Alpine plant populations as an indicator of climate change

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In two bouts separated by six years, alpine plant populations were sampled in the Adirondack High Peaks. Significant changes were observed in populations of several species, including *Diapensia lapponica.* Diapensia populations decreased over the sampling period.

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http://www.nsrcforest.org

Project Summary

Alpine communities are considered among the most vulnerable to climate change yet we still have far to go to understand how changes may occur in the alpine systems of Northeastern North America.

In 2006 and 2007, baseline population data was collected for rare alpine species through random sampling of New York's 173 acres of alpine habitat. 376 plots, each 5 x 5 meters, were sampled, allowing precise estimation of population and sub-population size. In 2013,the alpine zone was re-sampled, with a total of 384 plots surveyed.

Populations of rare alpine species changed significantly from 2006-2013. *Diapensia lapponica* decreased in population between the two sampling bouts.

This project was a successful collaboration of the New York Natural Heritage Program and the Adirondack High Peaks Summit Steward Program, demonstrating the potential for similar future partnerships throughout the Northern Forest region.

Background and Justification

- Globally, alpine areas are showing upward migration of lower elevation species (Gottfried et al 2012, Pauli et al 2012, Venn et al 2012).
- Northern Forest alpine areas have seen plant community changes that may be related to climate change (Beal 2009, Capers and Stone 2011).
- Snow cover and ice dates are demonstrably changing in the Adirondacks (Beier et al 2012) and throughout the Northern Forest Region (Seidel et al 2009).
- The Adirondack alpine zone comprises a small area (173 acres, Howard 2007) with a large number of rare/threatened/endangered species.
- New York's alpine zone contains both some of the state's rarest plants and also some of its most charismatic recreational opportunities.
- For 24 years the Adirondack High Peaks Summit Steward program has been protecting New York's alpine habitat through education, trail work, and research.

Background and Justification

Sedge/dwarf shrub community.
Photo: Tim Howard

Left: Alpine heath community.
Photo: Tim Howard

Below: Alpine snowbank community.
Photo: Tim Howard

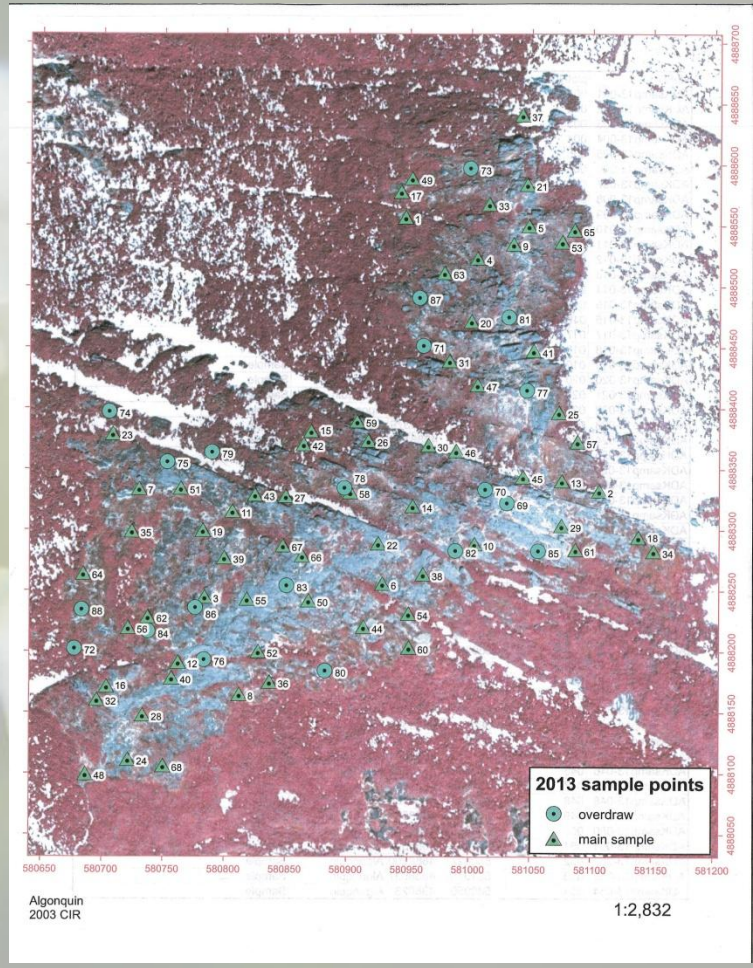
Climate change may cause shifts in alpine plant community composition and densities. Without repeated quantitative monitoring, such shifts will be impossible to detect.

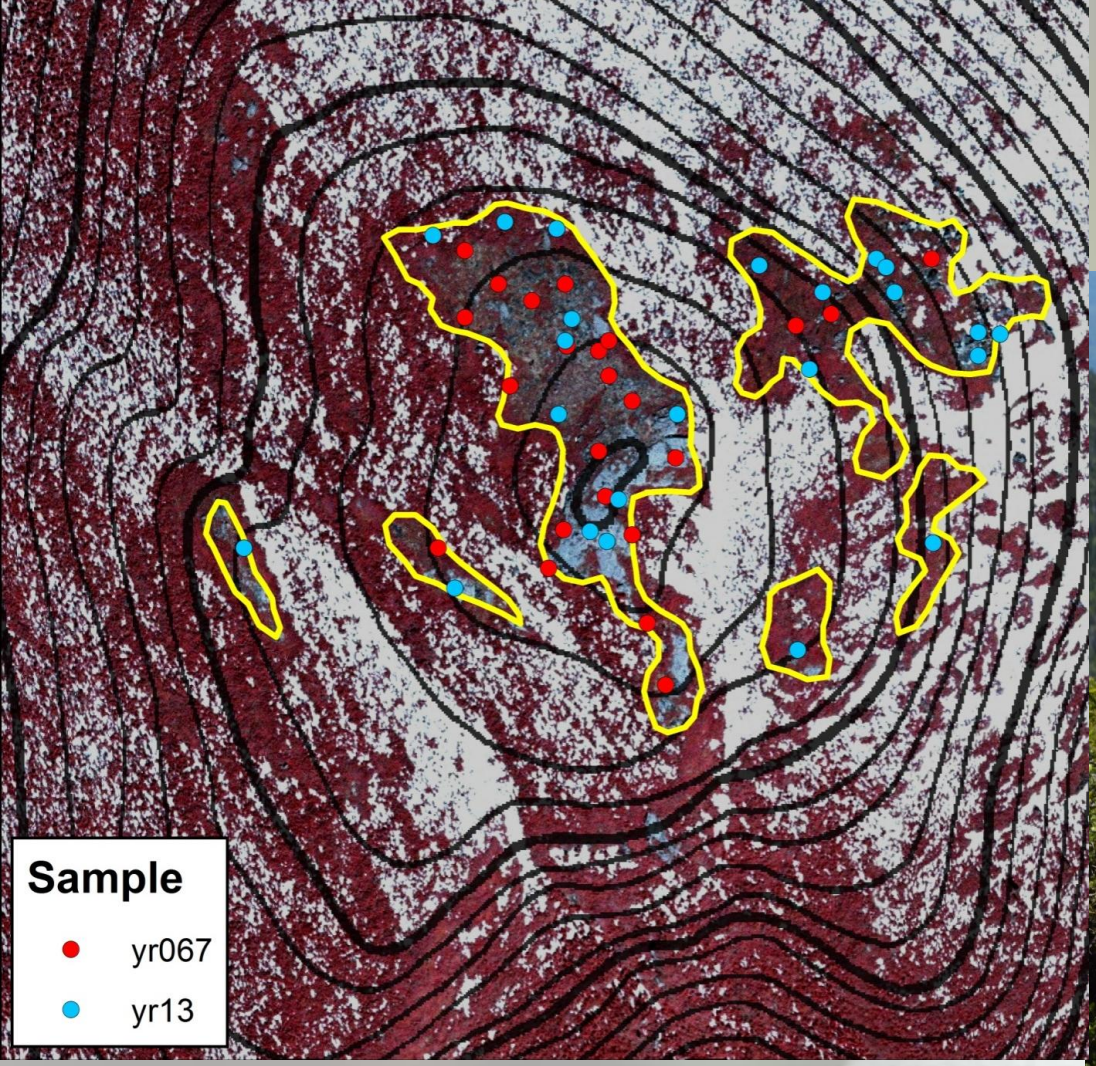
Methods

- We used GIS to overlay a 5 x 5 m grid on the alpine zone in each summit. In 2006 grid cells were randomly selected (without replacement) for sampling. In 2007 and 2013 the Generalized Random Tessellation Stratified (GRTS) spatially explicit sampling design developed by the EPA (Stevens & Olsen 2003, 2004) was used to randomly locate points on each summit.

- Maps of the grids with aerial photography and sampling coordinates were taken into the field and GPS was used to locate the corner coordinates as accurately and as feasibly as possible.

- At the plot, all targeted species were identified and counted within the plot. We counted the number of ramets, genets, and estimated the area of each species where counting individuals proved to be difficult.





Sample points on Skylight: 23 plots from 2006-7, 23 plots from 2013

Botanists Patrick Murphy and Jaime Barrett set up a sample plot
Photo: Seth Jones

Botany Steward Jaime Barrett counting target alpine species within a sample plot on Iroquois Peak.
Photo: Seth Jones

Results and Outcomes: Monitoring

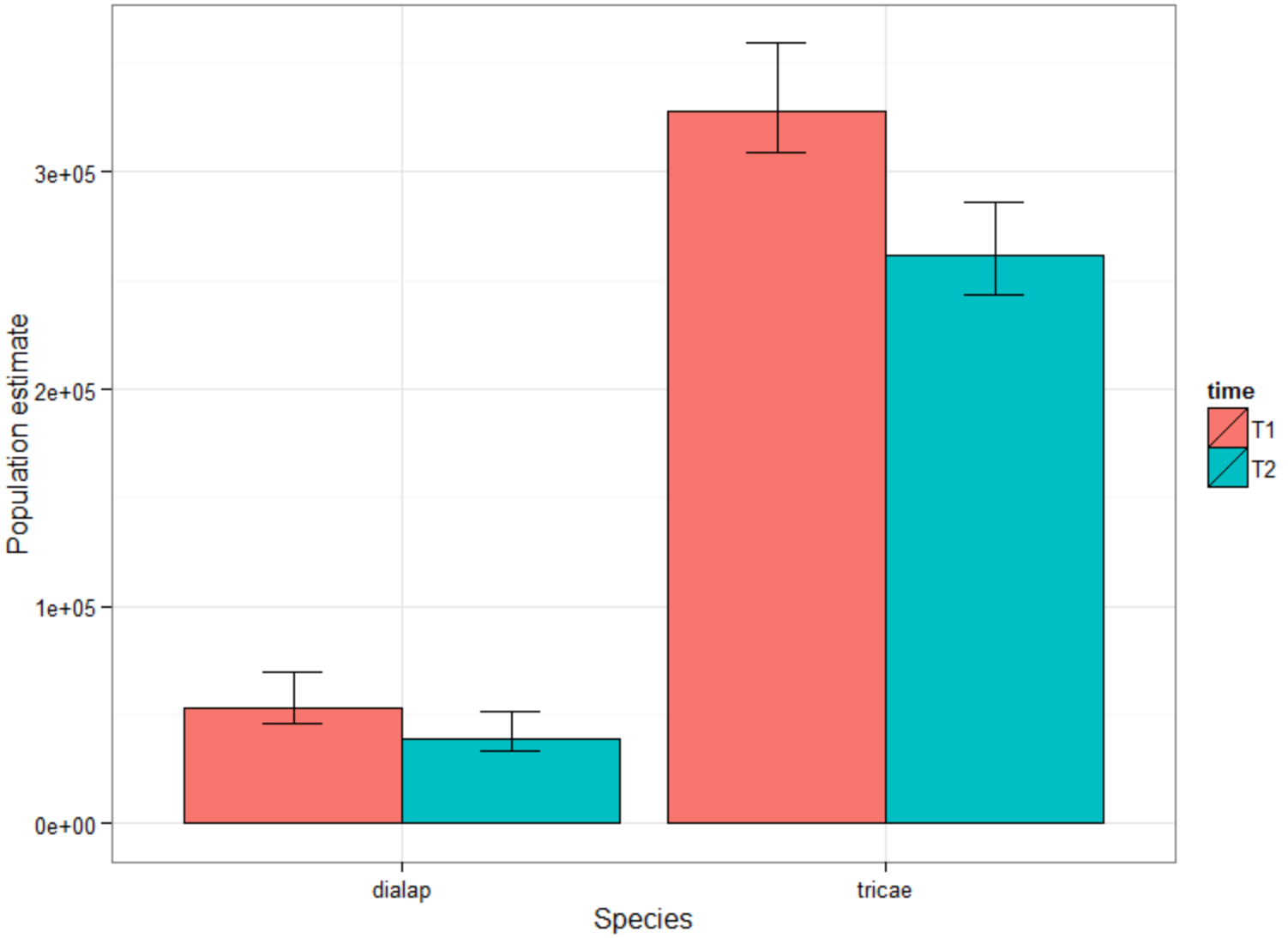
- 384 plots were sampled on 17 summits in 2013
- 376 plots were sampled on 17 summits in 2006-07.

Summit	2006	2007	2013
Boundary South	13		3
Colden	25		6
Dix			5
Haystack	27	9	39
Iroquois	20	2	24
Little Haystack	14		12
Marcy	19	42	117
Northeast Colden	3	9	3
Northwest Wright	2		
Wright Peak	30		13
Shepherd's Tooth	8		
Algonquin	13	48	68
Basin	21		8
Boundary 2 (North)	13		10
Saddleback			6
Skylight	11	12	23
Gothics		18	12
NW Algonquin		5	13
Whiteface		12	9
Total plots sampled	219	157	371

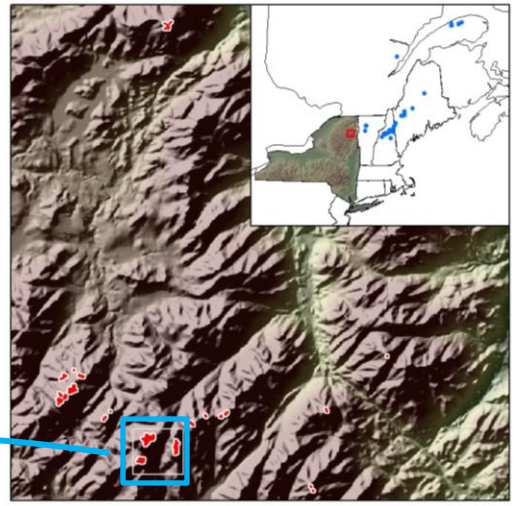
Table 1. Adirondack summits sampled as a part of this study and the number of plots sampled in each year of the study.

Results and Outcomes: Specific populations

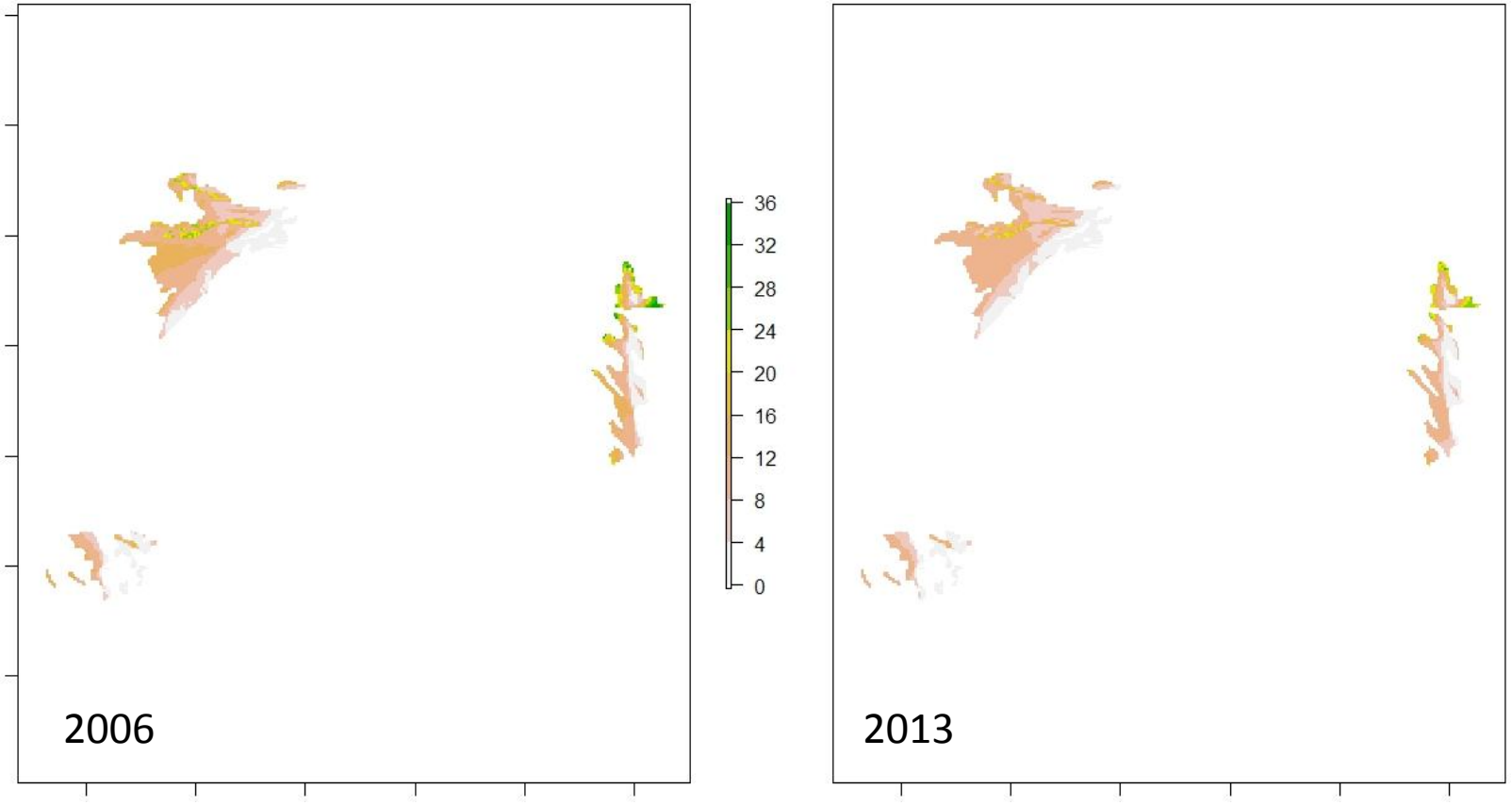
Population estimates from first sampling period to second, based on projecting best-fit likelihood models throughout the alpine zone and summing total population size. Error bars represent two “support limits” for the likelihood estimate.



Densities for two species (diapensia and deer's hair sedge) were modeled using likelihood methods. Models incorporated four environmental variables (elevation, western exposure, solar radiation, water flow) and time. In both cases, models showed better fits with the time factor included, indicating differences in populations sizes over time.



Deer's Hair Sedge (*Tricophorum cespitosum*) density projections for three summits.



Results and Outcomes: Partnerships

- Engaging Summit Steward to participate in research had strong benefits for all involved:
  - Botany stewards gained experience in field work, and gained skills in mountain scrambling, botanical identification skills, and GPS technological knowhow.
  - Other stewards and visiting public were exposed to active research on pressing issues on the summits.
  - The Summit Steward Program was able to bring on two additional stewards, increasing the breadth and depth of the team.
  - The NY Natural Heritage Program gained experienced partners in the mountains for the data collection. This resulted in a large, powerful data set.

Results and Outcomes: Outreach

- This research was presented at the 8th Northeastern Alpine Stewardship Gathering in Keene, NH.

- Public presentations were given at the Johns Brook Lodge, the Atmospheric Sciences Research Center's Marble Lodge, and on Whiteface Mountain for the Wild Center.

- Presentations were made at Middlebury College, Ithaca College, SUNY Plattsburgh, Paul Smiths College, Massachusetts College of Liberal Arts, Saranac Lake Rotary Club, North Country Community College, Williams College, and for the Forest Preserve Advisory Committee

Results and Outcomes

- "Monitoring Plant Populations in the Adirondack Alpine" was submitted to the proceedings of the 8th Northeastern Alpine Stewardship Gathering

- New York Natural Heritage Program's Element Occurrence Database, a statewide database used for project review and data sharing among agencies and partners, was updated for the targeted species.

Implications for the Northern Forest Region

- Diapensia decrease may be caused by competition from other species, such as ericaceous shrubs.
- These competitors may be more successful as a result of educational efforts to protect plants from trampling.
- Diapensia decrease may be caused by climate change, in which case we would expect to see similar decreases in other alpine species.
- Ericaceous shrubs and other competitors may see increased success as a result of more favorable conditions created by climate change.

Implications for the Northern Forest Region

- Partnership between a science-based organization and a field-based stewardship program provides the opportunity for high quality, inexpensive field work with a high degree of student involvement.

Diapensia in bloom. Photo: Seth Jones

Future directions

- Analysis of data collected for additional species may help reveal whether the declines in diapensia are anomalous or part of a larger trend.

- Future monitoring will help detect consistent patterns in all targeted species.

- Comparison between Adirondack results and those in other Northern Forest alpine areas will help determine whether these results are part of a larger trend.

List of products

- Leveraged grant from the 46er Conservation Trust in honor of Fred Johnson allowed an additional Botany Steward to be hired to conduct the field work. (2006-07 monitoring funded by the Biodiversity Research Institute and the Waterman Alpine Stewardship Fund)

- Updates to the New York Natural Heritage Program Element Occurrence Database.

- Second set of monitoring data for Adirondack alpine (371 plots sampled)

- Publications:
  - Howard, Tim and Julia Goren. "Monitoring Plant Populations in the Adirondack Alpine" in *Proceedings of the 8th Northeastern Alpine Stewardship Gathering*. (In preparation.)
  - Goren, Julia. "Mid-Season Report" Adirondack High Peaks Summit Steward Program
  - Goren, Julia. "Final Report on the 24th Season" Adirondack High Peaks Summit Steward Program.

- Presentations:
  - Conference Presentation: "Monitoring Plant Populations in the Adirondack Alpine" at the 8th Northeastern Alpine Stewardship Gathering
  - Public Presentations: Johns Brook Lodge, Atmospheric Sciences Research Center, and Wild Center
  - Other Presentations: Middlebury College, Ithaca College, SUNY Plattsburgh, Paul Smiths College, North Country Community College, Massachusetts College of Liberal Arts, Williams College, the Saranac Lake Rotary Club, and the Forest Preserve Advisory Committee

Thank you!

New York Natural Heritage Program