Final Project Report (for 2012)

Alpine Snowbed communities of Mt. Washington and the monitoring of Populations of Rare Bryophytes and Lichens in relation to Future Climate Change

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Introduction: Project Members:

Nancy G. Slack, Ph.D. Ecology S.U.N.Y. Albany; Professor, Biology Dept.The Sage Colleges, Troy, NY; plant ecologist and bryologist, author of mamy papers, AMC and ADK alpine guides, and editor of *Bryophyte Ecology and Climate Change* (Cambridge U. Press, 2011); public workshops on Mt. Washin.

Robert Capers, Ph.D. University of Connecticut; Collections Manager and research ecologist at U.Conn, author of papers in plant ecology, currently also working on another Mt. Washington research project on the effects of the cog railroad disturbance and another project on Mt. Moosilauke disturbance.

Jeffrey Duckett, Ph.D. U. of Bangor, North Wales, Professor of Botany, Queen Mary's U.,London, currently a Fellow and researcher at the Natural History Museum, London, President of the International Association of Bryologists. He is an excellent field botanist and bryologist and a liverwort specialist.

Allison Bell, Northampton, Massachusetts, photographer and designer (AWBell, Design), co-author (photographs and design) of Appalachian Mountain Club and Adirondack Mountain Club alpine field guides; co-author with Nancy Slack of AMC magazine articles, volunteer speaker and workshop leader for AMC.

Kate Storms, Albany N.Y., voluntee, recently retired NY State librarian who helped with field work on Mt. Washington and has since become our data manager for the project.

Evelyn Greene, North Creek, NY, and **Kathie Armstrong**, Niskayuna N.Y., amateur botanists who volunteered in June and September, helping with Mt. Washington data collection in June and September respectively.

Need for Project:

While editing (and writing two chapters for) *Bryophyte Ecology and Climate Change* Nancy Slack was impressed by changes in alpine communities in response to a 3 degreeC. temperature rise in parts of Europe. In both northern Sweden and the Austrian Alps the plant communities that were most affected by this aspect of climate change were the snowbed communities, in which snow was not lasting as long as in the past, affecting both vascular plants and bryophytes (mosses and liverworts). The

snowbed communities on Mt. Washington had been studied by both Larry Bliss and Hinrich Harries in the early 1960s and were reported on more recently, but no quantitative study had been done since then. The climate change has not been so great in the Mt. Washington alpine zone, but a baseline study in relation to future climate change seemed important to do. Nancy Slack talked about this at the Alpine Stewardship meeting in Vermont a year ago, and proposed doing this research together with Jeffrey Duckett and Allison Bell. Bob Capers gave a talk at that meeting, also recommending snowbed community study; he offered to join us. He has proved a very valuable member of the research team.

The Waterman Fund also deemed this project important and approved a grant in January 2012 to Nancy Slack for our research expenses. The project also involves finding and locatingpopulations of rare bryophytes and of several rare (ARctic) lichens for future monitoring.

Both aspects relate to the mission of the Waterman Fund to preserve the alpine flora and ecosystem. In addition we are writing both scientific articles and popular ones to help educate the public about our project and the need to monitor the alpine flora in relation to ongoing climate change.

Methods:

What did you do and when?

2012

June 8-10

Nancy Slack, Bob Capers, Allison Bell, and volunteer Evelyn Greene made a trip to Mt. Washington**.** Charlie Cogbill kindly joined us one day in our search for snowbeds, with which he also has experience in the the White Mountains. It was a very early spring, and most snowbeds were gone in the Alpine Garden area and above where we had decided (in our grant proposal) to work. One extensive snowbed high up in the cone area was still largely snow-covered. We knew the snowbed communities from the plants, however, anad were able to locate a number of sites for quantitative study. We also found and located some of the rare mosses and lichens on the mountain.

June 23-July 1

Jeff Duckett came from England (at his own expense) to work on this project for this whole period. Nancy Slack and Bob Capers worked on the research during this whole period as well and Allison Bell and volunteer Kate Storms for part of it. We had seven snowbed sites in the Alpine Garden and up above it toward the summit of Mt. Washington. Some of the snowbeds were quite extensive and involved two transects each. We recorded for at least 10 one meter square quadrats along each line transect all the vascular plants, bryophyte, and lichens (except those on boulders that were not part of the snowbeds) on alternate sides of the transect line. We all recorded cover values for each species in each quadrat.

The first day the weather was fine. We drove up and spent a whole day at our sites on the mountain, but then there were two days of Mt. Washington's famous

terrible weather and the (private) toll road was closed--not unusual in June. We were told by AMC personnel that it was not safe to be in the alpine on the mountain. In any case it was not possible to climb the mountain and also have time for our research. We needed the toll road to get up to the trails for our sites, which we could do on good days by 9 AM,. On the two bad days most of us went out in the rain looking for rare mosses and liverworts on the lower parts of the mountain and nearby limestone sites. Jeff recoded over 50 species of liverworts, some of them quite rare in New Hampshire and New England generally..

We had earlier found four rare mosses on the mountain: *Aulacomnium turgidum. Dicranum elongatum, Conostomum tetragonum, and Pseudocalliergon trifarium*, the first three are all arctic (and alpine) mosses, the fourth a rich fen moss very rare in New England and not yet found in NY State. It was not in a fen on the mountain, but growing in a solid mat of *Marsupella*, a liverwort often found in the alpine. (In the alpine it forms an extensive black mat; people walking on it have no idea it is a liverwort). We also found the Arctic (and alpine) lichens that we had decided to monitor, snow lichens and worm lichen, species of *Cetraria* and *Thamnolia* and recorded locations of their populations. They are all very scarse on the Adirondack high peaks, but we found them doing well on Mt. Washington, is some cases in large populations in the alpine.
The following day the road was still closed to the public but their own vehicles were going up and we got rides up the mountain at 9 and down after 5, in their vehicles. We did this for two days. Finally the road opened again and we could have a long day with our own vehicle. We managed to complete the data-taking for all eight sites.
Bob Capers came back to Mt. Washington to do another study with a co-worker on disturbance along the cog railway in July and stayed an extra day to look at our snowbed sites.

September 1-September 3

Nancy Slack, Bob Capers and volunteer Kathie Armstrong came to Mt. Washington for this weekend. We went back to our snowbed sties. The species composition was the same, but species such as the large-lead goldenrod (*Solidago macrophylla*) had grown much larger. For this reason it is important to take all the cover measurements during the same time period, late June in our case. However, we decided to do one large site two linear) of a “rill” (streamside) community to compare the species composition with that of the snowbeds. These sites are moist for an even longer part of the season that is true of the snowbeds.This site is in the alpine Garden area (Site I on the map which accompanies this report).

Waterman Fund grant monies

These were used almost entirely lor lodging, breakfast, and dinner. We stayed at the AMC Joe Dodge Lodge at Pinkham notch, where a bunk bed comes with two meals. Lunches were on our own as was transportation to and from Mt. Washington (from London, Connecticut, Massachusetts, and New York State). Our other main expense was for the toll road; Bob Capers paid this in 2012 as he was returning to work on another Mt. Washington project later in the summer; we all used his car. The two days we had to go in the (private) Toll Road company vehicles we had to pay, but they gave us a reduced price. I also bought clipboards and other small pieces

of equipment but have not charged these to the Waterman Fund. Volunteers paid for themselves, but we did pay for a bunk and dinner for Charlie Cogbill for one night; his ideas were helpful to our project. There were no funds left for the September trip; we all chipped in, with Nancy Slack's apologies. (She was afraid the project would not be funded if she asked for more money). We paid for our own housing, but we still had the toll road pass. I highly recommend the lodge. Although the bunks cost more than elsewhere (ADK lodge), the meals are excellent and food plentiful, a boon for people who have been hiking to our sites from the toll road, often over felsenmeer, and taking data all day, sometimes in rain and cold. (Several of us have done field research expeditions where we stayed in tents and had to prepare our own meals, usually freeze-dried, after a hard day's fieldwork.)

We had no matching funds, but our volunteers worked hard and climbed over difficult terrain, so I guess that is "matching labor." In addition, Kate Storms used her computer skills doing Excel sheets (data managing) and helping with laboratory identifications of bryophytes and lichens at Russell Sage College with Nancy Slack--all unpaid.

Results

Nancy Slack and Bob Capers are analyzing the data from the snowbed sites and the one rill community site,which proved to have some of the same plant species as the snowbed communities, but different ones as well and additional bryophyte species and cover.This is an ongoing process, and will result in a paper for a scientific journal. However, I have applied for a new 2013 grant for the original four of us plus Kate (Katherine) Storms to make one more research trip to Mt. Washington on the same dates as in 2012 to compare the state of the snowbeds on that date in another year, when the spring melt may not be quite so early. We are also planning to do some work in the Great Gulf, where the species composition of snowbed communities is reported to be somewhat different from the ones we have studied in the Alpine Garden and above.

The following is a short data summary largely compiled by Bob Capers. See also the Excel data sheets accompanying this report.

Preliminary summary of snowbed data.

We found a total of 55 vascular plant species in seven surveyed snowbeds and one rill community. Of the total, 50 species were recorded in the snowbed communities and 26 were found in the rill community. Five species were found only in the rill community: Stellaria borealis, Agropyron brachycaulon, Epilobium hermanii, Viola palustris and Rubus pubescens.

The species with the highest frequency values in the snowbeds (the species occurring in the most snowbeds) were Carex bigelowii, Juncus trifidus and Vaccinium uliginosum,

which appeared in all seven snowbed communities. Cornus canadensis and V. cespitosum occurred in six of the seven, and those occurring in five were Clintonia borealis, Coptis trifoliata, Maianthemum canadense, Solidago cutleri, S. macrophylla and Trientalis borealis.

The species with the highest frequency values in individual quadrats in snowbeds (frequent at the quadrat scale, combining across snowbeds) were Vaccinium cespitosum and V. uliginosum, in 63% of all quadrats (n=102); Carex bigelowii occurred in 61% of quadrats, and Solidago macrophylla occurred in 58%.

The most frequent species in the rill community were Epilobium hornemanii and Stellaria borealis, which were recorded in 70% of the quadrats (n = 23). Other species that were found in more than half of the rill community quadrats were Calamogrostis canadensis, Salix planifolia, Solidago macrophylla, Campanula rotundifolia and Veratrum viride.

A total of 43 species of bryophytes and lichens were found in snowbeds and the rill community; of the total, 35 species were found in snowbeds and 17 in the rill community. The majority of these occurred in only one community type, not in both the snowbeds and rill communities.

Among bryophytes, Dicranum fuscescens was most widespread. It was the only species that was recorded in all seven snowbeds. Pleurozium schreberi and Polytrichum alpinum occurred in five. At the quadrat level, Dicranum fuscescens occurred in 45% of all quadrats, followed by P. alpinum (37%) and P. juniperinum (23%). Cladonia species were most common among the lichens.

Species richness of vascular plants in the 1 meter (spared) quadrats ranged from 4 to 15 species. Mean richness was 8.96 species per quadrat for vascular plants and 2.81 species for bryophytes and lichens combined. Mean richness per snowbed ranged from 6.6 to 11.8 for vascular plants and from 1.8 to 4.3 for bryophytes and lichens. Mean species richness for all snowbeds was 9.6 for vascular plants and 2.8 for bryophytes and lichens . The species richness for the rill community was 7.8 for vascular plants and 3.1 for bryophytes and lichens (The numbers here refer largely bryophytes; these two groups need to be treated separately in a later scientific account; we hope to have additional data after next June's research).

Additional data is on separate sheets and separate emails (map and Excel sheets)

Submitted by Nancy G. Slack, Project Leader

Frequency values for vascular plants in the snowbed and rill communities. The values are the proportion of quadrats in each snowbed in which the individual species were recorded. The number of quadrats is shown after the community name. If no value is shown, the species did not occur in that snowbed.

	F (n=20)	G (n = 10)	C (n = 20)	H (n = 10)	D (n = 20)	A (n = 10)	B (n = 12)	I (n = 23): The rill community
Abies balsamea						0.3		0.087
Agropyron brachycaulon								0.00
Agrostis mertensii	1		0.35	0.9	0.95			0.39
Betula cordifolia			0.05			0.1		
Calamogrostis canadensis					0.1			0.61
Campanula rotundifolia		0.6	0.65					0.57
Carex bigelowii	0.9	0.3	0.6	0.9	0.65	0.1	0.25	0.22
Carex brunescens	0.05			0.1			0.08	
Carex scirpoidea		0.9	0.5					
Clintonia borealis	0.9			0.6	0.3	0.9	0.92	
Coptis groenlandica	0.6	0.1		0.6		0.9	0.75	0.17
Cornus canadensis	0.7		0.15	0.7	0.35	1	0.92	
Deschampsia flexuosa						1	1	0.44
Diapensia lapponica			0.05					
Dryopteris campyloptera	0.1							0.04
Empetrum nigrum	0.05			0.4		0.4	0.08	
Epilobium hornemanii								0.67
Geum pecki		1	0.9		0.25			0.26
Hierochloe alpina		0.1	0.8					0.04
Houstonia caerulea	0.1		0.3		0.45			
Juncus filiformis	0.05					0.1		
Juncus trifidus	0.55	0.1	0.4	0.1	0.05	0.2	0.17	
Loiseleuria procumbens			0.05					
Luzula parviflora				0.1				
Luzula spicata			0.25					0.44
Lycopodium annotinum	0.05					0.8		

Maianthemum canadense	1			0.4	0.35	0.4	0.92	
Phegopteris connectilis					0.05			
Phyllodoce caerulea	0.35				0.05			
Polygonum viviparum		0.8	0.45					0.26
Potentilla tridentata		0.3			0.05			0.04
Prenanthes boottii			0.15					0.09
Prenanthes trifoliata		0.9	0.25					0.04
Rhododendron groenlandicum				0.8		0.9		
Rhododendron lapponicum		0.1	0.05					
Rubus pubescens								0.30
Salix planifolia			0.15					0.61
Salix uva-ursi		1	0.15					0.09
Sibbaldiopsis tridentata			1					
Solidago cutleri		0.8	0.35	0.2	0.05		0.25	0.26
Solidago macrophylla	0.95			0.4	0.95	0.6	0.92	0.65
Stellaria borealis								0.67
Spinulum annotinum				0.3				
Spiraea alba var. latifolia				0.1	0.2			
Streptopus lanceolatus					0.2	0.1		0.04
Streptopus roseus						0.2		
Thelypteris palustris				0.3	0.15			
Trichophorum cespitosum	0.05	0.5	0.25			0.1		
Trientalis borealis	0.45		0.1	0.2		0.2	0.33	
Vaccinium angustifolium				0.5				
Vaccinium cespitosum	1		0.2	0.9	0.5	1	0.92	
Vaccinium uliginosum	0.5	0.8	0.35	0.9	0.1	0.9	0.92	
Vaccinium vitis-idaea		0.1	0.95	0.1				
Veratrum viride	0.05		0.55	0.2	0.85			0.52
Viola palustris								0.39

Excel sheets and map of all the sites will also be included in this Results summary (separate email)

Discussion (Some of this has been done above)

In terms of setbacks, we were hampered by the extreme weather and the lack of consolidation of the surface of the upper toll road in June. This should be taken into consideration when planning the number of days you will be working on the mountain. When we return to Mt. Washington in June of 2013, we need to plan at least one extra day in case the extreme weather of 2012 is repeated.

In terms of unexpected results, the species composition of our snowbeds is somewhat different from that reported in the 2960s. This will be pointed out and discussed in the forthcoming scientific paper. That is a long lapse in time and environmental changes other than climate change have no doubt taken place. It may be possible to locate the ealier snowbeds that were studied in the 1960s in relation to ours. Fortunately our sites are all located by GPS, so that anyone wanting to repeat this study in ten years or thereafter will have no difficultly in locating our sites.

In terms of alpine stewardship, we may be able to determine if any snowbed species have been lost in this part of Mt. Washington since the 60s. Importantly for the Waterman Fund, monitoring for future species presence and the size of populations of rarer species (from cover measurements) will be easy to do bt using the present data.

In terms of future needs, rare species of both vascular plants and bryophytes that are in the snowbeds right along the sides of the Alpine Gardens trail should be monitored.There is a lot of traffic there on nice days and visitors should be encouraged to stay on the trail as much as possible. Most of the other snowbeds we studied are in steep areas with felsenmeer and shouldnot be impacted by visitor use.

Accounting

Please see receipts sent by snail mail. We had no other sources of income. Contributed volunteer labor is discussed above. The volunteers also contributed expertise and ideas and in the case of Kate Storms, computer skills.

Digital images You already have a great many of these, some of which you have used in your newsletter--though unfortunately not in color. Allison Bell also took some photos of the people involved. She will send them separately. She also has photos of many of the alpine plants. Bob Capers has sent some of his already.

Publications/Education ? (not on your form)

Jeff Duckett and Nancy Slack have written two articles about this project. One of them is about a great discovery that Jeff made--the finding of the ancient liverwort, *Haplomitrium hookeri*, in Tuckerman's Ravine. It had been found in Huntington's Ravine by Evans nearly 100 years ago--but althogh several experts have looked for it, the plant has not found it on Mt. Washington nor anywhere in New Hampshire.. It is very rare in the Northeast. It is of great interest because this species and its close relatives are probably the oldest green land plants, and they have symbiotic fungi from very old fungal groups as well. (You could see the fungus with your naked eye). Jeff thinks there are probably more populations of this rare bryophyte to be found in the White Mountains. He and Nancy Slack wrote an article about it and about the project in general which will come out in the next issue of *Evansia.* The title is "The First Twenty-First Century Record for the Liverwort *Haplomitrium hookeri* in Northeastern North America with notes on its Fungal Endophyte and Snowbed Communities." by Jeffrey G.Duckett and Nancy G.Slack (It has been accepted for publication, but we cannot distribute it ahead of time. We also wrote s about the project as a whole). Here is a photo of *Haplomitrium hookeri* , though not the one Jeff took, which may appear on one of the covers of the journal.

Nancy Slack also wrote an popular article about the project for the IAB journal, *Bryological Times,* which goes to over 600 people worldwide. Nancy Slack and Allison Bell plan to write an artcle with color photos about our snowbed project for AMC publication in 2013.

Submitted by Nancy G. Slack, Ph.D., Project Director

December 30, 2012