omalotheca supina, Oryzopsis canadensis, Poa laxa* ssp. *fernaldiana, Prenanthes boottii, Saxifraga paniculata* ssp. *neogaea, Silene acaulis* var. *exscapa,* and *Vaccinium boreale.*

The primary threat to the species is trampling by hikers and some efforts have been made to reduce these through the use of scree walls, cairns, and signage. Potentially much greater threats to the community, however, are increased nitrogen deposition and global climate change.

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COMMUNITY CLASSIFICATION SYSTEM AND SYNONYMS

The alpine community of the White Mountains defined by the Regional Forester Sensitive Species (RFSS) discussed herein is broadly defined. The alpine zone is generally recognized as the area above tree line. In New Hampshire, climatic tree line occurs at approximately 4900 ft, but alpine vegetation can be found below this elevation when wind exposure, poor soils or disturbance by fire combine to emulate the harsh conditions of higher elevations (Sperduto and Cogbill 1999).

Historically, there have been several detailed descriptions of the vegetation of the White Mountains. The Presidential Range has perhaps received the greatest attention. Alexander (1940) details the "faunal areas or life zones" described from the first scientific expedition to Mount Washington by Reverend Dr. Manasseh Cutler in 1784 through the work of Dice in 1938. Each author recognized the alpine zone as roughly that which is found above tree line ("above the limits of vegetation", "highest bald district", "alpine rocks", "summits of the higher mountains".)

Bliss was perhaps the first to systematically study and describe the alpine communities of the Presidential Range (1963). By investigating soils and vegetation, Bliss came up with nine alpine community types: Sedge meadow; Sedge-dwarf shrub heath; Sedge-rush-dwarf shrub heath; Dwarf shrub heath-rush; Dwarf shrub heath; Diapensia; Snowbank; Streamside; and, Bog.

Sperduto and Cogbill (1999) made a more comprehensive study of 94 alpine or subalpine sites in the White Mountains including peaks beyond the Presidential Range. They describe five major community types, each with two to four variants, all found within the alpine or subalpine zone: Alpine herbaceous snowbank and herbaceous–heath meadow; Diapensia shrubland; Dwarf shrub/sedge-rush meadow; Heath/krummholz; and, Subalpine bog an subalpine heath snowbank. They also include Red spruce/heath/cinquefoil rocky ridge and moist montane heath woodland, and Undifferentiated subalpine cliff, ledge, cold-air talus slope, landslide, red pine woodland at lower elevations.

Outside the Presidential Range, Whitney and Moeller (1982) define three broad community types of Mount Cardigan: Dwarf evergreen shrub community; Deciduous shrub community; and, Subalpine spruce-fir community.

In a study of the subalpine heath vegetation Doyle et al. (1987) relate five community types of the Mahoosuc range to a moisture gradient. From best to poorly drained the community types are: *Empetrum nigrum* shrubland; *Kalmia angustifolia* shrubland-*Vaccinium angustifolium/Cladonia* lichen phase; *Kalmia angustifolia* shrubland-*Ledum groenlandicum/Chamaedaphne calyculata* phase; *Sphagnum* peatland-*Rubus chamaemorus/Chamaedaphne calyculata* phase; and, *Sphagnum* peatland-*Scirpus cespitosus/Vaccinium oxycoccus* phase.

Table 1 lists the alpine and subalpine community types as defined by states of the northeast and by Association for Biodiversity Information (NatureServe) and their respective rankings.

Table 1. Alpine community types defined by classification system of northeastern states.

Classification System	Alpine Community Types	Rank	Citation
NatureServe	Alpine Heath #CEGL006298 Alpine Heath Snowbank #CEGL006155 Black Crowberry Alpine Heathland #CEGL006140 Biglow's Sedge Alpine Meadow #CEGL006081 Black Spruce Krummholz #CEGL006038		Nature Serve 2002
NH Natural Heritage Inventory	Diapensia-Dwarf Heath Shrubland Bigelow Sedge Meadow Dwarf Heath/Graminoid Meadow Bilberry-Crowberry Dwarf Shrubland Black Spruce and Balsam Fir Krummholz Labrador Tea-Heath/Krummholz Sheep Laurel-Heath/Krummholz	S1 ? S2 S1S2 S2S3 S1S2 S1	Sperduto 2000 *draft*
VT Nongame and Natural Heritage Program	Alpine Meadow Alpine Peatland Subalpine Krummholz Boreal Calcareous Cliff (mostly subalpine) Boreal Outcrop (mostly subalpine)	S1 S1 S1 S2 S4	Thompson and Sorenson 2000
ME Natural Areas Program	Dwarf Heath-Graminoid Alpine Ridge Alpine Cliff Subalpine Heath-Krummholz Diapensia Alpine Ridge Crowberry–Bilberry Summit Bald Boreal Circumneutral Open Outcrop Spruce-Fir-Birch Krummholz Bilberry-Mountain Heath Alpine Snowbank	S2 S1 S4 S1 S3 S2 S3 S1	Gawler 2001 *draft*
New York Natural Heritage Program	Alpine Meadow Alpine Krummholz	S1 S2	Edinger *et al*. 2002 *draft*

DESCRIPTION OF COMMUNITY
Plant Community

The White Mountain Alpine Community is made up of a number of distinct community types described in detail by Bliss (1963), Sperduto and Cogbill (1999), Sperduto (2000), and Sardinero (2001). I have included brief descriptions of each of the community types defined by each author below:

Bliss (1963) studied the vegetation and its relationship to environmental conditions of the Presidential Range and divided the vegetation into nine community types:

1. Sedge meadow - dominated by *Carex bigelowii*, scattered *Minuartia groenlandica* and cryptogams especially mosses;
2. Sedge-dwarf shrub heath - richer than sedge meadow and includes *Carex bigelowii*, *Minuartia groenlandica*, *Vaccinium vitis-idaea* with greater cover of lichens;
3. Sedge-rush-dwarf shrub heath - mostly *Juncus trifidus*, *Vaccinium vitis-idaea*, *Sibbaldiopsis tridentata* with less *Carex bigelowii* and *Minuartia groenlandica*;
4. Dwarf shrub heath-rush – conspicuous clumps of *Juncus trifidus* with low scattered *Vaccinium vitis-idaea*, *Vaccinium uliginosum*, *Sibbaldiopsis tridenta*, less *Carex bigelowii* and *Diapensia lapponica*;
5. Dwarf shrub heath – dominated by *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, *Vaccinium angustifolium* and *Ledum groenlandicum*;
6. Diapensia – dominated by *Diapensia lapponica* and *Juncus trifidus* with small amounts of *Vaccinium uliginosum*, *Solidago cutleri*, *Loiseleuria procumbens* and *Rhododendron lapponicum*;
7. Snowbank community – very rich floristically, dominated by *Vaccinium cespitosum* and *Deschampsia flexuosa*, includes *Vaccinium uliginosum*, *Carex bigelowii* and *Solidago macrophylla*;
8. Streamside community – rich flora along streams frequently bordered by *Salix planifolia* and *S. uva-ursi* with *Geum peckii*, *Trichophorum cespitosus*, *Persicaria vivipara*, *Vaccinium vitis-idaea*, predominantly away from the streams with *Carex scirpoidea*, *Sibbaldiopsis tridentata* and *Prenanthes nana* on drier sites;
9. Alpine bog – bog community dominated by *Carex bigelowii*, *Trichophorum, cespitosum*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, *Kalmia polifolia* and *Vaccinium oxycoccos*.

Sperduto and Cogbill (1999) used several ordination techniques to define plant communities of the alpine and subalpine regions throughout the White Mountains based on floral assemblages and general site descriptions. The five major groups and 13 finer-scale communities are described nearly verbatim as follows:

1. Alpine herbaceous snow bank and herbaceous-heath meadows - herb and herb-heath snow bank communities in lee positions with late–melting snow packs;
    a. Alpine herbaceous snow bank meadow – a mixture of alpine and montane plants protected by late-melting snow. Some are associated with seepages. Characteristic species include *Deschampsia flexuosa*, *Solidago macrophylla*, *Vaccinium cespitosum*, *Clintonia borealis*, *Coptis trifolia*, *Carex brunnescens* along with *Carex bigelowii*;

    b. Moist alpine herb-heath meadow – Moist tundra dominated by a diverse mix of forbs, sedges, and heath shrubs. Found only in Alpine Garden and includes *Geum peckii* and *Prenanthes boottii*;
2. Diapensia shrublands - on the most exposed, snow-free sites and are composed of two finer-scale communities:
    a. Diapensia–azalea-rosebay dwarf shrubland – more diverse alpine compositions found at higher elevations with *Loiseleuria procumbens*, *Rhododendron lapponicum*, *Salix urva-ursi*, *Solidago cutleri* and *Carex bigelowii*;
    b. Diapensia-bilberry heath – less diverse *Diapensia* heaths found at lower elevations that usually lack *Loiseleuria procumbens* and *Rhododendron lapponicum*;
3. Dwarf shrub/sedge-rush tundra without trees with four finer-scale communities:
    a. Alpine heath snowbank – mixture of *Vaccinium uliginosum* and cranberry heath, *Carex bigelowii* and *Juncus trifidus* with *Ledum groenlandicum*, *Empetrum nigrum*, *Vaccinium cespitosum* and montane herbs where late melting snowbanks occur at high elevations;
    b. Bigelow's sedge meadow – *Carex bigelowii* dominates with minor amounts of *Minuartia groenlandica* and dwarf herbs;
    c. Sedge-rush-heath meadow – mixture of *Carex bigelowii*, *Juncus trifidus* and dwarf heath and other shrubs. At lower elevations rush-heath mixtures with less sedge are a prominent variant;
    d. Dwarf shrub-bilberry-rush barren – found in exposed situations, and generally at lower elevation. It is dominated by *Vaccinium uliginosum*, *Vaccinium vitis-idaea* along with other dwarf shrubs, particularly *Empetrum atropurpureum* and/or *Sibbaldiopsis tridentata* on mineral or shallow organic materials over mineral substrate;
4. Bogs on poorly drained concavities on ridges and sometimes on slopes with three finer-scale communities;
    a. Wet alpine/subalpine level and sloping bog – mostly level to slightly sloping peatlands dominated by *Sphagnum* spp. with *Empetrum nigrum*, *Vaccinium uliginosum* and *Rubus chamaemorus*, *Vaccinium oxycocco*s and *Eriophorum vaginatum*;
    b. Subalpine wooded heath snowbank, slope bog and bog margin – shallow to moderately deep peat, found where deeper snow accumulates, on drier borders of bogs and moist slopes. Common species are *Ledum groenlandicum* and *Kalmia angustifolia* with higher cover of krummholz, abundant lichen and absence of wet site species;
    c. Sliding fen – shallow peat bogs on 5-30º slopes containing *Calamagrostis pickeringii*, *Sphagnum compactum* and other bog plants;
5. Heath/krummholz communities on somewhat lower peaks where a broader diversity of montane shrubs mix with krummholz alpine shrubs and are divided into two finer-scale communities
    a. Labrador tea heath/krummholz – *Abies balsamea* and *Betula papyrifera* var. *cordifolia* krummholz are common with *Picea rubens* at the lower elevations and *Picea mariana* at higher elevations. *Empetrum atropurpureum*,

Vaccinium uliginosum, *Vaccinium vitis*-idaea and *Vaccinium boreal*e are among the dwarf shrubs.

b. Sheep laurel-Labrador tea heath/krummholz – characterized by a mix of *Kalmia angustifolia* and *Ledum groenlandicum*. *Abies balsamea* and *Betula papyrifera* var. *cordifolia* krummholz are frequent or abundant with *Picea rubens* more common than *Picea mariana*. *Rhododendron canadense* and *Nemopanthus mucronatus* are occasional with *Vaccinium angustifolium* at higher elevations.

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Sardinero (2001) used an altitudinal gradient to ordinate the plant communities of the Presidential Range. He distinguished twelve main plant communities including four montane communities not included here:

1. *Picea mariana-Abies balsamea*
   closed krummholz
   scattered krummholz
   dwarf shrub heath variant
   dwarf heath shrub variant
2. *Vaccinium uliginosum-Cetraria islandica*
   with *Ledum groenlandicum* and *Betula cordifolia*
   without *Ledum groenlandicum* nor *Betula cordifolia*
3. *Empetrum hermaphroditum-Vaccinium cespitosum*
4. *Minuartia groenlandica-Agrostis mertensii*
5. *Diapensia lapponica-Rhododendron lapponicum*
6. *Carex bigelowii-Solidago cutleri*
7. *Salix urva-ursi-Solidago cutleri*
8. *Deschampsia flexuosa-Solidago cutleri*

Sperduto (2000) divides the alpine communities of New Hampshire into two major groups; the Alpine meadows and dwarf shrubland barrens and the Alpine/subalpine heath/krummholz communities and further divides these and names additional variants from his earlier work (Sperduto and Cogbill 1999). Descriptions for all these communities are not complete as the document is still in a draft, but I summarize nearly verbatim from Sperduto (2000) below:

Diapensia-lapland rosebay-alpine azalea dwarf shrubland: At exposed higher elevations of the Presidential Range *Diapensia lapponica* is found in association with *Juncus trifidus*, and lesser quantities of *Rhododendron lapponicum* and *Loiseleuria procumbens*…*Vaccinium uliginosum* is also common. Other scattered individuals of *Solidago cutleri* and *Agrostis mertensii* may be found.

Diapensia-alpine bilberry dwarf shrubland: This type occurs on similar exposed positions on lower and smaller alpine peaks, and probably some areas of the Presidential Range as well. The primary difference is the lack of *Rhododendron lapponicum* and *Loiseleuria procumbens*. *Diapensia lapponica* and *Vaccinium uliginosum* are the most abundant plants over open gravel and stone that may cover more than 50-60% of the ground surface.

Bigelow sedge meadow: This community is found especially at high elevations of the larger peaks of the Presidential Range on north and west slopes where high precipitation and fog drip are especially prevalent. Snow accumulation is typically minimal or ephemeral. These conditions are favorable for *Carex bigelowii* to dominate to the near exclusion of other species, in part because of its photosynthetic efficiency in low light conditions.

Dwarf heath graminoid meadow: The dominant species of this type include *Carex bigelowii*, *Juncus trifidus* and various heath shrubs including *Vaccinium uliginosum*.

Sedge-heath-rush meadow variant: West and north exposures of moderate to high alpine elevations where Bigelow sedge is joined by dwarf heath shrubs and often large clumps of *Juncus trifidus*…Some examples have much exposed rock and may grade into the fellfield community.

Heath-rush meadow variant: Lower elevation, well drained soils dominated by dwarf shrubs with or without shared dominance of *Juncus trifidus*. Some winter snow may accumulate but it melts early. *Vaccinium vitis-idaea* and *Vaccinium uliginosum* are most common along with *Sibbaldiopsis tridentata*.

Bilberry-crowberry dwarf shrubland: This community is found on exposed, well-drained summits, slopes and ridges of smaller alpine peaks. It lacks the dominance of *Diapensia lapponica* found on the most exposed sites, contains *Empetrum* spp. and subalpine *Vaccinium* spp., a moderately low abundance or absence of alpine/subalpine sedges and rushes…and lacks the "mixed heaths" and abundance of krummholz patches.

Black spruce and balsam fir krummholz: *Abies balsamea* and *Picea mariana* are the primary krummholz forming trees, with balsam fir being generally more common. *Betula cordifolia* is also frequently present. Species of lower elevation spruce-fir forests are often present.

Labrador tea-heath /krummholz: The krummholz layer consists of variable mixes of *Abies balsamea* , *Picea mariana*, and *Betula cordifolia*, in decreasing order of prominence. Dwarf shrubs usually include *Ledum groenlandicum*, *Vaccinium uliginosum*, *Empetrum atropurpureum* and/or *Empetrum nigrum*, *Vaccinium vitis-idaea* and typically come combination of *Vaccinium angustifolium*, *Vaccinium boreale*, and *Vaccinium myrtilloides*. *Empetrum* spp. may be locally more abundant on bedrock or otherwise shallow, more well-drained soils. Lichens characteristic of alpine areas are prominent.

Woodland variant: Krummholz accounts for >20-25% of the cover in this variant. It is probably most common in somewhat more protected situations than the shrubland variant.

Black spruce Phase: At higher elevations or more exposed positions, dwarf heath shrubs and krummholz are often less than 30 cm and 50 cm, respectively, with occasional krummholz to 1.2 – 2 m in height. Black spruce is the most abundant spruce. Most examples are found above 3600 ft.

Red spruce phase: Examples at lower elevations or in somewhat more protected exposures may have taller (2 – 5+ m) krummholz, considerably more red spruce, and less or no black spruce…This variant apparently extends down to as low as 2700 ft on burned summits.

Shrubland variant: Krummholz accounts for <20-25% of the cover in this variant. This variant is probably more prevalent in more exposed situations. In some cases fires may have reduced the abundance of trees, at least temporarily. A black spruce and red spruce phase can also be identified.

Sheep laurel-heath/krummholz: Several distinct plant associations can be recognized along a soil drainage gradient from most to least well drained (see Doyle 1987). It bears a resemblance to the Labrador tea heath/krummholz community, but has the added presence of *Kalmia angustifolia*, has a lower average elevation, somewhat deeper organic soils, and is often associated with moister habitats around subalpine peat bogs on moderately flat ridges.

> Sheep laurel-bilberry-crowberry shrubland variant: This variant corresponds to moderately well drained soils with moderately shallow organic and mineral veneers over bedrock…The shrub layer is short and the krummholz ranges from 15 to 150 cm in height. *Kalmia angustifolia* is accompanied by *Vaccinium uliginosum*, *Empetrum atropurpureum*, and/or *Empetrum nigrum*, *Vaccinium boreale*, and *Vaccinium vitis idaea*. Lichens are abundant.
>
> Sheep laurel-Labrador tea-bilberry-leatherleaf shrubland variant: This variant represents the wetter end of the hydrologic gradient found in the community (moderately well to somewhat poorly drained). It has a similar stature and composition, with an increased abundance and importance of *Ledum groenlandicum* and *Chamaedaphne calyculata*, and a decrease in abundance or absence of *Empetrum* spp.

Labrador tea-heath snowbank: These communities are found just above timberline and in the lee of rocks, ledges, ridges and krummholz islands where moderately deep snow accumulates and persists until late spring.

Rhodora-sheep laurel-Labrador tea boreal heath woodland: Similar to heath krummholz shrublands without the subalpine plants (*Vaccinium uliginosum*, *Empetrum* spp. and little or no *Vaccinium vitis-idaea*).

Herbaceous snowbank meadow: No description provided, but may include *Vaccinium cespitosum*. *Veratrum viride*, *Castilleja septentrionalis*, *Deschampsia flexuosa* (similar to the snowbank community of Bliss 1963.)

Table 2 shows the community associations of the Regional Forester Sensitive Species according to the State Heritage Programs.

Table 2. Community associations of Regional Forester Sensitive Species according to Natural Heritage Programs.

Species	NatureServe	NH Natural Heritage Inventory	VT Nongame and Natural Heritage Program	ME Natural Areas Program
Arnica lanceolata Arnica	Alpine Heath Snowbank Biglow's Sedge Alpine Meadow Bog Blueberry Dwarf Shrubland	Alpine Garden (Sperduto)		
Betula minor Dwarf white birch	Subalpine krummholz, Meadows (alpine, and arctic tundra), Alpine	Alpine herbaceous snowbank meadow, Dwarf shrub-bilberry-rush barren, Labrador tea heath/krummholz, Sheep laurel-Labrador tea heath/krummholz	not known from Vermont (St. Hilaire 2001)	Subalpine Heath-Krummholz community , Dwarf Heath-Graminoid Alpine Ridge
Calamagrostis lacustris Pond reedgrass		Smaller or subalpine peaks (Sperduto 1999)	Boreal calcareous cliff ??	
Cardamine bellidifolia Alpine bittercress	Meadows-as in arctic tundra Alpine, Outcrops, cliffs and talus	Moist alpine herb-heath meadow and others (St. Hilaire 2001)	not known from Vermont (St. Hilaire 2001)	Alpine Cliff community (St. Hilaire 2001)
Carex wiegandii Wiegand's sedge				
Euphrasia oakesii Oakes' eyebright		Alpine cliff community Alpine cliff community (St. Hilaire 2001)	not known from Vermont	Alpine Cliff community
Festuca prolifera Poliferous red fescue		Moist alpine herb-heath meadow (St. Hilaire 2001)	not known from Vermont	?? one occurrence at Baxter State Park
Geocaulon lividum Northern comandra		Sheep laurel-heath/krummholz (Sperduto 2000), smaller or subalpine peaks (Sperduto and Cogbill 1999)	Alpine Peatland –*extirpated* (Thompson and Sorenson 2000)	

Species	NatureServe	NH Natural Heritage Inventory	VT Nongame and Natural Heritage Program	ME Natural Areas Program
Geum peckii Mountain avens		Moist alpine herb-heath meadow (Sperduto and Cogbill 1999)	not known from Vermont (single record is suspect)	not known from Maine
Omalotheca supina Alpine cudweed		Calcareous Cliff	not known from VT	Snowbank community
Oryzopsis canadensis Canada mountain ricegrass		smaller or subalpine peaks (Sperduto and Cogbill 1999)	not known from VT	
Poa laxa ssp. fernaldiana Wavy bluegrass		Diapensia-azalea-rosebay dwarf shrubland (Sperduto and Cogbill 1999)	Alpine meadow	Diapensia alpine ridge Alpine cliff
Prenanthes boottii Boot's rattlesnake root		Moist alpine herb-heath meadow (Sperduto and Cogbill 1999)	Alpine Meadow	Alpine Cliff
Saxifraga paniculata Livelong saxifrage		Alpine cliff community (Sperduto 1993 cited in Hilaire 2001)	Boreal Calcareous Cliff (Hilaire 2001)	Boreal Circumneutral Open Outcrop (Hilaire 2001)
Silene acaulis var. *exscapa* Moss campion	Meadows-alpine, Alpine	Moist alpine herb-heath meadow, Diapensia-azalea-rosebay dwarf shrubland (St. Hilaire 2001)	Alpine Meadow?? (Thompson and Sorenson 2000)	Diapensia Alpine Ridge
Vaccinium boreale Boreal blueberry	Subalpine krummholz (P) Meadows-alpine meadows (P), Alpine (P), Outcrops, cliffs and talus (X)	Labrador tea heath/krummholz (Sperduto2000), Bilberry-crowberry dwarf shrubland, Sheep laurel-bilberry–crowberry shrubland variant (Sperduto 2000)	Subalpine Krummholz (S1), (Thompson and Sorenson 2000) Alpine Meadow (St. Hilaire 2001)	Subalpine Heath-Krummholz, Dwarf Heath-Graminoid Alpine ridge, Diapensia Alpine Ridge, Heath-Crowberry Maritime Slope Bog.

Animal Community

Table 3 lists the birds, mammals a, reptiles and amphibians that use the alpine and krummholz communities. For an extensive list of invertebrates of the Presidential Range, see Alexander 1940.

Table 3. Animal members of the alpine community.

Common Name	Latin Name	Habitat used
Birds		
Golden eagle (E)	*Aquila chrysaetos*	alpine and krummholz
Peregrine falcon (E)	*Falco peregrinus*	alpine and krummholz
Spruce grouse	*Falcipennis canadensis*	krummholz
Gray jay	*Perisoreus canadensis*	krummholz
Common raven	*Corvus corax*	krummholz
Black-capped chickadee	*Poecile hudsonicus*	krummholz
Red-breasted nuthatch	*Sitta canadensis*	krummholz
Golden-crowned kinglet	*Regulus satrapa*	krummholz
Ruby-crowned kinglet	*Regulus calendula*	krummholz
Bicknell's thrush	*Catharus bicknelli*	krummholz
American robin	*Turdus migratorius*	krummholz
American pipit	*Anthus rubescens*	alpine
Yellow-rumped warbler	*Dendroica petechia*	krummholz
Blackpoll warbler	*Dendroica striata*	krummholz
Fox sparrow	*Passerella iliaca*	krummholz
White-throated sparrow	*Zonotrichia albicollis*	alpine and krummholz
Dark-eyed junco	*Junco hyemalis*	krummholz
Pine grosbeak	*Pinicola enucleator*	krummholz
Red crossbill	*Loxia curvirostra*	krummholz
White-winged crossbill	*Loxia leucoptera*	krummholz
Mammals		
Masked shrew	*Sorex cinereus*	alpine and krummholz
Long-tailed shrew	*Sorex dispar*	krummholz
Pygmy shrew	*Sorex hoyi*	krummholz
N. Short-tailed shrew	*Blarina brevicauda*	krummholz
Snowshoe hare	*Lepus americanus*	krummholz
Eastern chipmunk	*Tamias striatus*	krummholz
Red squirrel	*Tamiasciurus hudsonicus*	krummholz
Deer mouse	*Peromyscus maniculatus*	alpine and krummholz
White-footed mouse	*Peromyscus leucopus*	alpine and krummholz
S. Red backed vole	*Clethrionomys gapperi*	alpine and krummholz
Rock (yellow nosed) vole	*Microtus chrotorrhinus*	alpine and krummholz
S. bog lemming	*Synaptomys cooperi*	krummholz
N. bog lemming	*Synaptomys borealis*	alpine and krummholz
Porcupine	*Erethizon dorsatum*	krummholz
Red fox	*Vulpes vulpes*	alpine

Common Name	Latin Name	Habitat used
American marten (T)	*Martes americana*	krummholz
Fisher	*Martes pennati*	krummholz
Ermine	*Mustela erminea*	alpine and krummholz
Long-tailed weasel	*Mustela frenata*	alpine and krummholz
Lynx (E)	*Lynx canadensis*	krummholz
Bobcat	*Lynx rufus*	krummholz
Moose	*Alces alces*	krummholz
Reptiles		
Garter snake	*Thamnophis sirtalis*	alpine and krummholz
Amphibians		
Wood frog	*Rana sylvatica*	krummholz

From DeGraaf and Yamasaki 2001.
(T) = threatened status in NH
(E) = endangered status in NH
The Graycheeked thrush (also known as Bicknell's thrush) uses the Alpine meadows and breeds in the subalpine krummholz in Vermont (Thompson and Sorenson 2000).

COMMUNITY ECOLOGY/ENVIRONMENTAL CONDITIONS

While elevation is a key factor in determining community type and has long been used to delineate the alpine zone, compounding factors like exposure to wind, snow cover, soil development, fire history and others described below are also important determinants.

Soils
From stations in each of three community types (sedge meadow, heath rush meadow, and heath-rush fellfield), Bliss (1966) examined soils on Mount Washington. All soils were loamy sands in the A horizon and sandy loams in the B and C horizons, with a low percentage of clay throughout. While all soils were well drained, frequent rains and low evapotranspiration result in high soil moisture levels throughout the growing season. Soil pH ranged from 4.1 in the A horizon to 4.9 in the C horizon. Organic matter was highest in the A horizon and depended on the percent plant cover. Total nitrogen was low as were exchangeable bases, percent base saturation, available calcium, potassium, and phosphorus. Bliss (1963) found that calcium concentrations in soils of the streamside community far exceeded those of the soils of any of the other alpine communities. Soil pH ranged from 4.7 in the A horizon to 4.9 in the C horizon of the streamside soils, making them slightly less acid than surrounding soils.

In an investigation of the species composition of the heath balds of the Mahoosuc Range, Fahey (1976) found a correlation between species composition and topographic position and soil depth. He attributes the persistence of ericaceous shrubs and the failure of climax forest species to invade the balds to poor soil quality. Other factors include "the extreme microclimatic conditions on the ridgetop site and the inhibiting effect of water-soluble substance in roots of *Kalmia angustifolia* on seedlings of *Picea mariana*."

Moisture

High levels of atmospheric and soil moisture distinguish the climate of the White Mountains from other alpine areas and moisture gradients have been used arrange the various community types.

Comparing the vegetation of the White Mountains to other alpine regions across the globe, Bliss (1963) concluded that the alpine vegetation of the Presidential Range is floristically and vegetationally "more closely related to that of the Arctic and to the alpine communities of Scandinavian and central Europe than to the alpine vegetation of the western mountains. This relationship probably results from the higher moisture levels and extensive fogginess in the Presidential Range and other high New England mountains as opposed to the drier and sunnier environments of the Rocky Mountains and Sierra Nevada." The abundance of *Carex bigelowii*, *Juncus trifidus* and heath species of the eastern mountain ranges reflects the abundance of moisture in the east compared to the mountains of the west where herbs predominate (Bliss 1985). Bliss (1963) identified atmospheric moisture as one of three important gradients that determine community type.

Soil moisture was one of two major environmental gradients identified by Whitney and Moeller (1982) on Mount Cardigan that affected vegetation. Factors contributing to soil moisture include available moisture capacity of the substrate (percent organic matter) and, microtopographic configuration of the slope.

Doyle et al. (1987) use a moisture gradient to describe the five community types of the Mahoosuc Range. Sperduto and Cogbill (1999) list soil moisture as an important environmental condition related to plant communities they define.

Snow

Related to the moisture gradients discussed above, snow also provides thermal insulation and protection from exposure. Thermal insulation depends upon snow density. Apart from the thermal properties of snow, snow depth and duration are the most important determinants of plant and soil temperatures (Körner 1999). Snowfall early in the winter can actually prevent soils from freezing, while the absence of snow can allow soils to freeze deeply (Körner 1999). Because of the adaptations of alpine plants to survive in their respective habitats, it is not surprising that accumulation of snow is an important factor in their distribution.

Of the Presidential Range, Bliss (1963) says "snow-depth gradients, while present on the north and west-facing slopes, are much more prevalent on east and southeast-facing slopes, in the lee of prevailing winds. These gradients usually extend for only a few hundred feet at most and often occupy relatively small areas in relation to snow accumulation." Snow depth was one of the three important gradients identified by Bliss (1963) in controlling plant communities.

Griggs (1946) found that upright shoots of *Abies balsamea* on Mt Washington were routinely winter-killed when they rose above their prostrate neighbors that were probably protected by snowdrift during the winter.

Frost

Permafrost has been documented in the Presidential Range. In late July, soil was found to be frozen at a depth of 2 ft at the Madison Springs Hut (elevation 4825 ft) and in mid August, frozen earth was encountered at 3 ft and continued frozen to more than 6 ft at the Lakes of the Clouds Hut (elevation 5000 ft) (Alexander 1940). May and Davis (1978) include the presence of permafrost as factor that divides alpine community types.

While Bliss (1963) had not personally observed permafrost, he noted that it was encountered when wells were drilled on Mount Washington and that "frost phenomena (stone stripes, stone nets, solufluction terraces, soil polygons) are important features and factors in alpine plant community dynamics."

Wind

Alpine environments are commonly subjected to wind and wind velocities experienced at the Mount Washington observatory are legendary. However, all summits and locations are not subject to the same conditions. "Wind velocity is greatly influenced by micro and mesotopography, and is greatly reduce at the plant canopy" (Bliss 1985).

Exposure was one of two major environmental gradients identified by Whitney and Moeller (1982) on Mount Cardigan. The recognized that a combination of environmental factors including presence or absence of forest cover, topographic orientation, elevation, aspect, and probably winter snow cover contribute to the exposure gradient.

Solar radiation

The alpine environment of White Mountains differ from alpine environments elsewhere in that summer cloudiness and/or fog is much more common resulting in reduced solar radiation (Bliss 1985). The variability of solar radiation during the growing season is of note in the alpine areas of New England (Alexander 1940, Bliss 1985).

Bliss (1966) found that mean monthly air temperature and mean monthly soils temperatures differed by community type with temperatures in the Sedge meadow community being lower than either the Heath-rush meadow or Heath-rush fellfield. He found that temperatures decreased with increasing elevation.

Fire

Fires following logging in the early 20th century are thought to have promoted conversion of subalpine krummholz to stands of heart-leaved paper birch (Thompson and Sorenson 2000) in the Green Mountains. Although fire has been implicated in the creation of a number of treeless summits (Damman 1964 and Strang 1979 in Fahey 1976), it has been dismissed by several authors. Whitney and Moeller (1982) acknowledge Mount Cardigan burned in 1855 and provide evidence for the re-invasion of the summit by spruce and fir during recovery after the fire. However, they state that the reinvasion "eventually ground to a halt" once reforestation was restored to its original condition. Fahey (1976) finds no evidence that fire is responsible for the treeless nature of the Mahoosuc Range balds.

Competition within and between communities

The limits of the various alpine and subalpine plant communities appear to be controlled by edaphic, and climatic conditions as discussed above. However, there have been a few studies directed at changes between community boundaries and within community types. In his study of trees on Mount Washington, Griggs (1946) concluded that the tree line (at the krummholz/alpine interface) was receding. He attributes this mainly to weather and changing climatic conditions.

Within a 15 ac open summit on Mount Marcy (NY), Ketchledge and Leonard (1984) recorded only minor changes in plant cover after remeasuring the same area previously measured by Woodin 24 years earlier. However, they did think it notable to have found a 2.36 percent increase in cover of *Sphagnum pylaesii* and a decrease in bare rock of 1.59 percent. They state that "lateral expansion of the vascular plant community on the open Adirondack summits is mediated by the *Sphagnum* mat that engulfs other bryophytes and in time provides a substrate permitting the establishment of herbaceous and woody plants" implying that rock surfaces are actively being colonized.

In a study to identify the importance of competition and facilitation between vascular, alpine plants in the Alps, Choler et al. (2001) found "highly significant shifts from strong competitive effects in low and sheltered sites to strong facilitative responses in high and exposed sites." They concluded that "the distribution and abundance of many species in high-elevation communities of the western Alps appears to be enhanced by neighbors, and that species continua commonly observed along environmental gradients are the result of both negative and positive plant interactions."

Individual Species Habitat Requirements

Table 4 summarizes the individual Regional Forester Sensitive Species habitat requirements. Species such as *Arnica lanceolata, Calamagrostis stricta, Oryzopsis canadensis* are not strictly confined to alpine habitats. *Geum peckii* appears to be an alpine species in the White Mountains, but is found at low elevations in Nova Scotia (the only other site from which it is known.)

Table 4. Summary of Regional Forester Sensitive Species habitat associations.

Species	Habitat	Stand size	Elevation	Shrub layer	Ground cover	soil		Preferred Habitat Features
						pH	perme-ability	
Arnica lanceolata	X-Upland shores X-Meadows X-Alpine X-Rivers and streams X-Seeps, springs, vernal pools	Unknown	No preference	Sparse – absent	Unknown	5.1-6.5	Unknown	Bedrock/outcrops Gravel Clay
Betula minor	X- Subalpine krummholz X-Meadows (alpine and tundra) X-Alpine	1-10 ac	2500 – 3500 ft	Deciduous Ericaceous Dense	Herbs/forbs Moss/lichen Dense	<5.0	Moderate	openings-forest edge openings-forest interior
Calamagrostis stricta	X-Open peatlands X-Marshes, sedge meadows X-Wet shores X-Shrub swamps X-Outcrops, cliffs, talus X-Seeps, springs, vernal pools		No preference					Wetland edge Wetland interior Sandy, muddy, peat edge Wet shores Wet outcrops, cliffs, talus
Cardamine bellidifolia	O-Meadows-arctic tundra O-Alpine X-Outcrops, cliffs, talus	Unknown	>3500 ft <1500 ft Newfoundl and	Intermediat e- dense?	Herbs/forbs Moss/lichen Dense	<5.0	Moderate	Near water Bedrock/outcrops

Species	Habitat	Stand size	Elevation	Shrub layer	Ground cover	soil		Preferred Habitat Features
						pH	perme-ability	
Carex wiegandii	X-Hardwood swamps X-Softwood swamps X-Open wetland X-Wet cliff walls Peatland Features: X-Basin bog X-Lakeshore bog X-Poor fen		2200 – 2500 ft					Beaver influenced Wetland edge Sandy, muddy or peat edge Wet shores
Euphrasia oakesii	O-Alpine X-Outcrops			Deciduous Ericaceous unknown Dense	Herbs/forbs Moss/lichen Dense-sparse	<5.0	Moderate - slow	Bedrock/outcrops
Festuca prolifera	O-Meadows (arctic) O-Alpine	Unknown	>3500 ft	Deciduous Ericaceous Intermediat e	Herbs/forbs Moss/lichen Dense	<5.0	Moderate	Shrubs and herbs at streamside
Geocaulon lividum	X-Spruce fir northern hardwood forests X-Subalpine krummholz X-Alpine X-Softwood swamps X-Flood plain forests X-Open wetlands	Variable	>3500 ft	No preference	Moss/lichen Leaf litter			P-Old growth P-late successional Moss Palustrine Features: Balsam fir dominated Wetland edge Sandy, muddy, or peat edge
Geum peckii	O-Alpine (NH) O-Open peatlands (NS) X-Subalpine krummholz	1-10 ac	<1500 ft (NS) >3500 ft (NH)	No preference	No preference	<5.0	Moderate or slow	
Omalotheca	O-Alpine		2000 –	Absent	Herbs/forbs	<5.0	Slow	Snowbank Community

Species	Habitat	Stand size	Elevation	Shrub layer	Ground cover	soil		Preferred Habitat Features
						pH	perme-ability	
supine	X-Meadows X-Outcrops, cliffs, talus		3500 ft		Dense	or ~7.0		Bedrock/outcrops Gravel
Oryzopsis canadensis	X-Northern hardwood forests X-Shrub openings X-Outcrops, cliffs, talus	1-10 ac	>3500 ft	Sparse	Unknown	Unk	Rapid	Dry Bedrock/outcrops Sand
Poa laxa ssp. *fernaldiana*	O-Alpine X-Outcrops, cliffs, talus	Variable	>3500 ft	Deciduous Ericaceous Sparse	Herbs/forbs Moss/lichen Sparse	<5.0	Rapid – slow	Mosses Bedrock/outcrops Cobbles
Prenanthes boottii	O-Alpine X-Outcrops, cliffs, talus	Unknown	2500 - >3500 ft	Deciduous Ericaceous	Herbs/forbs Moss/lichen	<5.0 ?	Moderate – none	Cliffs Bedrock/outcrops
Saxifraga paniculata ssp. *neogaea*	P-Alpine rocky areas P-Outcrops, cliffs, talus		Unknown	Absent	Herbs/forbs Moss/lichen Sparse	5.1- 8.4		Cavities Bedrock/outcrops Cobbles Gravel
Silene acaulis var. *exscapa*	O-Meadows alpine O-Alpine		>3500 ft	Deciduous Ericaceous Sparse – ?	Herbs/forbs Moss/lichen Dense - sparse	<5.0 7.4- 8.4 Nfld	Moderate	Gravel
Vaccinium boreale	P-Subalpine krummholz P-Meadows-alpine P-Alpine U-Outcrops, cliffs, talus	Unknown	>3500 ft	Ericaceous Unknown density	Herbs/forbs Moss/lichen Dense	<5.0	Moderate	Bedrock/outcrops

Compiled from individual species conservation assessments.
O = obligate, P= prefers; X= uses habitat
NH = New Hampshire; NS = Nova Scotia; Nfld = Newfoundland

RANGE OF NATURAL VARIABILITY: COMMUNITY DISTRIBUTION AND CONDITIONS

By definition, alpine habitats are restricted to high elevation. While elevation is not the only factor in determining the habitat suitable for a specific community type (see above), it is often the first variable used for determining habitat potential. In New Hampshire, alpine and subalpine communities are found throughout the Presidential Range, and on 35 peaks outside the Presidential Range (Sperduto and Cogbill 1999). Table 5 shows the approximate range of elevations in which specific community types are found.

Table 5. Approximate elevation ranges of alpine and subalpine communities of Sperduto and Cogbill (1999)

Community Type	Elevation in feet
Alpine herbaceous snowbank meadow	4700 – 5500
Moist alpine herb-heath meadow	5000 – 5500
Diapensia-azalea-rosebay dwarf shrubland	4400 – 5500
Diapensia-bilberry heath	4000 – 4600
Alpine heath snowbank	4600 – 5500
Bigelow’s sedge meadow	4300 – 6000+
Sedge-rush-heath meadow	4800 – 5500
Dwarf shrub-bilberry-rush barren	3400 – 4800
Labrador tea heath/krummholz	3500 – 4900
Sheep laurel-Labrador tea heath/krummholz	3000 – 3700
Subalpine bogs and subalpine heath snowbanks	2900 – 4900

Körner sums up the significance of variation in environmental conditions well: “The most important of these influences (shape of the landscape, exposition, soils, mineral nutrients, water availability and microclimate change over short distances), emerging from environmental micro-fragmentation, are variable radiation and -- in temperate and subpolar mountain ranges -- changing patterns of snow distribution and hence, spatial variations of seasonality. These in turn feed back on moisture and nutrient availability. Despite the fact that the shape of the alpine land surface can be considered constant within the time frame of interest here, its influence on snow distribution is co-determined by wind direction and thus varies from year to year, causing spatial and annual variations in seasonality over relatively small areas. Small-scale “change” is thus one of the most important factors of alpine life conditions. Because of these strong exposure and radiation controlled microenvironments, the true climate experienced by alpine plants cannot be predicted from standard meteorological data. Beyond the tree line, the macro-climate deviates from the micro-climate to an extent that elevation per se also becomes a very poor predictor of life conditions or the occurrence of certain plants or plant life forms.”

CURRENT COMMUNITY CONDITION, DISTRIBUTION AND ABUNDANCE

New Hampshire
Sperduto and Cogbill (1999) did a comprehensive survey of the alpine and subalpine summits of the White Mountains. They documented 35 peaks beyond the Presidential Range that support alpine or subalpine vegetation on at least 1 ac. Most of the 600+ ac. was found among the Franconia Ridge, Bondcliff, Guyot, Baldface Ridge, Moosilauke, Cannon Mountain, Mahoosuc Range and in the Shelburne-Moriah vicinity. All the peaks are generally above 3500 ft elevation with 24 of them above 4000 ft. The climatic tree line is only exceeded by Franconia Ridge and South Twin (Sperduto and Cogbill 1999).

Records of community occurrences from the New Hampshire Natural Heritage Program are not as comprehensive as those presented by Sperduto and Cogbill (1999) but represent known exemplary occurrences (table 6).

Table 6. Exemplary occurrences of alpine/subalpine community types in New Hampshire.

Community Type	County	Town	Sites
NE Alpine/subalpine bog	Coos	Beans Grant	1
NE Alpine/subalpine bog	Coos	Sargents purchase	1
NE Alpine/subalpine bog	Coos	Success	1
NE Alpine/subalpine bog	Coos	Thompson & Meserve	1
NE Alpine/subalpine bog	Grafton	Benton	1
NE Alpine/subalpine bog	Grafton	Franconia	1
NE Moist subalpine heathland	Coos	Beans Purchase	1
NE Moist subalpine heathland	Coos	Shelburne	1
NE Moist subalpine heathland	Coos	Success	1
NE Subalpine heath/krummholz	Coos	Thompson & Meserve	1
NE Subalpine heath/krummholz	Grafton	Livermore	1
New England Alpine		Low & Burbanks	1
New England Alpine	Coos	Beans Grant	1
New England Alpine	Coos	Chandlers Purchase	1
New England Alpine	Coos	Sargents Purchase	1
New England Alpine	Coos	Tompson & Meserve	1
New England Alpine	Grafton	Benton	1
New England Alpine	Grafton	Franconia	1
New England Alpine	Grafton	Lincoln	1

From New Hampshire Natural Heritage Inventory June, 2002

Maine
In Maine there are 30 peaks that exceed 3500 ft elevation. Fourteen of these peaks have treeless summits and are located "mainly in the Katahdin mountains of central Maine and in the Saddleback, Bigelow, and Mahoosuc Ranges of western Maine" (May and Davis 1978). Eight peaks harbor substantial areas of alpine vegetation ranging in size from less than one acre to nearly 1mi^2 on Mount Katahdin. Records of alpine and krummholz community occurrence

obtained from the Maine Department of Conservation Natural Areas are presented in table 7 below.

Table 7. Occurrence of alpine and subalpine communities in Maine.

Community Type	County	Town	Sites
Alpine Cliff	Piscataquis	Mt. Katahdin Township	1
Crowberry-bilberry summit bald	Oxford	Mason Twp., Batchelders Grant	1
Crowberry-bilberry summit bald	Oxford	Newry, Grafton Twp.	1
Crowberry-bilberry summit bald	Piscataquis	Mt. Katadhin Township	1
Crowberry-bilberry summit bald	Piscataquis	Elliottsville Township	1
Crowberry-bilberry summit bald	Piscataquis	T03 R10 Wels	1
Crowberry-bilberry summit bald	Somerset	Bald Mt. Twp., T2 R3	1
Diapensia alpine ridge	Franklin	Mt. Abram Township	1
Diapensia alpine ridge	Franklin	Sandy River Plt., Madrid	1
Diapensia alpine ridge	Piscataquis	Mt. KatahdinTownship	1

From Maine Department of Conservation Natural Areas Division June, 2002. See Appendix A for additional subalpine community types that may support sensitive species.

Vermont

Compared to New Hampshire, Vermont has fewer peaks above 3500 ft elevation and therefore, fewer locations that can support alpine and subalpine community types (Table 8). Alpine Meadows are found on exposed ridgetops exceeding 3500 ft elevation in Vermont limiting the community to the summits of Camels Hump, Mount Mansfield and Mount Abraham.

Table 8. Occurrence of alpine and subalpine communities in Vermont.

Community Type	County	Town	Sites
Alpine meadow	Washington	Duxbury	1
Alpine meadow	Chittenden	Underhill	1
Alpine meadow	Orleans	Lowell	1
Alpine peatland	Lamoille	Stowe	1
Subalpine Krummholz	Chittenden	Underhill	1
Subalpine Krummholz	Orleans	Westfield	1
Subalpine Krummholz	Rutland	Sherburne	1
Subalpine Krummholz	Rutland	Mendon	1

From Vermont Nongame and natural Heritage Program September, 2002. See Appendix A for additional subalpine community types that may support sensitive species.

New York

In New York there are 20 peaks that support alpine communities. All are in the High Peaks region of the Adirondack Mountains (Ketchledge et al. 1995), providing about 40 ac of alpine vegetation. Occurrence information from the New York Natural Heritage Program is presented in table 9.

Table 9. Occurrence of alpine and subalpine communities in New York.

Community Type	Name	County	Town	Sites
Alpine meadow	Iroquis Peak	Essex	Newcomb	1
Alpine meadow	Algonquin Peak	Essex	North Elba	1
Alpine meadow	Mount Skylight	Essex	Keene	1
Alpine meadow	NW Algonquin	Essex	North Elba	1
Alpine meadow	Haystack Mountains	Essex	Keene	1
Alpine meadow	MacIntyre Range	Essex	Newcomb, North Elba	1
Alpine meadow	Boundary Peak S	Essex	Newcomb	1
Alpine meadow	Boundary Peak N	Essex	Newcomb, North Elba	1
Alpine meadow	Wright Peak	Essex	North Elba	1
Alpine meadow	Mount Colden	Essex	Keene	1
Alpine meadow	Iroquis Peak SW	Essex	Newcomb	1
Alpine meadow	Gothics	Essex	Keene	2
Alpine meadow	Mount Marcy	Essex	Keene	1
Alpine meadow	Northwest Wright	Essex	North Elba	1
Alpine meadow	Northeast Colden	Essex	Keene	1
Alpine meadow	Basin Mountain	Essex	Keene	1
Alpine meadow	Dix Mountain	Essex	North Hudson, Keene	1
Alpine meadow	Whiteface Mountain	Essex	Wilmington	1
Alpine meadow	Noonmark Mountain	Essex	Keene	1
Alpine krummholz	Algonquin Peak	Essex	North Elba	1
Alpine krummholz	Haystack Mountains	Essex	Keene	1
Alpine krummholz	MacIntyre Range	Essex	Newcomb, North Elba	1
Alpine krummholz	MacIntyre Range SW	Essex	North Elba, Newcomb	1
Alpine krummholz	Mount Skylight	Essex	Keene	1
Alpine krummholz	Mount Marcy	Essex	Keene	1
Alpine krummholz	Northwest Algonquin	Essex	North Elba	1
Alpine krummholz	Whiteface Mountain	Essex	Wilmington	1
Alpine krummholz	Wright Peak	Essex	North Elba	1
Alpine krummholz	Northwest Wright	Essex	North Elba	1
Alpine krummholz	Mount Colden	Essex	Keene	1
Alpine krummholz	Gothics	Essex	Keene	1
Alpine krummholz	Dix Mountain	Essex	North Hudson, Keene	1
Alpine krummholz	Basin Mountain	Essex	Keene	1

From New York State Department of Environmental Conservation Natural Heritage Program August, 2002.

REGIONAL FORESTER SENSITIVE SPECIES ASSESSMENT TABLE

Table 10. Regional Forester Sensitive Species occurrence by geographic area.

Species	New Hampshire		Maine		Vermont	
	TOTAL	WMNF	TOTAL	WMNF	TOTAL	GMNF
Arnica lanceolata	5(3)	3(2)	13(4)	4	(1)	0
Betula minor	13(8)	13(8)	2	0	0	0
Calamagrostis stricta	8(5)	1(4)	2(3)	0	3(1)	1
Cardamine bellidifolia	2(7)	2(7)	2	0	0	0
Euphrasia oakesii	1(4)	1(4)	1	0	0	0
Festuca prolifera	1(1)	1(1)	1	0	0	0
Geocaulon lividum	2(6)	1(3)	16(5)	0	0	0
Geum peckii	28(9)	24(9)	0	0	0	0
Omalotheca supina	1(3)	1(3)	2	0	0	0
Oryzopsis canadensis	1(3)	0	4(9)	0	0	0
Poa laxa ssp. *Fernaldiana*	5(12)	5(11)	1	0	2(1)	0
Prenanthes boottii	4(1)	4(1)	3	0	2	0
Saxifraga paniculata ssp. *Neogaea*	2	1	0	2	5	0
Silene acaulis var. *exscapa*	2(6)	2(6)	(1)	0	0	0
Vaccinium boreale	12(3)	10(2)	9(1)	0	3	0
Carex wiegandii	3(6)	3	27(11)	0	1?(6?)	0

Compiled from individual species Conservation Assessments.
The numbers in parentheses indicate the number of historic occurrences. These numbers are not included in the totals.

POPULATION VIABILITY

Individual species Conservation Assessments include information about species viability. Table 11 summarizes the Regional Forester Sensitive Species State and Forest conservation status.

Table 11. Conservation status of Regional Forester Sensitive Species.

Species	NH State Rank	ME State Rank	VT State Rank	NY State Rank	White Mountain National Forest	Green Mountain National Forest
Arnica lanceolata	21,T	S2,T	SX	S1	Sensitive	
Betula minor	S1S2	S1,E	S1,E		Sensitive	
Calamagrostis stricta	SU,E	S1,T	S1,E			Sensitive
Cardamine bellidifolia	S1,E	S1,E			Sensitive	
Carex wiegandii	S1S2	S3	S1	S1	Sensitive	
Euphrasia oakesii	S1,E	S1,E			Sensitive	
Festuca prolifera	S1,E	S1,E			Sensitive	
Geocaulon lividum	S2,T	S2,SC	SX	S1	Sensitive	
Geum peckii	S2,T				Sensitive	
Omalotheca supina	S1,E	S1,E			Sensitive	
Oryzopsis Canadensis	SH,E		S1?,SC	S1S2	Sensitive	
Poa laxa ssp. *Fernaldiana*	S2S3,E	S1,E	S1	S1	Sensitive	
Prenanthes boottii	S1,T	S1,E	S1,E	S1	Sensitive	
Saxifraga paniculata ssp. *Neogaea*	S1,E	SH,PE	S1	S1	Sensitive	Sensitive
Silene acaulis var. *exscapa*	S1,T	SX,PE			Sensitive	
Vaccinium boreale	S3	S2S3,T	S1	S2	Sensitive	

Compiled from individual species Conservation Assessments.

POTENTIAL THREATS

Most of the threats to alpine communities area relate to human impacts. Trampling is perhaps the greatest threat (Table 11). Although pollution is listed as a threat to many of the Regional Forester Sensitive Species, specifics are not mentioned in individual species assessments. Körner (1999) discusses the implications of increased nitrogen deposition in the alpine community: "More vigorously growing plants tend to be more receptive to atmospheric fertilizer. Commonly, such fast growing species are not very robust when facing physical stress. Their increasing abundance under continuously enhanced N availability could weaken the overall robustness of ecosystems…Among all compounds deposited in alpine ecosystems, soluble nitrogen deserves greatest attention, because of the key role of nitrogen for plant metabolism and its immediate influence on plant growth and biodiversity." Changes in community composition could result from the accelerated growth of a few species to the detriment of others.

Global climate change, particularly warming, is thought to lead to decreased alpine biodiversity. This is especially likely on low mountains where species of predominantly lower elevation will begin to displace species restricted to the highest elevation (Grabherr et al. 1995). However, "the current rates of upward migration documented in the Alps are far below those that might be expected from the rate of temperature increase; this suggests a remarkable time lag between a change in climate and alpine vegetation" (Grabherr et al. 1995). Körner (1985) predicts that changes will not occur as a direct result of warmer temperatures, but that changing patterns of snowfall and length of growing season will have a greater influence. The limited area of the peaks in the northeast and their relatively low stature is reason to be concerned about the ability of the highest elevation alpine communities to persist.

Invasive species are indicated as threats for only the species that are not strictly limited to alpine communities. It is likely that the stresses of alpine regions are sufficient to prevent invasion by species not commonly associated with alpine habitats.

Table 12. Threats to Regional Forester Sensitive Species.

	Habitat loss or alteration	Invasive species	Harvest/ collection	Pollution	Roads/trails - trampling	Human presence	Succession	Other
Arnica lanceolata	✓				✓		✓	
Betula minor	✓			✓	✓	✓		
Calamagrostis stricta	✓	✓			✓		✓	
Cardamine bellidifolia	✓			✓	✓	✓		
Euphrasia oakesii	✓			✓	✓	✓		
Festuca prolifera	✓			✓	✓	✓		
Geocaulon lividum								Benefits from flooding and fire
Geum peckii	✓NS	✓NS	?	✓	✓	✓		
Omalotheca supina	✓				✓			
Oryzopsis Canadensis	✓				✓	✓		
Poa laxa ssp. *Fernaldiana*	✓	✓		✓	✓	✓		Competition
Prenanthes boottii	✓		✓	✓	✓	✓		
Saxifraga paniculata ssp. *Neogaea*	✓	✓		✓				Parasitism Atmospheric Dep.
Silene acaulis var. *exscapa*	✓			✓	✓	✓		Disease
Vaccinium boreale				✓	✓			Predation Competition Genetics
Carex wiegandii	✓	✓			✓		✓	Forestry Agriculture

Compiled from individual species Conservation Assessments.

SUMMARY OF LAND OWNERSHIP AND EXISTING HABITAT PROTECTION

New Hampshire

Most of the alpine habitat in New Hampshire is located within the bounds of the White Mountains National Forest. Percy Peaks, Monadnock, and Success are the only peaks listed by Sperduto and Cogbill (1999) that are in New Hampshire, have potential alpine habitat and are unprotected. Mt Cardigan is outside the National Forest, but within the bounds of Mt Cardigan State Forest.

Maine

The Maine Critical Areas Program has documented and registered eight alpine areas; Traveler Mountain, Mt. Abraham, Bigelow, Saddleback, Baldpate, Goose Eye, Mahoosuc and Mount Carlo (Pierson and Vickery). Table 13 lists the protected peaks of Maine.

Table 13. Protected areas of alpine vegetation in Maine.

Mountain	Name	Administration
Mt Katahdin Traveler Mountain	Baxter State Park	Baxter State Park Authority
Old Speck Mountain	Grafton Notch State Park	Maine Department of Conservation
Mahoosuc Mountain Baldpate Mountain Bigelow Mountain Mount Carlo	Maine Public Reserve Land	Maine Department of Conservation Bureau of Parks and Lands
	White Mountain National Forest	USDA Forest Service

Vermont

In Vermont, alpine communities are limited in distribution and size. Mt Mansfield, Camel's Hump and Mt Abraham are the only peaks to have alpine habitat (Table 14). All of the three are on public land, so have some level of protection, however, Thompson and Sorenson (2000) report that the alpine meadow on Mount Abraham is highly disturbed.

Table 14. Protected areas of alpine vegetation in Vermont.

Mountain	Name	Administration
Mount Mansfield -alpine -krummholz	Mount Mansfield State Forest Underhill State Park	Vermont Department of Forests, Parks and Recreation University of Vermont
Camel's Hump -alpine -krummholz	Camels Hump State Park	Vermont Department of Forests, Parks and Recreation
Mt Abraham -alpine	Green Mountain National Forest	USDA Forest Service

-krummholz		
Jay Peak -krummholz	Jay State Forest	Vermont Department of Forests, Parks and Recreation
Killington Peak -krummholz	Coolidge State Forest	Vermont Department of Forests, Parks and Recreation

From Thompson and Sorenson 2000

New York
All of the peaks supporting alpine vegetation in New York are located in the High Peaks area of the Adirondacks and afforded a degree of protection.

SUMMARY OF EXISTING MANAGEMENT ACTIVITIES

White Mountains National Forest
Path relocation has been successful in protecting sensitive vegetation from hiker impacts. Relocation of a short section of Crawford Path at Monroe flats was successful in protecting populations of *Potentilla robbinsiana*, as was part of the Dry River Trail up the headwall south of the Crawford Path junction. Other efforts to keep hikers off sensitive vegetation include the construction of scree walls, improved cairns and signage. Scree walls (low rock walls to confine hikers to a narrow path) have been effective in allowing trampled areas to revegetate on Franconia Ridge from the Falling Waters trail junction south of Mt. Lincoln to north of Mt. Lafayette. Scree walls have been somewhat successful in protecting *Minuartia glabra* colonies on Welch Mountain in Waterville Valley (above information from John Williams pers. comm.). Some experimental reseeding with non-native grasses took place along Franconia Ridge, but was not entirely successful in that the non-native species have persisted rather than dying back as planned (Rebecca Oreskes pers. comm.).

New York
All of the peaks supporting alpine vegetation are located in the High Peaks area of the Adirondacks. The New York Department of Environmental Conservation instituted a policy that prohibits overnight camping above 4000 ft elevation in the Adirondacks in 1980 in order to limit hiker impacts (Ketchledge at al. 1995). Efforts by Ketchledge et al. (1995) have shown some degree of success in restoring native, alpine vegetation by first seeding denuded areas with non-native, sod-forming grasses and applying fertilizer and lime. If the seeded areas are protected from hiker impacts, mosses invade the sites, followed slowly by seedlings or rhizomes of vascular plants.

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CONTACTS

Sara Cairns
Data Manager / Biologist
NH Natural Heritage Inventory
Division of Forest & Lands
(603) 271-3623
www.nhdfl.com/formgt/nhiweb

Doug Bechtel
Director of Conservation Science
The Nature Conservancy, New Hampshire Chapter
(603) 224-5853 ext. 16; FAX (603) 228-2459

Tracy Bengal
Maine Department of Conservation
Natural Areas Division
95 State House Station
159 Hospital Street
Augusta, ME 04333-0093

White Mountain National Forest
300 Glen Road
Gorham, NH 03581
603-466-2713, extension 212
603-466-2856, fax

Rebecca Oreskes
Dispersed Recreation and Wilderness
roreskes@fs.fed.us

Emily Pinkham
Information Manager
Maine Department of Conservation
Natural Areas Division
95 State House Station
159 Hospital Street
Augusta, ME 04333-0093
emily_pinkham@state.me.us

Eric Sorenson
Community Ecologist
Nongame and Natural Heritage Program
Vermont Fish and Wildlife Department
103 South Main Street
Waterbury, Vermont 05671-0501
(802) 241-3714

APPENDIX B

Subalpine community types of Maine that may harbor sensitive species.

Community Type	County	Town	Sites
Boreal circumneutral open outcrop	Aroostook	T15 R09 Wels	1
Boreal circumneutral open outcrop	Franklin	Carrabassett Valley	2
Boreal circumneutral open outcrop	Oxford	Bowmantown Township	1
Boreal circumneutral open outcrop	Piscataquis	Kineo Township	1
Boreal circumneutral open outcrop	Piscataquis	Days Academy Grant	
Boreal circumneutral open outcrop	Piscataquis	T07 R14 Wels	1
Boreal circumneutral open outcrop	Piscatequis	T04 R11 Wels	
Boreal circumneutral open outcrop	Somerset	Comstock Township	1
Boreal circumneutral open outcrop	Somerset	Caratunk	1

Subalpine community types of Vermont that may harbor sensitive species.

Community Type	County	Town	Sites
Boreal acidic cliff	Essex	Norton	1
Boreal acidic cliff	Chittenden	Bolton	2
Boreal acidic cliff	Essex	Averill	1
Boreal acidic cliff	Washington	Middlesex	1
Boreal acidic cliff	Rutland	Wallingford	1
Boreal calcareous cliff	Essex	Brighton	1
Boreal calcareous cliff	Orleans	Glover	1
Boreal calcareous cliff	Lamoille	Cambridge	1
Boreal calcareous cliff	Bennington	Manchester	1
Boreal calcareous cliff	Orleans	Westfield	1
Boreal calcareous cliff	Windsor	Rochester	1
Boreal calcareous cliff	Caledonia	Sutton	1
Boreal calcareous cliff	Chittenden	Underhill	1
Boreal calcareous cliff	Orleans	Westmore	3
Boreal outcrop	Chittenden	Bolton	1
Boreal outcrop	Bennington	Bennington	1

From Vermont Nongame and natural Heritage Program September, 2002