

## Waterman Fund Grant Report

### Assessing the Condition, Treatment and Costs of Rehabilitating the Alpine Trails of the White Mountains of New Hampshire



*Figure 1:* Eroding informal trail adjacent to staircase on Mount Monroe, White Mountains.

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## Introduction

The focus of this project was the creation of a comprehensive analysis of alpine trail conditions in the White Mountains of New Hampshire, including recommended treatments and projected costs for addressing identified trail problems. A second goal was a review of available information about trail conditions in other alpine regions in the northeastern United States.

Alpine trails provide access to a fragile and special resource. Traveling through the alpine zone is a popular destination for hikers, and the use of alpine trails in the Northeast is increasing (Sarnacki, 2015). Over 50 million people live within a day's drive of the White Mountains, a year-round hiking destination (United States Forest Service, 2003). With recreation in the alpine zone on the rise, and with millions of people having easy access to the White Mountain trail network, appropriate White Mountain alpine trail maintenance becomes paramount. Proper maintenance of alpine trails helps to protect rare plants and unique alpine habitats, and allows for continued recreation above tree line (Marion, 1994).

Effective management of alpine zone visitation has the potential to be significantly enhanced with a comprehensive overview of trail problems occurring due to overuse within a given region. The goal of this project was to generate that overview for the White Mountains, and to survey available information for other alpine zones in the Northeast.



*Figure 2:* Measuring an unofficial trail along the Presidential Ridge, White Mountains (AMC Lakes of the Clouds Hut in the background).

## Methods

During Phase 1 of the project (February 2016 - May 2016), currently available information on the status of White Mountain alpine trails was obtained from the Appalachian Mountain Club (AMC), U.S. Forest Service (USFS), Randolph Mountain Club (RMC), and Appalachian Trail Conservancy (ATC). Interviews were conducted with professionals with deep experience in the field, including Jeffrey Marion, Charles Jacobi, Robert Manning and Jeremy Wimpey.

Organizations involved in the management of alpine zones elsewhere in the Northeast were also contacted to obtain available information on the status of alpine trails, including the Adirondack Mountain Club (ADK), Green Mountain Club (GMC), Baxter State Park Authority (BSPA), and Acadia National Park.

In addition, a trail assessment tool was developed and tested for the collection of field data (Appendix A). The problem assessment method was utilized to develop the trail assessment tool used in evaluating alpine trails. The problem assessment method is an appropriate assessment technique when monitoring problem types that are easily pre-defined, such as excessive width, excessive erosion, and other problem types monitored in this study (Marion and Leung, 2001).

During Phase 2 (June 2016 - October 2016), a survey of all alpine trails in the White Mountains was completed, and all trail problem sites encountered were identified and described. For each trail problem site, key data points were gathered and recorded, including dimensions, GPS coordinates and other identifying data points. Coordinates of each problem site were recorded using a Garmin handheld GPS. In addition, multiple photographs were taken of each problem site.

Trail problems were organized into four categories, with appropriate measurements recorded depending on problem type:

- Excessive erosion was defined as sections of trail where the erosion incision exceeded five inches in depth from original tread; these sites were measured by recording the length, width and depth of the eroded area.
- Excessive wetness was defined as seasonally or permanently wet soils where boot prints exceeded 0.5 inches in depth; these sites were measured by recording the length and width of the wet section of trail.
- Excessive width was defined as sections of trail where the current tread was at least three feet wider than the original tread; these sites were measured by recording the length and width of the widened tread.
- An unofficial trail was defined as an informal, visitor-created trail. Unofficial trails were measured by recording the length and width of the unofficial trail.

In addition, supplementary measurements were taken in order to align this assessment with other visitor assessment surveys (J. Marion, personal communication, January 2016). Rock percentage in soil, graminoid cover, sunlight intensity, and occurrences of previous failed trail work were recorded. Rock percentage was measured by estimating the percentage of rock in the trail using 10% intervals. Graminoid cover was measured by estimating the percentage of graminoids within five feet of the trail edge using 10% intervals. Sunlight intensity was measured by estimating the percentage of the tread with direct sunlight on it during daylight hours using 10% intervals. Previous failed trail work was recorded using photographs.

Finally, a specific treatment for each trail problem site was recommended based on the author's trail rehabilitation experience. Frequently recommended solutions included scree walls and rock staircases; a variety of other measures were also recommended (Appendix B).

During Phase 3 (September 2016 - January 2017), field data were analyzed and synthesized into a Trail Problem Inventory spreadsheet (Appendix B). In addition, a GIS map was created incorporating location and information for each trail problem site using ArcMap 10.4.1 (Appendix C). Finally, a projection of trail work costs was developed for the identified solutions (Appendix B, Appendix D).



*Figure 3: Excessive erosion on the Jewell Trail, White Mountains.*

## Results - White Mountains

This project resulted in a survey of all alpine trail miles in the White Mountains and the identification of 149 alpine trail problem sites on those trails. The survey covered a total of 51.35 alpine trail miles, which was calculated using publicly available geographic information system (GIS) data and ArcMap 10.4.1 (United States Forest Service, 2013).

Field data for all trail problems were synthesized into the following summary documents:

- White Mountain Alpine Trail Problem Inventory (Appendix B)
- White Mountain Alpine Trail Problem Map (Appendix C)
- White Mountain Alpine Trail Problem Reports (PDF report for each trail problem site including photos, GPS data, category of trail problem, measurements for trail problem, recommended treatment and supplementary measurements) (Appendix E)

Problem sites were categorized based on the type of trail problem present. In total, 90 problems were categorized as unofficial trails, 54 problems were categorized as excessive erosion, 17 problems were categorized as excessive width, and 3 problems were categorized as excessive wetness (Appendix B). Total problems recorded by category (164) exceeded the total number of problem sites identified (149) because a small number of problem sites were multi-faceted and therefore were categorized as more than one problem type.

Treatments were recommended for all trail problem sites. Recommendations included the following trail structures in aggregate: 8,273 feet of scree wall, 30 rock check steps, 170 rock staircase steps, 10 cubic feet of rock crush, 43 stepping stones, 3 rock water bars, and 6,890 square feet of brushing in. In addition, the following miscellaneous structures were recommended: 23 “Stay on Trail” signs, 100’ of trail relocation, 2 wooden bog bridges, improved blazing in 3 locations, relocation of 1 cairn, 2 instances of creating an official viewpoint, and 1 improved trail structure (Appendix B).

The total projected cost of installing the above trail structures was calculated as \$266,425, as detailed in the Trail Problem Inventory (Appendix B). Calculations were based on costs for specific trail structures as shown below in Table 1. Table 1 was developed based on a sampling of work reports for both alpine and non-alpine areas between 2010 and 2015 from the AMC White Mountain Professional Trail Crew. Additional important considerations related to costs are included in the discussion section below.

Table 1  
*Cost per Trail Structure*

<b>Trail structure</b>	<b>Cost<sup>a</sup></b>
Scree Wall (ft.)	\$15
Rock Check Step (count)	\$375
Rock Staircase (step count)	\$400
Rock Crush (cu.ft.)	\$25
Stepping Stones (count)	\$150
Rock Water Bar (count)	\$300
Brushing In (sq.ft.)	\$5
Miscellaneous	Varied - see Appendix B

<sup>a</sup> Based on sampling of AMC Trail Crew work reports 2010-2015

Several years ago, the AMC and USFS developed a Work in Lieu of Fee chart for various trail structures; it is included as Appendix F for reference, but was not incorporated in calculations for this report as the figures appear to be out of date.

The total projected cost of \$266,425 for the installation of the identified trail structures yields an average cost of \$5,188 per trail mile, and an average cost of \$1,788 per trail problem as shown in the Table 2 and Table 3 below.

Table 2  
*Projected Average Cost per Mile for Recommended Treatments*

<b>Projected total cost of recommended trail structures</b>	<b>Total trail miles surveyed</b>	<b>Projected average cost per trail mile</b>
\$266,425	51.35	\$5,188

Table 3  
*Projected Average Cost per Problem Site for Recommended Treatments*

<b>Projected total cost of recommended trail structures</b>	<b>Total number of problem sites identified</b>	<b>Projected average cost per problem site</b>
\$266,425	149	\$1,788

## Discussion - White Mountains

It is important to note that cost projections were based on trail work costs for both alpine and non-alpine areas. Therefore, these cost projections do fully not take into account the costs required to transport materials and supplies into the alpine zone, a substantial task. It is reasonable to expect that actual costs would be higher than the projected cost reported here as a result of these transportation costs.

Average figures for projected costs per mile and projected costs per problem site are rough calculations. In some cases, an alpine trail may be heavily damaged and solutions will be far more expensive than \$5,188 per mile, while other trails may require no work at all. Similarly, the cost to repair some trail problem sites will be far above \$1,788 per site, while other sites will be less expensive. Costs associated with specific trails and specific trail problem sites vary widely from the average figures presented in this report.

The fieldwork portion of this assessment of the alpine trails of the White Mountains was conducted during the summer and early fall of 2016. Conditions were unseasonably dry throughout New England during this time, including the White Mountains. In the 51.35 miles of alpine trails surveyed in the White Mountains, only three instances of extreme wetness were identified. Dry conditions likely reduced the occurrences of extreme wetness.



*Figure 4: Recording excessive erosion problem on the Alpine Garden Trail, White Mountains.  
(Photo: C. Jacobi)*

Soil sample is a measure of the percentage of rock in the trail tread. This metric was included in the study at the recommendation of United States Geological Survey (USGS) scientist Jeffrey Marion. Soil substrate is strongly related to the number of trail problems and the durability of a trail. Generally, trails with a higher percentage of rock in the trail tread have fewer problems and are more durable. It is interesting to note, for example, that trails crossing the summit cones of Mt. Madison and Mt. Jefferson exhibit few to no trail problem sites as a result of a substrate that is almost entirely rock.

The composition of trailside vegetation can also play a significant factor in trail quality. Alpine grasses that are resistant to trampling can help to reduce trail widening, trail erosion and development of unofficial trails (Marion, 1994). Graminoid cover was recorded to document trailside grass population.

## Results - Other Alpine Regions

Other initiatives to document alpine trail problems exist throughout the Northeast. The GMC, BSPA, ADK, ATC and Acadia National Park are all involved in alpine trail maintenance and documentation of alpine trail problems.

The Green Mountain Club is working on the passive behavior modification of visitors to the Green Mountain alpine zones. The Green Mountains do not have a lot of surface rock for trail repair, so the GMC has experimented with using string as a method of keeping hikers on the trail (M. Debonis, personal communication, December 2016). In addition, the GMC hires backcountry summit caretakers to work on Mount Mansfield, Camel's Hump, and Mount Abraham. Among other tasks, these summit caretakers serve to educate visitors about the fragility of their alpine surroundings. The GMC does not have access to a comprehensive survey of alpine trail problems (D. Hardy, personal communication, January 2017). The Green Mountains contain 1.5 miles of alpine trails (State of Vermont, 2017). Using the projected cost per mile to repair alpine trails in the White Mountains, the estimated projected cost to repair all alpine trail miles in the Green Mountains is \$7,782.

The Baxter State Park Authority is involved in alpine trail maintenance in Baxter State Park. Similar to the GMC, Baxter has found notable success using string to keep hikers on the trail. Baxter also uses summit stewards to help educate visitors about the importance of staying on the trail and avoiding alpine vegetation. Baxter State Park does not use cairns to mark alpine trails, but blazes are used above tree line. Baxter State Park uses a trail census from several years ago to help plan projects. There is no comprehensive survey of all alpine trail problems available to Baxter State Park (S. Guay, personal communication, December 2016). Baxter State Park has 11.4 miles of alpine trails (Appalachian Mountain Club, 2012). Using the projected cost per mile to repair alpine trails in the White Mountains, the estimated projected cost to repair all alpine trail miles in Baxter State Park is \$59,143.



*Figure 5: Summit sprawl on the summit of Little Haystack Mountain, White Mountains.*

Acadia National Park performs regular trail maintenance on their alpine trails and has a thorough list of trail problems on their alpine trails. An annual hike-through of all alpine trails is completed by employees of Acadia National Park for the purpose of documenting trail problems that need rehabilitation. Acadia National Park uses a Facility Management Software System (FMSS) to report and monitor trail problems. Trail problems are categorized as either “actively degrading” or as being a “stable system” to assist with prioritizing trail work needs (G. Stellflug, personal communication, December 2016). Acadia National Park has 10.1 miles of alpine trails (C. Jacobi and K. Anderson, personal communication, December 2016). Using the projected cost per mile to repair alpine trails in the White Mountains, the estimated projected cost to repair all alpine trail miles in Acadia National Park is \$52,398.

The Adirondack Mountain Club (ADK) works closely with the New York State Department of Environmental Conservation (NYSDEC) to maintain trails throughout the Adirondack Park. The ADK employs a large seasonal staff including a professional trail crew and several summit stewards. Both the professional trail crew and summit stewards spend hundreds of hours working in the Adirondack alpine zones, performing tasks such as scree wall construction, cairn construction, brushing in unofficial trails and performing visitor outreach and education. The ADK remains committed to their Photopoint Monitoring Project, a program that seeks to document and better understand alpine stewardship through annual photo documentation. The ADK does an impressive job of documenting the alpine visitor impacts in the Adirondack High Peaks. There is no comprehensive survey of all alpine trail problems available to the ADK or NYSDEC (J. Goren, A. Hamlin, and K. White, personal communication, December 2016). The

Adirondack Park has 6.25 miles of alpine trails (J. Goren, personal communication, April 2016). Using the projected cost per mile to repair alpine trails in the White Mountains, the estimated projected cost to repair all alpine trail miles in the Adirondack Park is \$32,425.

The Appalachian Trail Conservancy (ATC) has an impressive track record of stewardship along the Appalachian Trail. In 2015 and 2016, the ATC completed a census of the entire northern third of the Appalachian Trail, from the southern tip of Connecticut to the summit of Mount Katahdin in Maine (B. Proudman and M. Stevens, personal communication, September 2016). In addition, the ATC works with land management partners such as the AMC, GMC and RMC to identify and complete needed repairs along the Appalachian Trail. The ATC does have a complete survey of all alpine trail problems along the Appalachian Trail. However, the ATC is chiefly focused on maintenance of the Appalachian Trail and therefore the ATC does not survey trails other than the Appalachian Trail.

Table 4

*Projected Costs to Repair All Alpine Trails throughout the Northeast*

<b>Organization</b>	<b>Miles of alpine trail maintained</b>	<b>Projected average cost per mile to repair White Mountain alpine trails</b>	<b>Projected total cost to repair all alpine trails</b>
Green Mountain Club	1.5	\$5,188	\$7,782
Baxter State Park Authority	11.4	\$5,188	\$59,143
Acadia National Park	10.1	\$5,188	\$52,398
Adirondack Mountain Club	6.25	\$5,188	\$32,425

## Discussion - Other Alpine Regions

In addition to the factors affecting projected costs noted in the White Mountain discussion above, there are additional sources of potential distortion in projected trail repair costs that must be noted for other alpine areas in the Northeast. Variability in natural materials in different regions is one factor that may distort a calculation of projected costs. The natural materials available in the White Mountains may be unavailable or very difficult to access in other alpine regions in the area. For instance, the White Mountains have an abundance of rock available for use, so a large portion of trail repairs employ rock. On the other hand, there is much less rock available for use in the Green Mountains, and as a result the GMC has explored trail repairs that do not involve the use of rock.

Another potential source of distortion is the use of labor costs for the AMC White Mountain Professional Trail Crew in the calculations of projected costs. Other trail crews operating in the

Northeast may well have operating costs that vary from those of the AMC White Mountain Professional Trail Crew.

Varying tree line altitudes throughout the Northeast is an additional source of potential distortion to projected trail repair costs. In the White Mountains, tree line usually begins between 4,000' and 4,200' in elevation. At Acadia National Park, however, tree line usually begins between 1,000' and 1,500' in elevation. Lower tree line altitudes in areas like Acadia National Park could potentially result in comparatively lower transportation costs. While tree line altitude is a factor, it is also important to note that altitude gain from the trailhead and total mileage required to reach the alpine zone would both have an impact on the total cost per problem site.



*Figure 6: Excessive wetness forces hikers to step off the trail on the Crawford Path, White Mountains.*

Concentration of alpine trail use is an additional source of potential distortion to projected trail repair costs for other alpine areas in the Northeast. While the White Mountains receive over six millions visitors each year, the density of hikers per alpine mile may be less than that of other alpine regions (United States Forest Service, 2006). The White Mountains have over 50 miles of alpine trails and visitor impact is distributed over this extensive system, though there are certainly hotspots of activity and visitor impact. In contrast, Acadia National Park receives approximately three million visitors annually (National Park Service, 2017), while there are only ten miles of alpine trails (C. Jacobi and K. Anderson, personal communication, December 2016). At Acadia National Park, alpine visitor impact is more densely concentrated across a smaller

system. Heightened alpine visitor density focuses visitor impacts onto smaller sections of trail, and therefore can result in increased costs per mile to repair alpine trails.

## Acknowledgments

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## Appendix A: White Mountain Alpine Trail Problem Assessment Tool

### Site Number

- Start at #1 for each different trail problem. Eg: Tuckerman Ravine Trail #1-14, Lion head Trail #1-8 etc.
- Give each unofficial trail its own site #.

### GPS Coordinates (start)

- Take GPS coordinates at beginning of trail problem.
- If GPS gives code, record it
- Mark beginning of unofficial trails as well.

### GPS Coordinates (end)

- Take GPS coordinates at end of trail problem.

### Trail Name

- Name of trail or intersection.

### Trail Problem

- Choose between excessive muddiness, excessive erosion, and unofficial trail development.
- Excessive muddiness is defined as: seasonal or permanently wet soils where boot prints exceed .5 inches deep. Record surface area of muddy section.
- Excessive erosion is defined as: sections of trail where erosion incision exceeds 5 inches deep from original tread. Record cubic feet of soil displaced by erosion.
- Unofficial trails are defined as: unofficial, visitor-created trails. Often made to seek out viewpoint, reach water source, cut switchback, or walk around obstacle. Write number of unofficial trails.
- \*\*\*\*\*Do not count problem areas that have already been dealt with. For example, a mud pit with good stepping stones is a problem that has been dealt with. If a rock is wobbly, or submerged, then that section of the mud pit should be noted. Similarly, if unofficial trails have been successfully brushed in or otherwise covered up, they should not be recorded\*\*\*\*\*

### Size of Problem Site

- Estimated size of problem site.
- Unofficial trails: estimate the length of unofficial trails.
- Muddiness: give length (parallel to trail) and width (horizontally perpendicular to trail)
- Erosion: Give length, width, and depth (vertically perpendicular to trail).

**Trail Structure Needed**

- In my best judgment, the trail structure(s) that is(are) needed to remedy the problem.
- Bog bridge, rock steps, rock/wood water bar, brush-in, etc.

**Failed Previous Trail Work At Site**

- Is there trail work at the site that has failed already? What is it?
- Why does it look like it failed?

**Soil Sample**

- Estimate the percentage of rock in the trail. Use 10% intervals.

**Graminoid Cover**

- Estimate the percent cover of graminoids within 5 feet of the trail edge. Use 10% intervals.

**Sunlight Intensity**

- Estimate the percentage of the tread that has direct sunlight on it during daylight hours. Use 10% intervals.

**Photos**

- Take at least two photos of each site, one from each trail direction. File names?

## Appendix B: White Mountain Alpine Trail Problem Inventory

The inventory includes information on all trail problem sites, including categorization, recommended trail structures for addressing each trail problem, and projected costs for those recommended trail structures. Images of the inventory have been included here for viewing. The live Microsoft Excel file has been included with the delivery of this report.

**WHITE MOUNTAIN ALPINE TRAIL PROBLEM INVENTORY (Samuel Kilburn, 2017)**

Trail	Problem Number	Trail Problem Category	Additional Trail Problem Category	Recommended Trail Structures for Trail Problems							Miscellaneous	
				Scree Wall (ft.)	Rock Check Step (count)	Rock Staircase (step count)	Crush (cu.ft.)	Stepping Stones (count)	Rock Water Bar (count)	Brushing In (sq.ft.)		
Franconia Ridge Trail	1	Unofficial Trail		140							5	"Stay on Trail" Sign & Post
Franconia Ridge Trail	2	Excessive Erosion					5			2		
Franconia Ridge Trail	3	Excessive Erosion			1							
Franconia Ridge Trail	4	Excessive Erosion			2							
Franconia Ridge Trail	5	Unofficial Trail		20							40	
Franconia Ridge Trail	6	Excessive Erosion			4							
Franconia Ridge Trail	7	Excessive Erosion				5				1		
Franconia Ridge Trail	8	Excessive Erosion			2							
Franconia Ridge Trail	9	Excessive Wetness							11			
Franconia Ridge Trail	10	Excessive Erosion			1							
Franconia Ridge Trail	11	Excessive Erosion			4		5					
Franconia Ridge Trail	12	Excessive Erosion		25								
Franconia Ridge Trail	13	Excessive Erosion		30								
Franconia Ridge Trail	14	Excessive Width		90								
Greenleaf Trail	1	Excessive Width		110								
Greenleaf Trail	2	Excessive Erosion			2							
Greenleaf Trail	3	Unofficial Trail		75								
Greenleaf Trail	4	Unofficial Trail		15						200		
Greenleaf Trail	5	Unofficial Trail		20								
Greenleaf Trail	6	Excessive Erosion			1							
Garfield Ridge Trail	1	Excessive Erosion		15								
Garfield Ridge Trail	2	Excessive Erosion		45								
Garfield Ridge Trail	3	Excessive Erosion		25								
Garfield Ridge Trail	4	Unofficial Trail		55								
Garfield Ridge Trail	5	Unofficial Trail		40								
Garfield Ridge Trail	6	Unofficial Trail	Excessive Width	110								
Garfield Ridge Trail	7	Excessive Erosion		20								
Garfield Ridge Trail	8	Excessive Erosion	Unofficial Trail	40								
Bondcliff Trail	1	Excessive Erosion		10								
Bondcliff Trail	2	Excessive Erosion		15								
Bondcliff Trail	3	Unofficial Trail		10								
Bondcliff Trail	4	Excessive Width								400	2	"Stay on Trail" Sign & Post
Lowe's Path	1	Unofficial Trail		35								
Parapet Trail	1	Unofficial Trail		35								
Chemin Des Dames Trail	1	Excessive Erosion				15						
Chemin Des Dames Trail	2	Unofficial Trail		45								
Air Line	1	Unofficial Trail		41								
Air Line	2	Unofficial Trail		35								
Air Line	3	Unofficial Trail		20							1	Improved Blazing
Air Line	4	Unofficial Trail		20							1	Improved Blazing
Air Line	5	Unofficial Trail									1	Cairn Improvement
Air Line	6	Unofficial Trail		50							1	Improved Blazing
Air Line	7	Excessive Erosion			2							
Air Line	8	Unofficial Trail		35								
Air Line	9	Excessive Width		35		12						
Air Line	10	Unofficial Trail		20								
Air Line	11	Excessive Width		40						50		
Air Line	12	Excessive Width	Unofficial Trail	40								
Air Line	13	Unofficial Trail		70								
Crawford Path	1	Unofficial Trail		40								
Crawford Path	2	Unofficial Trail		60								
Crawford Path	3	Excessive Erosion			2							
Crawford Path	4	Unofficial Trail		56								
Crawford Path	5	Excessive Erosion			1							
Crawford Path	6	Unofficial Trail		8								
Crawford Path	7	Unofficial Trail		250						250		
Crawford Path	8	Excessive Wetness							12			
Crawford Path	9	Excessive Width	Unofficial Trail	40						200		
Crawford Path	10	Unofficial Trail		10								
Crawford Path	11	Unofficial Trail		20								
Crawford Path	12	Unofficial Trail	Excessive Erosion	45		10						
Crawford Path	13	Excessive Erosion									100	Trail Relocation (feet)
Crawford Path	14	Excessive Erosion	Unofficial Trail	20	1							
Crawford Path	15	Unofficial Trail		45								
Crawford Path	16	Excessive Erosion		30		10						
Crawford Path	17	Unofficial Trail		50								
Crawford Path	18	Unofficial Trail		45								
Crawford Path	19	Unofficial Trail	Excessive Width	80						100		
Crawford Path	20	Excessive Erosion		15								
Crawford Path	21	Excessive Width		160								
Crawford Path	22	Unofficial Trail		160								
Crawford Path	23	Unofficial Trail	Excessive Erosion	50							1	Creation of Official Viewpoint
Crawford Path	24	Unofficial Trail		120								
Crawford Path	25	Excessive Erosion			2							
Crawford Path	26	Excessive Erosion	Unofficial Trail						20			
Crawford Path	27	Unofficial Trail		130								

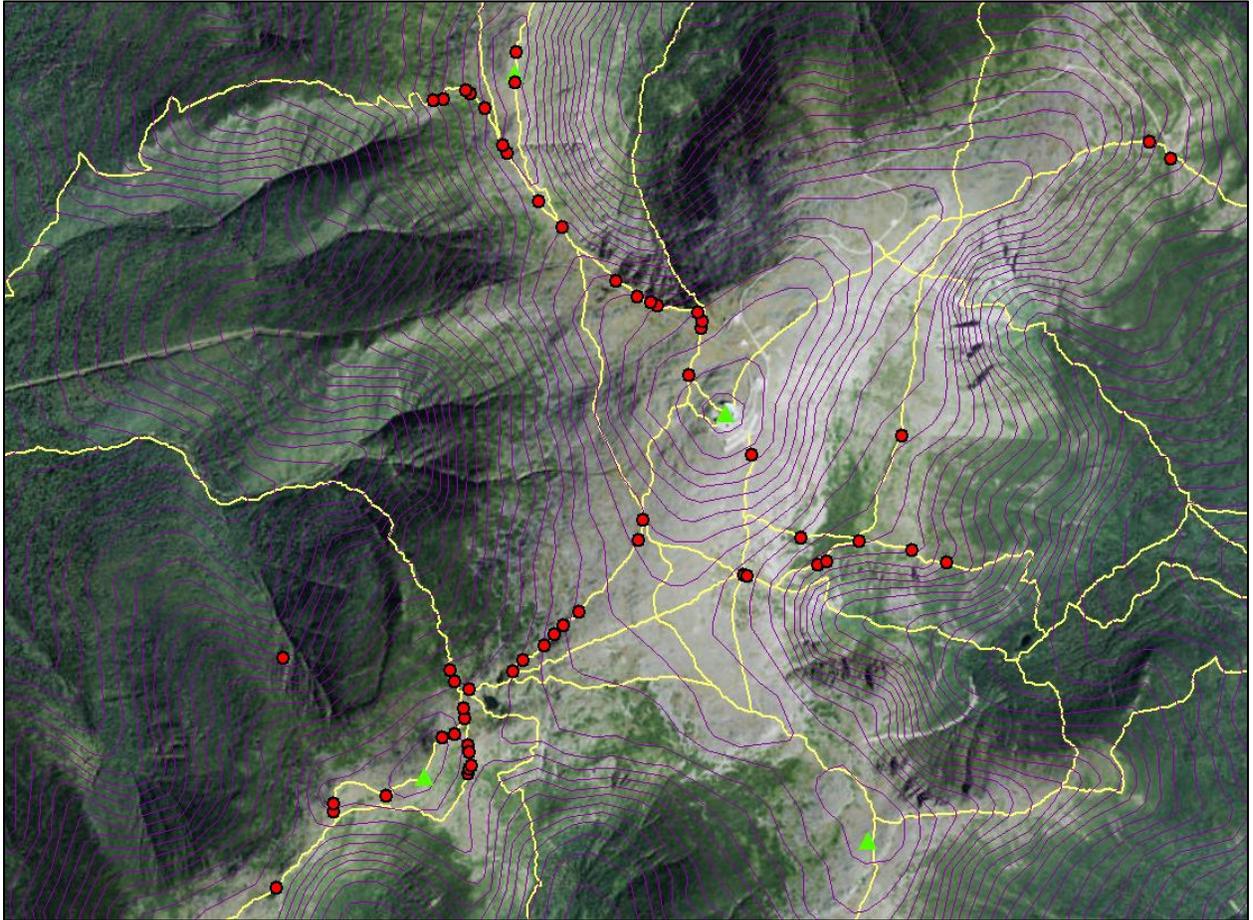
Crawford Path	28	Excessive Erosion		25										
Crawford Path	29	Excessive Erosion		40										
Crawford Path	30	Unofficial Trail		20										
Mount Monroe Loop Trail	1	Excessive Erosion				10								
Mount Monroe Loop Trail	2	Excessive Erosion				8								
Mount Monroe Loop Trail	3	Unofficial Trail		70										
Mount Monroe Loop Trail	4	Excessive Erosion				10								
Mount Monroe Loop Trail	5	Unofficial Trail		320					10				"Stay on Trail" Sign & Post	
Gulfside Trail (AT)	1	Unofficial Trail		60										
Gulfside Trail (AT)	2	Unofficial Trail		30										
Gulfside Trail (AT)	3	Unofficial Trail		75										
Gulfside Trail (AT)	4	Excessive Width		200										
Gulfside Trail (AT)	5	Unofficial Trail		140					100					
Gulfside Trail (AT)	6	Unofficial Trail		160										
Gulfside Trail (AT)	7	Unofficial Trail		140										
Gulfside Trail (AT)	8	Unofficial Trail		210		10				200				
Gulfside Trail (AT)	9	Unofficial Trail		140										
Gulfside Trail (AT)	10	Unofficial Trail		90										
Gulfside Trail (AT)	11	Excessive Erosion				2								
Gulfside Trail (AT)	12	Unofficial Trail		70										
Gulfside Trail (AT)	13	Excessive Erosion		30										
Gulfside Trail (AT)	14	Unofficial Trail		35										
Gulfside Trail (AT)	15	Excessive Erosion		20										
Gulfside Trail (AT)	16	Unofficial Trail		50										
Gulfside Trail (AT)	17	Excessive Erosion				15								
Gulfside Trail (AT)	18	Unofficial Trail		35										
Gulfside Trail (AT)	19	Unofficial Trail		45										
Gulfside Trail (AT)	20	Unofficial Trail		40						1			Improved Trail Structure	
Gulfside Trail (AT)	21	Unofficial Trail		35										
Caps Ridge Trail	1	Unofficial Trail		20										
Caps Ridge Trail	2	Excessive Width		70					100					
Caps Ridge Trail	3	Excessive Erosion				2								
Caps Ridge Trail	4	Unofficial Trail		35										
Caps Ridge Trail	5	Unofficial Trail		40					200					
Mount Jefferson Loop Trail	1	Unofficial Trail		130										
Randolph Path	1	Excessive Erosion		20										
Six Husbands Trail	1	Unofficial Trail		10						1			Creation of Official Viewpoint	
Mount Eisenhower Loop	1	Excessive Erosion		10										
Mount Eisenhower Loop	2	Excessive Erosion		15										
Mount Eisenhower Loop	3	Excessive Erosion	Unofficial Trail	50		10								
Mount Eisenhower Loop	4	Excessive Erosion		15										
Mount Eisenhower Loop	5	Unofficial Trail		20										
Alpine Garden Trail	1	Excessive Erosion				1								
Alpine Garden Trail	2	Unofficial Trail		10					40					
Ammonosuc Ravine Trail	1	Unofficial Trail		15										
Ammonosuc Ravine Trail	2	Unofficial Trail		15					40					
Tuckerman Crossover	1	Unofficial Trail		8										
Tuckerman Ravine Trail	1	Unofficial Trail	Excessive Width	100					150					
Tuckerman Ravine Trail	2	Unofficial Trail		20										
Tuckerman Ravine Trail	3	Unofficial Trail		460					250					
Tuckerman Ravine Trail	4	Unofficial Trail		130										
Lion's Head Trail	1	Excessive Width		600										
Lion's Head Trail	2	Excessive Erosion		20										
Lion's Head Trail	3	Unofficial Trail		30					60					
Lion's Head Trail	4	Unofficial Trail		15					30					
Lion's Head Trail	5	Excessive Erosion				6								
Nelson Crag Trail	1	Unofficial Trail		10					10					
Nelson Crag Trail	2	Unofficial Trail		120					200					
Jewell Trail	1	Excessive Width		100										
Jewell Trail	2	Excessive Erosion				5								
Jewell Trail	3	Excessive Width	Excessive Erosion, Unofficial Trail	200					4000	6			"Stay on Trail" Sign & Post	
Jewell Trail	4	Unofficial Trail		30										
Jewell Trail	5	Unofficial Trail		40										
Pine Link Trail	1	Excessive Wetness								2			Wooden Bog Bridge	
Pine Link Trail	2	Excessive Erosion				8								
Osgood Trail (AT)	1	Unofficial Trail		50										
Osgood Trail (AT)	2	Unofficial Trail							250					
Osgood Trail (AT)	3	Unofficial Trail		35										
Osgood Trail (AT)	4	Unofficial Trail		30					20					
Osgood Trail (AT)	5	Excessive Erosion				6								
Osgood Trail (AT)	6	Excessive Erosion	Excessive Width, Unofficial Trail	800		30								
Mount Clay Loop Trail	1	Unofficial Trail		20										
Mount Clay Loop Trail	2	Unofficial Trail		35										
<b>TOTALS - TRAIL PROBLEM CATEGORIES</b>														
Unofficial Trail Problems				90										
Excessive Erosion Problems				54										
Excessive Wetness Problems				3										
Excessive Width Problems				17										
<b>TOTAL FOR ALL TRAIL PROBLEM CATEGORIES</b>				<b>164</b>										
<b>TOTALS - RECOMMENDED TRAIL STRUCTURES</b>				<b>8,273</b>	<b>30</b>	<b>170</b>	<b>10</b>	<b>43</b>	<b>3</b>	<b>6,890</b>	<b>23</b>			"Stay On Trail" Sign & Post
											<b>100</b>		Trail Relocation (ft.)	
											<b>2</b>		Wooden Bog Bridge	
											<b>3</b>		Improved Blazing	
											<b>1</b>		Calm Improvement	
											<b>2</b>		Creation of Official Viewpoint	
											<b>1</b>		Improved Trail Structure	

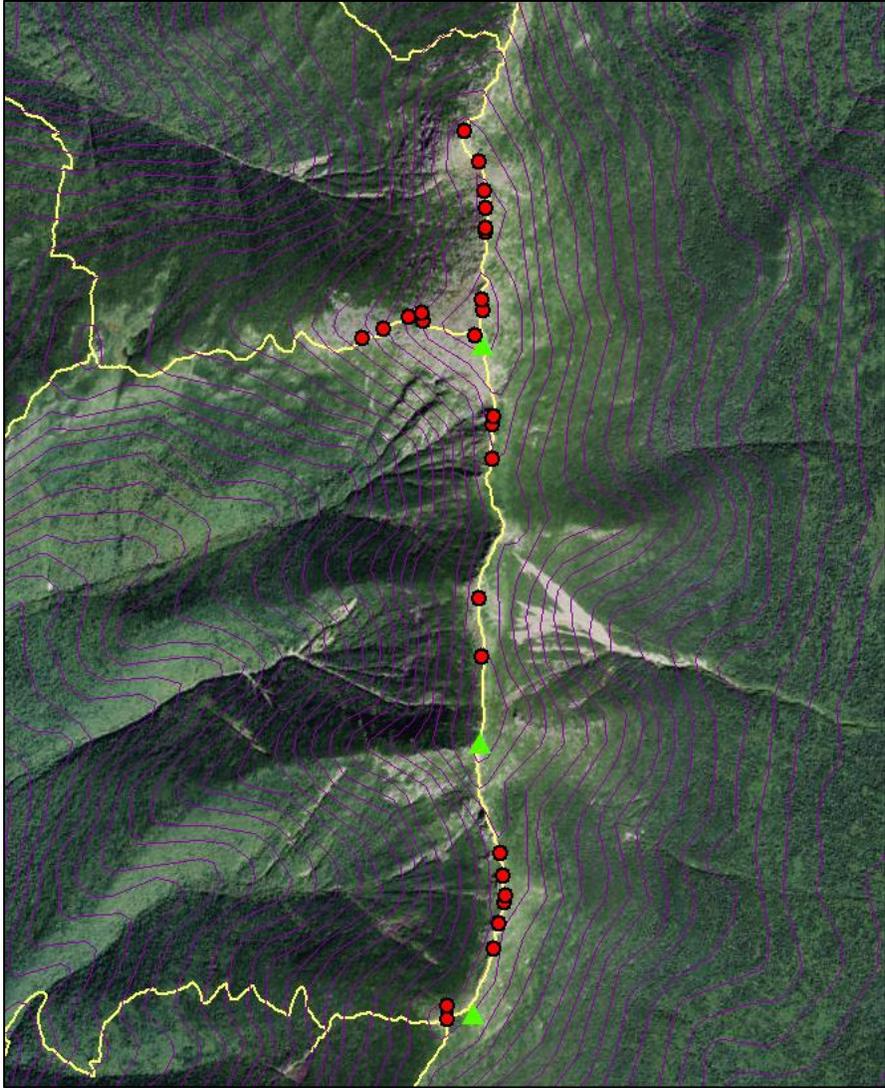
Projected Cost for Recommended Trail Structures										
Scree Wall (per ft.)	Rock Check Step (per each)	Rock Staircase (per step)	Crush (per cu.ft.)	Stepping Stones (per each)	Rock Water Bar (per each)	Brushing In (per sq.ft.)	Misc	PROJECTED TOTAL COST	Latitude	Longitude
\$15	\$375	\$400	\$25	\$150	\$300	\$5	\$400	\$4,100	44.14047222	-71.64588889
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$725	44.14086111	-71.64588889
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$375	44.14255556	-71.64397222
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$750	44.14333333	-71.64377778
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$500	44.14333333	-71.64377778
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,500	44.14394444	-71.64355556
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$2,300	44.14416667	-71.64347222
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$750	44.14475	-71.64358333
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,650	44.14544444	-71.64369444
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$375	44.15130556	-71.64444444
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,625	44.15305556	-71.64458333
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$375	44.15719444	-71.64405556
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$450	44.15825	-71.64405556
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,350	44.15847222	-71.644
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,650	44.16088889	-71.64472222
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$750	44.16133333	-71.64691667
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,125	44.16158333	-71.64697222
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,225	44.16147222	-71.64752778
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$300	44.16108333	-71.64855556
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$375	44.16083333	-71.64941667
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$225	44.161675	-71.644425
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$675	44.16198056	-71.64448611
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$375	44.164	-71.64430278
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$825	44.16410833	-71.64428333
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$600	44.16470556	-71.64428889
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,650	44.16522778	-71.64434861
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$300	44.16608333	-71.64458333
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$600	44.16700833	-71.64515833
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$150	44.14206	-71.53979778
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$225	44.14212	-71.539685
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$150	44.1427475	-71.53918
\$15	\$375	\$400	\$25	\$150	\$300	\$5	\$400	\$2,800	44.15286167	-71.53122528
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$525	44.32936111	-71.30683333
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$525	44.32547222	-71.28236111
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$6,000	44.33225	-71.28905556
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$675	44.33222222	-71.28847222
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$615	44.33255556	-71.28863889
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$525	44.33136111	-71.28797222
\$15	\$375	\$400	\$25	\$150	\$300	\$5	\$10	\$310	44.33111111	-71.28788889
\$15	\$375	\$400	\$25	\$150	\$300	\$5	\$10	\$310	44.33027778	-71.28741667
\$15	\$375	\$400	\$25	\$150	\$300	\$5	\$100	\$100	44.32972222	-71.28702778
\$15	\$375	\$400	\$25	\$150	\$300	\$5	\$10	\$760	44.32919444	-71.28672222
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$750	44.32861111	-71.28686111
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$525	44.32836111	-71.28713889
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$5,325	44.32816667	-71.28711111
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$300	44.3275	-71.28747222
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$850	44.32711111	-71.28766667
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$600	44.32697222	-71.28769444
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,050	44.32658333	-71.28755556
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$600	44.26594444	-71.30827778
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$900	44.26508333	-71.30855556
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$750	44.26202778	-71.31208333
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$840	44.26147222	-71.31305556
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$375	44.26108333	-71.31358333
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$120	44.26061111	-71.31419444
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$5,000	44.26002778	-71.31544444
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,800	44.25955556	-71.31602778
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,600	44.25880556	-71.31858333
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$150	44.22994444	-71.361
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$300	44.23369444	-71.35386111
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$4,675	44.23380556	-71.35386111
\$15	\$375	\$400	\$25	\$150	\$300	\$5	\$100	\$10,000	44.23386111	-71.35330556
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$675	44.23536111	-71.352
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$675	44.23688889	-71.351
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$4,450	44.24252778	-71.34391667
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$750	44.24330556	-71.34194444
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$675	44.24358333	-71.34152778
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,700	44.2445	-71.33944444
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$225	44.24561111	-71.33852778
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$2,400	44.24769444	-71.33683333
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$2,400	44.24852778	-71.33566667
\$15	\$375	\$400	\$25	\$150	\$300	\$5	\$400	\$1,150	44.25038889	-71.33002778
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,800	44.25641667	-71.31866667
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$750	44.25611111	-71.31863889
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$3,000	44.25522222	-71.31872222
\$15	\$375	\$400	\$25	\$150	\$300	\$5		\$1,950	44.25541667	-71.31861111

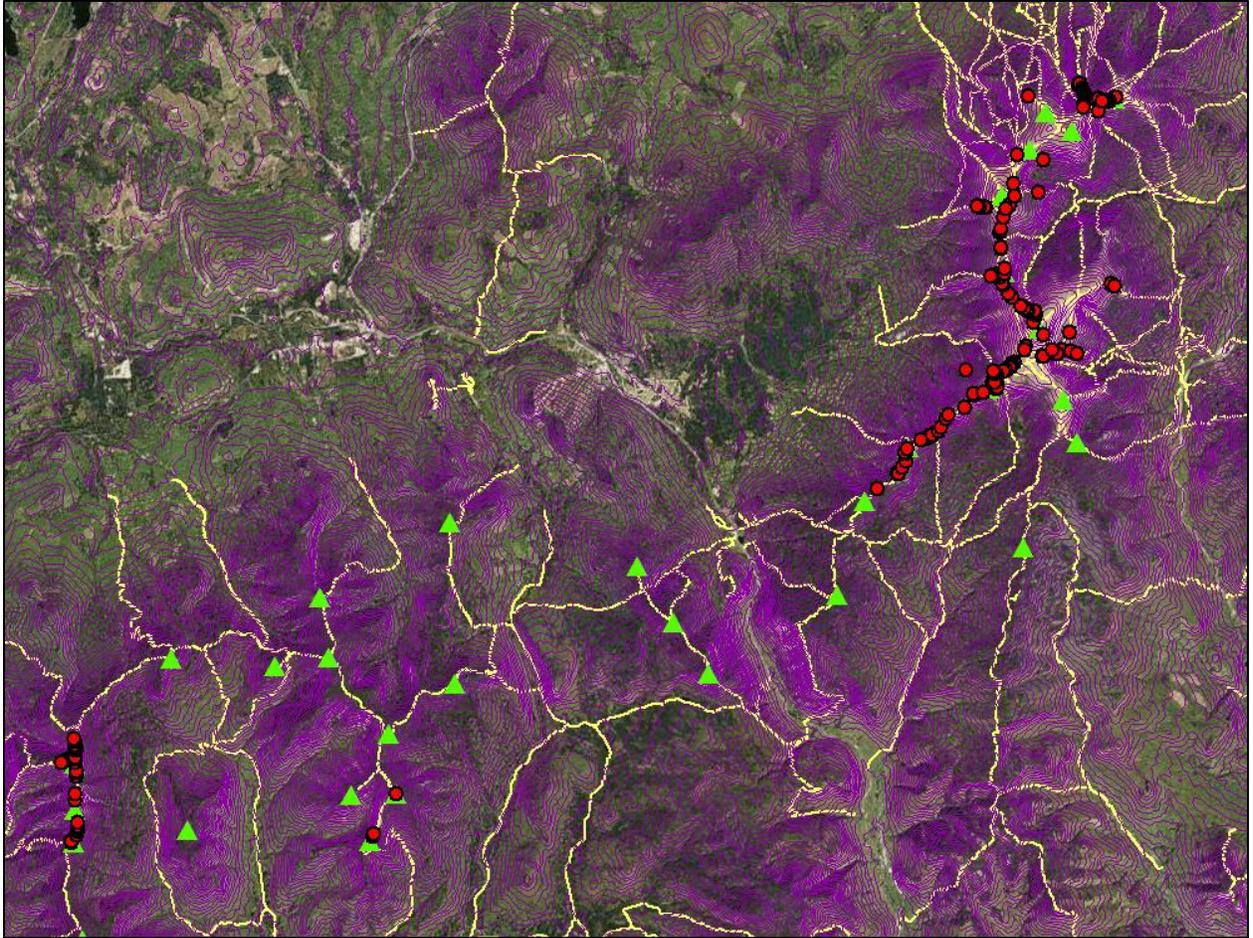


## Appendix C: White Mountain Alpine Trail Problem Map

The map is a shapefile that has been included with the delivery of this report. Selected images of the map have been included here for viewing.







## Appendix D: Projected Cost per Trail Structure

This chart includes each recommended trail structure, the cost associated with each recommended trail structure, and the projected total cost to repair all identified alpine trail problems in the White Mountains. Detail on these calculations is available in the Trail Problem Inventory (Appendix B).

<b>PROJECTED COST PER TRAIL STRUCTURE</b>			
<b>Trail Structure</b>	<b>Number of Units</b>	<b>Projected Cost (each)</b>	<b>Projected Total Cost</b>
Scree Wall (ft.)	8,273	\$15	\$124,095
Rock Check Steps (each)	30	\$375	\$11,250
Rock Steps (each)	170	\$400	\$68,000
Crush (cu.ft.)	10	\$25	\$250
Stepping Stones (each)	43	\$150	\$6,450
Rock Water Bar (each)	3	\$300	\$900
Brushing In (sq.ft.)	6,890	\$5	\$34,450
"Stay on Trail" Sign + Post (each)	23	\$400	\$9,200
Trail Relocation (ft.)	100	\$100	\$10,000
Wooden Bog Bridge (each)	2	\$200	\$400
Improved Blazing (each)	3	\$10	\$30
Cairn Improvement (each)	1	\$100	\$100
Creation of Official Viewpoint (each)	2	\$400	\$800
Improved Trail Structure	1	\$500	\$500
<b>TOTAL PROJECTED COST</b>			<b>\$266,425</b>

## Appendix E: White Mountain Alpine Trail Problem Reports

A Trail Problem Report was created for each trail problem which includes photo documentation, GPS coordinates, categorization of trail problem, recommended treatment, and supplementary measurements. A sample Trail Problem Report has been included here for viewing. All Trail Problem Reports (149 in total) have been included with the delivery of this report.

### FRANCONIA RIDGE TRAIL: PROBLEM 8

GPS Coordinates (start): N 44° 08' 41.1", W 71° 38' 36.9"

GPS Coordinates (end): N 44° 08' 41.3", W 71° 38' 37.0"

Location: Franconia Ridge Trail

Trail Problem: Excessive Erosion

Size of Problem Site: 27' x 5' x 2'

Trail Structure Needed: 2 Check Steps

Previous Failed Trail Work: None

Soil Sample: 30%

Graminoid Cover: 40%

Sunlight Intensity: 90%

Photos:





## Appendix F: Work in Lieu of Fee Chart

This chart was developed by the AMC and USFS. It is included as a point of reference but was not used in calculations in this report, as the costs listed appear to be out of date in comparison to cost information gathered for this report (see Figure 1).

<b>PRO TRAIL CREW</b>			
	<b># of Units</b>	<b>Agreed to Price</b>	<b>Cost</b>
Rock Steps (each)	0	\$50.00	\$0.00
Log Steps (each)	0	\$25.00	\$0.00
Stone Steps (each)	0	\$20.00	\$0.00
Wood Waterbars (ft)	0	\$10.00	\$0.00
Rock Waterbars (ft)	0	\$18.00	\$0.00
Ditching, including cross drains (ea)	0	\$4.00	\$0.00
Puncheon, double stringer (ft)	0	\$9.00	\$0.00
Scree/walls (ft)	0	\$5.00	\$0.00
Cribbing, rock & wood (ft)	0	\$24.00	\$0.00
Brushing (ft)	0	\$2.00	\$0.00
Side hill grubbing, existing trail (ft)	0	\$3.00	\$0.00
Side hill grubbing, new trail (ft)	0	\$8.00	\$0.00
Dips, earth water bars (ft)	0	\$4.00	\$0.00
Cairns, new (ea)	0	\$100.00	\$0.00
Carins, rebuild (ea)	0	\$30.00	\$0.00
Rubbling (sq ft)	0	\$2.00	\$0.00
Turnpike, basic 3' wide (sq ft)	0	\$12.00	\$0.00
Basic maintenance (mile)	0	\$175.00	\$0.00
Bridging*	0		\$0.00
New Trail Const./Relocation*	0		\$0.00
Ladders (ft)	0	\$0.00	\$ -
<b>Total Cost</b>			<b>\$0.00</b>