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3/9/2023

Forest Ecosystem Monitoring Cooperative
705 Spear Street
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FEMC Final Report

Submitted by Kayla White, PI

Project Title: Monitoring Vegetation Response to Trampling in the Adirondack Alpine Zone

White, K. 2023. *Monitoring Vegetation Response to Trampling in the Adirondack Alpine Zone Final Report to the Forest Ecosystem Monitoring Cooperative*. Adirondack Mountain Club. https://doi.org/10.18125/ep7era

Rationale

Alpine areas in the Northeast are entirely located within the temperate forest region, and, as such, are part of this forest's defining character. Just as important and despite their small geographical area, alpine zones are found in areas of significant recreational value: the higher summits of the Northeast. In New York State, the Adirondack alpine zone is home to some 27 rare, threatened, or endangered species of vascular plants and as many equally rare non-vascular plants (Ring 2023). Only 173 acres of this unique ecosystem exist in New York (Howard 2009), all of it located amidst the most heavily used recreational area in the state.

This photopoint monitoring project will continue to improve our understanding of the interdisciplinary relationship between education and outreach, recreational activity, and vegetation response. Research has suggested that vegetation recovery along trail corridors in the Adirondack alpine zone is due in part to management actions such as outreach, education by summit stewards, trail maintenance, and signage (Goren and Monz 2011, Robinson et al. 2010). This project measures ecological impacts (changes in alpine vegetation) and how these impacts change in response to social interactions (summit steward outreach) and policy and management actions (which summits get staffed by stewards and when; trail maintenance activity). Our goal is to continue our existing monitoring program and incorporate a more rigorous sampling strategy to ensure continued effective tracking of trends. This effort aligns more with photopoint monitoring baselines set up in Vermont (Haberle 1996, Larson 2004) and our improvements will ensure our methods are useful, transferrable, and can contribute to a photopoint monitoring standard that could be used throughout the region. This project is sustainable because resampling is low cost and low impact. Also, because this monitoring effort is integrated into the Summit Stewardship Program there will continue to be an interest and staff available for monitoring for the foreseeable future.

Approach/Methodology

Alpine biologist Matt Scott developed the photopoint monitoring system in 1999 based on The Nature Conservancy's methodology (The Nature Conservancy 1999). Historical photographs from the mid-1960s through the early-1990s were used as the baseline, making the project unique in Northeastern alpine stewardship efforts in having a long-term, systematic photographic monitoring system. From those historical photographs, 59 photopoints spread over nine summits were established. Analysis of data in 2009 showed that summits with a regular steward presence since the beginning of the program have substantial vegetation recovery in comparison to summits that do not have that regular steward presence (Goren and Monz 2011).

Tim Howard, from New York Natural Heritage Program (subawardee), reevaluated and updated the design of the monitoring project to improve the sampling strategy and statistical rigor. Regarding sampling, we've incorporated a scale measurement in photopoints and have introduced the line transect method to give us more quantitative data.

Revisiting Established Oblique Photopoints

Photopoints are relocated using a GPS unit, a map, directions, and prints of prior photographs. Once relocated, the camera is set above the marker nail using the specified height, angle, direction, aperture setting, lens, and film speed. The photograph is taken and assigned a unique code based on location and photopoint number (Scott 1999). Equipment included film and digital cameras, tripod, plumb bob, measuring tape, GPS unit, and compass. New photopoints additionally required a drill, survey nails, and epoxy.

Once the photopoint nail was located by GPS, former sketch maps, nail descriptions, and locator shots, the tripod was set up and leveled over the nail. The plumb bob was tied to the tripod to ensure the center of the tripod was directly over the nail. The height was measured accordingly from the nail to the camera base. A bearing and vertical angel were also measured to match the older photos. The meter stick was placed roughly in the center of the frame and in the foreground of vegetation and damage (Figure 1). Ensuring the meter stick remained straight was essential and a difficult task. The plumb bob was used via a metal stake at the top of the meter stick, although we found inserting the plumb bob in the hollowed-out meter stick was more successful.

Final adjustments to the camera were made before taking the picture, adjusting the focal length (mm) and direction while comparing the camera view with the original photograph. The Nikon camera focal length needed to be converted; dividing the original focal length by 1.5 yielded an equivalent length for the new camera. The F-stop (aperture) was noted during this time. After the photo was taken, the distance from the nail to the front of the base of the meter stick as well as the bearing from the nail to the meter stick were measured. The field data form was updated to record these new measurements.

Establishing New Oblique Photopoints

New photopoints were selected at areas of recent recreational damage of alpine vegetation. Many points are pictures of 'herd paths', or areas off trail or near trail where hikers either accidently head in the wrong direction or where hikers avoid an obstacle in the trail (i.e., scramble, mud, ice, etc.) Different management strategies exist in the alpine zone to prevent hikers from wandering onto 'herd paths' and damaging fragile vegetation. Scree walls, brushing (pieces of dead krummholz placed in paths and alongside the trail), informative signage, and string fence are among the management practices used in the alpine zone.

Setting up the tripod and looking through the camera before drilling a new nail into rock helped determine a proper location for the photo. A negative vertical angle was required for most of the points to capture the damage/vegetation. The same methods were used to set up the meter stick. Once the camera was set up, the data was collected (height, bearing, etc.) on the field form. Hanging the plumb bob off the tripod marked the location for the new nail. Using 5/32" drill bits, a hole was drilled, and epoxy was inserted into the hole to hold the nail in place. Finally, a reference photo was taken of the tripod situated over the nail so future field techs could easily find the nail. The last data recorded on the field form sheet was a detailed description, GPS point, sketch map of nail location, and management action.

Establishing New Line Transects

Transects were chosen to stretch over herd paths. The 30m transect tape was stretched and held taut. When possible, the tape was stretched across the main trail to create a control to compare with the rest of the herd path. Two nails were put on either side of the herd path on exposed rock. The measuring tape was secured using weight or stewards who assisted. The ends of the tape were held in the center of the nail, and the exact length was recorded. The PVC ½ m x ½ m quadrat sampling frame was placed along the transect on the left, right or both sides of the tape depending on the location of damage. Pictures were taken looking directly over the quadrat, ensuring the entire sampling frame and tape were included in the frame. A photo was taken every half meter along the tape pointed down at the frame. All photos were taken at a 18mm focal length at a meter height (Figure 2).

The data was recorded on the field forms including quadrat placement, description of starting nail, bearing of transect from starting nail, length of transect, sketch map, F-stop, and management action. Locator shots were also taken. A GPS point was taken at both nails if the transect was particularly lengthy (>20m).

Digital and scanned photos will be stored on the Adirondack Mountain Club's server and archived in FEMC's system. Photographs are digitally archived with locator photographs and field forms for replication. Past photopoint pictures are also stored as hard copies at the Adirondack Mountain Club.

Activities Completed

In 2021, the Adirondack High Peaks Summit Stewardship Program hired Photopoint Monitoring Field Tech Audrey Fatone. She started the Friday of Memorial Day weekend and went through two and a half weeks of training on botany, photography, sampling methodology, trail maintenance/management actions, and field protocols. From mid-June until Indigenous People's Day, Audrey retook 59 photopoint images, added new photopoints to the collection, and added another monitoring cycle to the long-term photopoint monitoring library. Mid-season, new photopoint locations were located on Wright, NW Wright, Algonquin, Boundary, Iroquois, Shepherd's Tooth, Colden, NE Colden, Marcy, Skylight, Haystack, and Little Haystack.

We were not able to complete the project in 2021 so we added another field season in 2022. We hired Photopoint Monitoring Field Tech Troy Tetreault, who completed adding new oblique photos and line transects to the alpine zone. The photopoint monitoring field techs were able to add 82 new oblique photos, 50 new transects which contained 606 quadrats, and retook our 59 established photopoints. This expansion in photopoints were at newly damaged areas on some peaks with existing photopoints and new summits that historically haven't had photopoints. This has expanded our photopoint coverage from nine to 16 summits. Our new design and set of photos will set a baseline for sampling and tracking vegetation change in and adjacent trampled areas into the future.

Results

For the analysis, Tim Howard researched image classification to differentiate the rock, soil, and vegetation in the images. Image classification is a very active field of research right now with many approaches within artificial intelligence and machine learning. Many approaches use a set of images (such as 20 photos of traffic lights) to train a model which is then applied to a new set of images (where traffic lights will ideally be identified and extracted). Our problem is more complex than that in two ways: 1. Our vegetation varies considerable in color (fall browns, summer greens) and shape, and 2. We are interested in classifying all parts of the image not just a part of the image (the traffic lights).

Tim found a promising approach using image segmentation where the entire image is segmented into groups of relatively similar pixels and then we use statistics or manual methods to identify the classes for each segment. This is called "class segmentation" (or "semantic segmentation"). Once an image is segmented, then each segment can be classified to its cover type. He has explored both statistical algorithm training and classification as well as manual classification.

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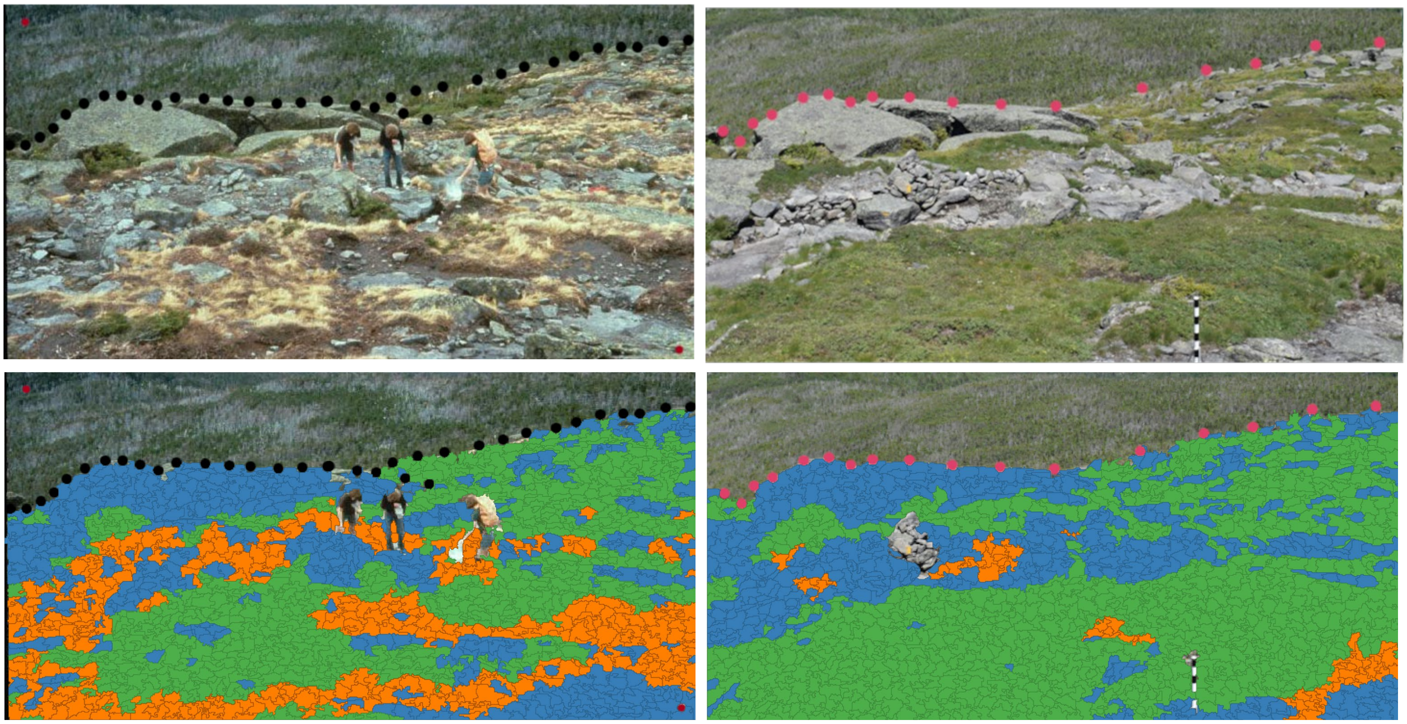
Because of the variation in color and texture within a class ("veg", "soil", "rock"), the statistical classification approach, while very good, tends to get a few segments wrong each time (not 100% accuracy). Manual classification, simply selecting polygons and assigning a type, may be more accurate, albeit a little more time consuming. Classes include 'veg', light green; 'moss', darker green; 'peat', brown; 'rock', grey; 'soil', orange; 'sky', blue, and 'registration dot', red.



1971 **2021**

Blue: rock, Green: vegetation, Orange: soil

After exploring various options, we found the most efficient method for classifying superpixels was to begin with an unsupervised classification based on color characteristics of the image. After the image is divided into segments ('superpixels'), then one gathers characteristics for each segment and use random forests (a machine learning algorithm) to group all superpixels into 20 different groups. Those groups can then be quickly assigned to the cover types in the image using efficient polygon selection and editing in GIS. An additional complication is the calculation of segmentation size. A 'superpixel' needs to be small enough to isolate the variability in the image but also large enough to make sure the analysis isn't overwhelmed. The wide range in image dimensions makes a one-size-fits-all approach difficult.

The change analysis will explore vegetation change after treatment implementation, such as the placement of scree walls to guide hiker impacts.

Outcomes

Fieldwork updates were published in the 2021 and 2022 Summit Steward mid-season and end-of-season reports, circulated to program supporters and other alpine stewardship groups throughout the Northeast. Tim and I presented our methodology and analysis at the Northeastern Alpine Stewardship Gathering in the fall of 2022 to solicit feedback from other experts in the field.

This project is a long-term monitoring project and will continue to evolve over time. The newly established photopoints created a baseline for monitoring into the future. The retake cycle for the line transect method is

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every couple of years, while the oblique photopoints will continue to be on a five-year cycle. We look forward to finishing the analysis of the established photopoints and publishing our findings. This research will continue to assist land managers and the Summit Stewardship Program make data-driven decisions in protecting New York's fragile alpine ecosystem.

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Figure 1. Photopoint Monitoring Field Tech and summit stewards setting up the meter stick at an established photopoint.

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Figure 2. Installing a new line transect across a damaged area to document changes over time. Rock packing is the management action implemented here to stem soil erosion and promote revegetation.