HABITAT PROFILE

Alpine

Associated Species: White Mountain Arctic Butterfly (Oeneis Melissa semidea), White Mountain Fritillary (Boloria titania montinus)

Global Rank: Not ranked
State Rank: Alpine herbaceous snowbank/rill (S1)
Moist alpine herb-heath meadow (S1)
Alpine ravine shrub thicket (S1S2)
Diapensia shrubland (S1)
Alpine heath snowbank (S1S2)
Bigelow's sedge meadow (S1)
Sedge-rush-heath meadow (S1)
Dwarf shrub-bilberry-rush barren (S2)
Labrador tea heath-krummholz (S2)
Sheep laurel-labrador tea heath-krummholz (S2)
Wet alpine/subalpine bog (S1)
Wooded subalpine bog/heathsnowbank (S1S2)
Subalpine sliding fen (S1)
Felsenmeer (S2)
Alpine cliff (S2)

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Element 1: Distribution and Habitat

1.1 Habitat Description

In New Hampshire, alpine habitat occurs above treeline (trees taller than 6 ft) at approximately 4,900 ft, primarily within the Franconia and Presidential Ranges. This region endures high winds, precipitation, cloud cover, and fog, resulting in low annual temperatures and a short growing season (Bliss 1963, Sperduto and Crowley 2001). The interaction between severe climate and geologic features—such as bedrock, exposure, and aspect—determine the distribution and structure of alpine systems (Antevs 1932, Bliss 1963, Harries 1996, Sperduto and Crowley 2001). Alpine habitat is comprised of low, treeless tundra communities embedded in a matrix of bedrock, stone, talus, or gravel, with or without thin organic soil layers, and interspersed with krummholz. Soils are well drained, highly acidic, nutrient poor, and weakly developed (Sperduto and Cogbill 1999).

Alpine systems are comprised of 5 broad groups of communities: diapensia shrublands, alpine herbaceous snowbank/wet-mesic alpine communities, alpine/subalpine bogs, heath-krummholz communities, and dwarf shrub-sedge-rush meadow communities (Sperduto and Cogbill 1999). Diapensia shrublands occur on exposed windblown ridges above 4,300 ft and are characterized by a high abundance of *Diapensia lapponica* supported on a rock or gravel substrate. Alpine herbaceous snowbank/wet-mesic alpine communities are typically sloped, have shallow organic soils, and associated with late-melting snowpacks, seeps, rills, and ravine settings. They are by dominated by *Geum peckii, Solidago macrophylla,* and *Calamagrostis canadensis* and occur between 4,400 and 5,500 ft. Alpine/subalpine bogs occur at elevations ranging from 2,900 to 4,900 ft within concavities and are dominated by *Vaccinium uliginosum* and *Empetrum nigrum*.

In parts of the White Mountain National Forest (WMNF), these communities form a mosaic with heath-krummholz communities composing structures referred to as "heath balds." Heath-krummholz communities are composed of wind-dwarfed thickets of trees, primarily *Picea mariana* or *Abies balsamea*, distributed as a continuous zone between 3,800 and 4,800 ft or intermixed with heath shrubs, primarily bilberry, cranberry, and blueberry. Dwarf shrub-sedge-rush meadow communities dominate much of the vegetated portion of the alpine zone at elevations ranging from 4,600 to 5,600 ft. *Carex bigelowii*, *Juncus trifidus*, bilberry heaths, and cranberry heaths characterize this habitat.

1.2 Justification

Alpine habitat is a rare community throughout the Northeast, occurring mostly as isolated "islands" on high peaks. Unique alpine plant communities, extreme climate, and isolation lead to rare and endemic insect communities. White Mountain fritillary and artic butterflies are known to occur only on the Presidential Range, and their host plants may be sensitive to disturbance and climate change. Human impacts exist in almost every alpine zone, with the highest concentration occurring on ridges and summits (Harvey 2003). The impacts of human presence on alpine birds and mammals are not known. Alpine vegetation and soils are not well adapted to heavy recreational traffic.

There is widespread consensus that alpine habitat is extremely susceptible to climate change (Kimball and Weihrauch 2000). Climatic changes documented within the WMNF (Climate Change Research Center 1998, Harvey 2003, Grant and Pszenny 2004) are expected to cause interdependent shifts in species distribution and phenology as demonstrated in other alpine areas, and may eventually result in irreversible changes to the composition and structure of alpine plant communities (Halloy and Mark 2003, Lesica and McCune 2004). Isolated populations of low vagility alpine-dependent wildlife, especially insects, will be heavily influenced by the extirpation of climate-sensitive plants, rising treeline, and increasing woody plant cover.

1.3 Protection and Regulatory Status

The majority of New Hampshire alpine habitat is within the boundaries of the WMNF. The WMNF is part of the National Wilderness Preservation System (16 U.S.C. 1131-1136, 78 Stat. 890). This system is comprised of federally owned areas designated by Congress as "Wilderness Areas." Three Wilderness Areas in the WMNF (Great Gulf, Presidential-Dry River, Pemigewasset) contain alpine habitat.

1.4 Population and Habitat Distribution

In New Hampshire, alpine habitat occupies 0.13% (7,717 acres) of the state, with the highest concentration occurring in the Presidential Range. The Presidential Range distribution includes Alpine Garden (5,175 to 5,575 ft), Bigelow's Lawn (5,500 ft), Great Gulf (4,228 to 5,828 ft), Huntington Ravine (4,075 to 5,475 ft), Tuckerman's Ravine (4,525 to 5,125 ft), Monroe Flats (5,075 ft), Oakes Gulf (4,400 to 5,000 ft), Washington Summit (6,288 ft), and Lakes of the Clouds (5,012 ft) on Mt. Washington (6,288 ft); Edmunds Col (4,938 to 5,100 ft) on Mt. Madison (5,367 ft); Bumpus Brook (5,799 ft) on Mt. Adams; Monticello Lawn (5390 ft); Mt. Clay (5533 ft); King's Ravine (3825-5000 ft) on Mt. Jefferson; Mt. Franklin (5001 ft); Mt. Monroe (5,384 ft); and Mt. Eisenhower (4,760 ft) (Harvey 2003). The remaining New Hampshire alpine habitat includes: North Baldface, South Baldface, Mt. Davis (3,819 ft), Mt. Bond (4,690 ft), Mt. Bondcliff (4,265 ft), Mt.Guyot (4,580 ft), South Twin (4,902 ft), Mt. Lafayette (5,260 ft), Mt Lincoln (5,089 ft), and Mt Moosilauke (4,802 ft) (Harvey 2003).

1.5 Town Distribution Map

See attached.

1.6 Habitat Map

The definition of alpine habitat used in this analysis was areas with vegetation 8 ft in height that graduated down to bare rock. Alpine habitat was identified by isolating patches larger than 5 ac containing both krummholz and open rock per Hale and Rock's (2003) landcover classification for the WMNF. The resulting cover was appended with the Appalachian Mountain Club's (AMC) data depicting alpine areas in the Presidential Range and Franconia Ridge as well as New Hampshire Natural Heritage Bureau's (NHNHB) data depicting exemplary alpine communities. The NHNHB natural communities that were omitted included the following (with the exception of South Twin Mountain, Mt. Clinton, and Baldface): NHNHB alpine communities smaller than 5 ac; NHNHB alpine communities below 3,400 ft elevation, despite the appearance of diagnostic features; NHNHB peripheral/occasional alpine communities above 3,400 ft but greater than one quarter mile from a diagnostic community; and NHNHB peripheral/occasional alpine communities above 3,400 ft but greater than one quarter mile from the results of the other data sources. Other lower elevation habitat types will absorb alpine communities excluded in this analysis.

1.7 Sources of Information

Current distribution, historic distribution, and status of alpine habitat is synthesized from expert review and consultation, management plans, technical field reports, scientific journals, and plant and community records in the New Hampshire Heritage Biological and Conservation Data System (BCD). Habitat maps were generated utilizing Hale and Rock (2003) landcover analysis for the WMNF, AMC alpine habitat polygons for the Presidential Range and Franconia Ridge, and NHNHB exemplary alpine natural communities.

1.8 Extent and Quality of Data

The vegetation of New Hampshire's Presidential Range has been the subject of considerable study over the past 150 years. Plant and community databases, herbaria records, published reports, regional hiking guides, and articles on early exploration provide relatively thorough historical and current information about the Presidentials, but outlying occurrences in the state have received relatively little attention (Sperduto and Cogbill 1999). Although invertebrates dominate alpine-dependent fauna, very little is known about their distribution. Strong altitudinal and landform relationships make predicted alpine habitat occurrences reliable, and model validation should emphasize predicted habitat at marginal elevations.

1.9 Distribution Research

Surveys need be conducted to delineate alpine habitat outside the Presidential Range. Alpine invertebrate distributions need study.

Element 2: Species/Habitat Condition

2.1 Scale

Alpine habitat polygons derived from the mapping process were clustered by mountain range in which they occurred to facilitate conservation planning. Clustering helped define 6 conservation-planning units.

2.2 Relative Health of Populations

New Hampshire's largest expanse of alpine habitat occurs in the Presidential Range (6,931 ac), followed by Franconia Ridge (379 ac) and Baldface (247 ac). The remaining alpine habitat units comprise 160 ac.

2.3 Population Management Status

N/A

2.4 Relative Quality of Habitat Patches

The Presidential Range supports the largest and most ecologically diverse alpine community, containing more susceptible plants than any other habitat type (Kimball and Weihrauch 2000). It also supports the highest level of recreational use, containing the largest trail (50 mi), road (3.3 mi), and rail (1.4 mi) systems. Highly sensitive communities (e.g., snowbank) occur in Tuckerman's, Huntington, and King ravines, the Alpine Garden, Lakes of the Clouds, and Red Pond on Mt. Eisenhower.

2.5 Habitat Patch Protection Status

Alpine habitat within the WMNF is protected by the United States Forest Service (USFS) as designated by the National Wilderness Preservation System. National scenic trails bisecting alpine habitat throughout these Wilderness Areas will be protected and regulated in accordance with the Appalachian Trail regulations delineated in the Appalachian National Scenic Trail Comprehensive Plan (ATPO 1981). Further protection will be granted upon approval of the Proposed Land and Resource Management Plan for the White Mountain National Forest: Standards and Guidelines for Management Area 8.1- Alpine Zone.

2.6 Habitat Management Status

The Wilderness Areas in the WMNF containing alpine habitat (Pemigewasset, Presidential-Dry River, and Great Gulf Wilderness Areas) are managed according to the guidelines and standards delineated in the Land and Resource Management Plan for the White Mountain National Forest. Natural processes are allowed to continue with minimal impediment, effects and impacts of human use will be minimized, primitive recreation opportunities will be provided, appreciation of the qualities of wilderness landscapes will be fostered, and utilization for educational and scientific purpose will be continued (USDA Forest Service 2004).

National scenic trails bisecting alpine habitat will be administered in accordance with the Wilderness Act (ATPO 1981) and are under the management authority of the Cooperative Management System (1984 memorandum of understanding (MOU) USFS and Appalachian Trail Conference), composed of the AMC, Dartmouth Outing Club (DOC), New Hampshire Department of Environmental Resources (DES), and WMNF. In addition, an MOU between the New Hampshire Fish and Game (NHFG), United States Fish and Wildlife Service (USFWS), and the USFS was established in 1996 delegating authority to develop, maintain, and manage all of the fish and wildlife resources and their habitats within the WMNF to NHFG. Further management guidance of alpine habitat will be granted upon approval of the Proposed Land and Resource Management Plan for the White Mountain National Forest: Standards and Guidelines for Management Area 8.1- Alpine Zone.

2.7 Sources of Information

Information regarding the management and protection of alpine habitat was obtained from the Proposed Land and Resource Management Plan for the White Mountain National Forest; 2001 MOU between the Bureau of Land Management (BLM), National Park Service (NPS), USFS, United States Department of Transportation (USDOT), and National Endowment for the Arts (NEA); 1996 MOU between NHFG, USFWS, and USFS; Appalachian National Scenic Trail comprehensive management plans; and documents delineating the Wilderness Act. Habitat patch identification and quality were determined utilizing WMNF landcover analysis, Presidential Range and Franconia Ridge alpine habitat polygons, NHB, and Vermont Institute of Natural Sciences (VINS) alpine natural community delineations.

2.8 Extent and Quality of Data

See Species/Habitat Condition Technical Assessment

2.9 Condition Ranking

See Species/Habitat Condition Technical Assessment

2.10 Condition Assessment Research

Data on alpine habitat condition need to be compiled. Parameters for relative condition, including extent of recreational impacts and rare natural communities, need to be identified and measured.

Element 3: Species and Habitat Threat Assessment

3.1.1 Recreation

(A) Exposure Pathway

Recreational use of alpine habitat is high. Structures, designated trails, undesignated trails, climbing routes, popular ski areas, and viewpoints co-occur with some of the most sensitive alpine communities, such as ravines and snowbanks. Disturbance from snow compaction and trampling may result in vegetative stress, mortality, and erosion, thereby reducing recolonization within these sensitive communities.

(B) Evidence

The alpine zone throughout the Presidential Range is highly recreated, enduring high levels of foot traffic and snow compaction (USDA Forest Service 2004). Magnitude of response is strongly correlated with trampling intensity (Cole 1995, USDA Forest Service 2004). While robust in their ability to withstand severe environmental conditions, alpine communities and soils have low tolerances for trampling. Trampling substantially reduces vegetation cover and height and increases soil erosion. Communities dominated by dwarf heath shrubs and erect forbs are the least resistant to trampling (Cole 1995, Cole and Monz 2002). Despite varying tolerances of trampling resistance and resiliency among alpine communities, they all have a threshold beyond which impacts become irreversible (D. Sperduto, New Hampshire Natural Inventory Bureau, personal communication).

3.1.2 Climate Change

(A) Exposure Pathway

The composition of the earth's atmosphere is changing, altering temperature, precipitation, air quality, and frequency of extreme weather (Climate Change Research Center 1998). Climate change could significantly alter the phenology and distribution of alpine vegetation (Kimball and Weihrauch 2000). Alpine communities could be further disrupted by alterations in snow cover and ice extent, causing stress or mortality to snowbank vegetation (Ingersoll et al.

1995, Walther et al. 2002, Sperduto and Nichols 2004).

(B) Evidence
Alpine communities are strongly influenced by edaphic and microclimatic gradients, increasing their vulnerability to climate change (Grabherr and Pauli 2000, Kimball and Weihrauch 2000, Harvey 2003). Climate change has been extensively demonstrated regionally and locally (Harvey 2003). In New Hampshire, temperatures have increased by 0.7 °F, 2 to 3 times the regional average, (NERA 2001, Harvey 2003). This same trend has been documented on the summit of Mt. Washington, where a 69-year temperature record has demonstrated a 0.3+/-0.08°C increase for the period 1935 to 2003, with a sharper rise in minimum temperatures than in maximum temperatures (Grant and Pszenny 2004). In response, freeze-free periods in many subalpine/alpine regions are lengthening, decreasing snow cover and ice extent (Walther et al. 2002). Alterations in annual snowpack in the alpine zone negatively impacts the herbaceous snowbank/rill communities which depend on these late-melting snowbanks to abbreviate their growing season and limit exposure to extreme conditions (Ingersoll et al. 1995, Sperduto and Nichols 2004). Additionally, Walther (2002) has documented poleward and upward shifts of species ranges including treeline advancement toward higher altitudes, elevation shift of alpine plants, and northward range shifts of 39 butterfly species, each of which is linked to global warming (Gottfried et al. 1998; Grabherr et al. 1994, Pauli et al. 1996, Harvey 2003). Changing climatic regimes will ultimately alter species distributions and composition, disrupting community structure and function (Walther et al. 2002).

3.1.3 Acid Deposition

(A) Exposure Pathway
In alpine communities, acid deposition may change community structure, spatial distribution of ecosystems, soil properties, and soil fauna (Rusek 1993). These reactions are compounded by similar reactions to climate change (Rusek 1993). The reactions of alpine grassland communities precede changes in the lower elevation subalpine zone and mountain forests (Rusek 1993). Bioaccumulation of contaminants (such as mercury) and other interactive chemical impacts may be high in wet, high-elevation environments with reduced pH.

(B) Evidence
Exposure to acid deposition is high at high elevation and in areas with frequent direct exposure to clouds. Extensive studies have demonstrated the detrimental consequences of acid deposition on alpine communities. Data have linked acid deposition to decreased soil pH, increased range of acidophilic species, disappearance of calciphilic species, and changes in plant community distribution (Rusek 1993). Methylation of abiotic mercury is accelerated in acidic environments. The communities most sensitive to acid deposition were found in locations with snow accumulation and water runoff gullies (Rusek 1993).

3.1.4 Mercury
(See Threats, Mercury)

3.2 Sources of Information

Information regarding alpine threats was compiled from expert review and consultation, management plans, technical field reports, and scientific journals. AMC, WMNF, and DRED trail data were used to assess recreational impacts.

3.3 Extent and Quality of Data

Recreational impacts, climate change, and acid deposition are fairly well documented.

3.4 Threat Assessment Research

Further research should focus on range shifts of alpine flora and fauna, phenological changes, and pollution-induced wildlife stress/mortality. Measuring the effects of local alpine point sources of pollution, such as the cog railway, is a high priority. Responses of invertebrate and avian foodwebs to interactions among atmospheric pollutants and among pollutants and climate change need to be assessed.

Element 4: Conservation Actions

4.1.1 Advise Land Managers on Mitigating Trail Impacts, Regulation, and Policy

(see also Strategies, Inter-Agency Regulation and Policy)

(A) Trails in Sensitive Areas/ Trampling

(B) Justification

1. Restricting trail use, placement, and width in sensitive areas will reduce the area of exposure.
2. Alpine communities have historically responded positively to scree-walls and other trail design modifications.
3. Trail advisories will be designated for high-use trails through delineated sensitive areas.
4. Advisories will be provided immediately upon entry into trail management agreements (see G: Implementation).
5. Trail use and design will be modified based on habitat response indicators.

(C) Conservation Performance Objective
Eliminate the co-occurrence of trail impacts with delineated S1-ranked natural communities and rare alpine lepidopteran habitats. Performance will be indicated by entry into trail management agreements, modification of trails, and adoption of trail advisories.

(D) Performance Monitoring
Advisories will include trail use and design modification reporting protocols.

(E) Ecological Response Objective
Restore S1-ranked natural communities and rare alpine lepidopteran habitats to delineated areas. Advisories will include restoration and monitoring recommendations.

(F) Response Monitoring
Cover of alpine vegetation and soils will be measured in delineated areas prior to implementation of advisories and in subsequent years. Responses will be used to revise advisories.

(G) Implementation
NHFG will delineate sensitive areas and provide trail advisories to all managing agencies to mitigate trail impacts to wildlife and wildlife habitats. NHFG will become a recognized participant of the Appalachian Trail Conference (ATC) Cooperative Management System. Participants include AMC, DOC, NHDES, and WMNF formalized through a series of Cooperative Agreements at both the state-level and local level (New Hampshire is one of the only states that does not have a wildlife agency as a partner). NHFG will be involved in the development, review, and approval of the Appalachian Trail Local Management Plan. NHFG will enter a MOA with DRED to maintain and manage trails in accordance with the health of wildlife and wildlife habitats. NHFG will review the 1996 MOU between the Department, USFWS, and the USFS.

(H) Feasibility
Given that NHFG is one of the only New England states not party to the ATC, the ATC's success and trail maintenance resources, and the Department's regulatory authority, it is highly feasible for the Department to enter the ATC and assert that trail managers adopt activities to mitigate wildlife impacts.

- Advise IAFWA Regional Coordination Team on Climate Change and Acid Deposition Impacts, Regulation and Policy (see Strategies: Regional Coordination)
- Engage in Inter-Agency Risk Assessments for Climate Change and Acid Deposition, Regulation and Policy (see Strategies: Inter-Agency Regulation and Policy)
- Identify High Risk Areas, Conservation Planning (see Strategies: Conservation Planning)
- Monitor Indicator Species for Climate Change and Acid Deposition, Monitoring (see Strategies: Monitoring)
- Restrict Access to Sensitive Areas, Regulation and Policy (see Strategies: Inter-Agency Regulation and Policy)
- Cultivate Recreational User Stewardship, Education and Outreach (see Strategies: Education and Outreach)

4.2 Conservation Action Research

Baseline surveys need to be conducted to better identify diagnostic species for sensitive alpine habitat areas and indicators of climate change and acid deposition. A permanent monitoring scheme needs to be developed and implemented in order to assess habitat changes across space and time.

Element 5: References

5.1 Literature

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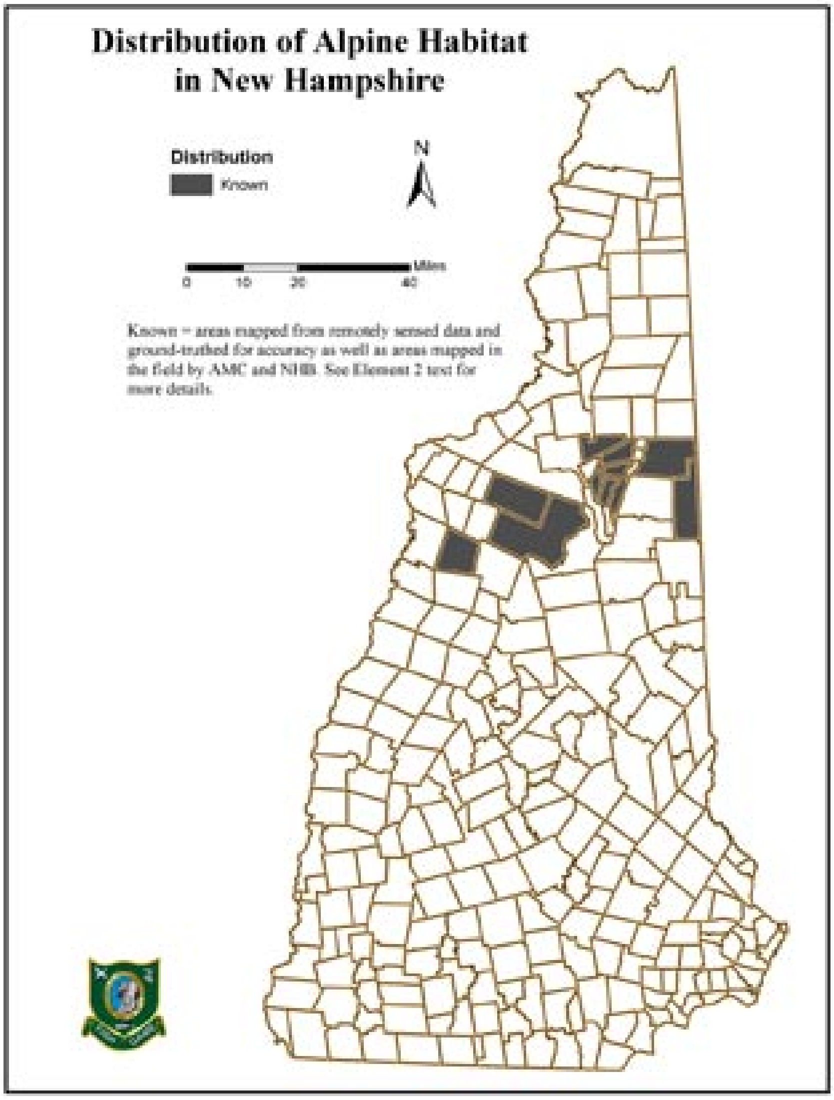
Distribution of Alpine Habitat
in New Hampshire
Distribution
Known
N
Miles
0 10 20 40
Known = areas mapped from remotely sensed data and ground-truthed for accuracy as well as areas mapped in the field by AMC and NHB. See Element 2 text for more details.