A MONITORING PROGRAM TO DETERMINE THE EFFECT OF CLIMATE CHANGE ON ALPINE PLANT COMMUNITIES IN THE SAN JUAN MOUNTAINS, SW COLORADO:

A New Site in the Global Observation Research Initiative in Alpine Environments (GLORIA) Program

A Brief Update Report

Dr. Koren Nydick
Mountain Studies Institute
March 21, 2008

Koren Nydick (left) and Julie Crawford (right)

Introduction

Even though direct human land use has affected alpine areas relatively little, today's climate warming may produce dramatic species shifts and could result in the reduction of alpine landscape extent. Increased temperatures can disturb the growth of cold-adapted species and may lead to competition on alpine plants from lower elevation species. Climate warming could force alpine plants to migrate upwards until they reach mountain tops with nowhere else to go. Mountain ranges with many endemic plants may suffer important species losses.

Upward migration of plants has already been observed in many mountain ranges where monitoring has occurred, but most mountain areas currently do not have the level of observation required to document subtle shifts that may warn of more drastic changes to come. Observations from the Alps show that alpine biodiversity may at first increase as lower elevation plants shift upwards, but model simulations suggest that as warming continues alpine species will be lost and overall diversity will decline.

A period of abrupt warming of about 2˚F on average has occurred since 1990 in the San Juan Mountains and global circulation model forecasts project a 4-5˚F increase by mid-century.

Whether or not this will cause alpine plant communities to shift is unknown, but this program ensures that we will be watching.

In the summer of 2006 the Mountain Studies Institute (MSI) initiated a long-term monitoring program to detect climate-induced changes in alpine plant communities in the San Juan Mountains. MSI's project is one "target area" in the Global Observation Research Initiative in Alpine Environments (GLORIA). This international program now has 35 active target areas, with 6 in the USA.

Methods, Location, and Project Team

GLORIA uses a multi-summit approach and standardized low-impact monitoring methodology that allows study of alpine plant communities and climate change impacts both within and among regions. Each target area requires four summits along an elevation gradient beginning just above treeline. The mountain tops have to be as conically-shaped as possible so that plots can be located on all four sides. Furthermore, geology and climate have to be very similar and peaks have to be as accessible as possible while avoiding areas impacted by recreation or mining. Each of the four summits is monitored using a specific observation protocol extending no farther than 10m below and 100m horizontal distance from a summit, with four main plots located at a specific distance below the summit in the primary cardinal directions. There are a total of 16 x 1 m^2 temporary gridded quadrats for detailed surveying and 8 larger areas for more general observations per summit. To facilitate repeat studies, small monument stakes or paint markers are installed to mark the summit origin point and the plot corners. The protocol also includes installation of a tiny, self-contained soil temperature monitoring sensor at a shallow depth inside each plot. The multi-summit array is observed at least once every five years, and temperature sensors are downloaded every two to three years.

Several candidate locations were considered before picking the four summits on public land near Lake City. The peaks range from 12,195 to 13,800 feet elevation. Working this high offered its share of obstacles, including difficult access, cold temperatures, rainy conditions, and lightning. A team of 13 people installed and monitored the plots in 15 very full days. MSI's Koren Nydick coordinated the project and led plot installation. Botanists Peggy Lyon (Colorado Natural Heritage Program) and Julie Crawford (University of Pavia, Italy) identified the plants. MSI's Kyle Skaggs and Ellen Stein, intern Lindsey Lennek from Fort Lewis College, and Michael Kelrick and his students from Truman State University rounded out the team. The project evolved into a tremendous educational experience for the undergraduates and a PhD dissertation for Julie Crawford, who is analyzing the baseline data for species-environmental relationships and the effects collecting data at different spatial scales and taxonomic resolutions.

2006 baseline data was submitted to the international GLORIA database at http://www.gloria.ac.at/.

The plots will be re-surveyed in 2011 and every five years thereafter with the temperature dataloggers being downloaded more frequently.

Summary of Findings

Ninety-nine plant species were identified in total at the San Juan target region, with 22, 58, 56 and 43 species found on each summit from highest to lowest. The average number of species found across all target regions globally is 92 and the median is 79.

Some of the San Juan species were found on all four peaks and some were found at only one location. These species appeared on at least one aspect of each summit: slender wheat grass (*Elymus trachycaulus*), spike trisetum (a grass, *Trisetum spicatum*), alpine fescue (*Festuca brachyphylla*), condensed phlox (flowering cushion plant, *Phlox condensata*), Rocky Mountain spikemoss (*Selaginella densa*, not really a moss), dwarf clover (*Trifolium nanum*, cushion plant with pretty pink flowers), Jacob's ladder (*Polemonium viscosum*, pretty purple flowers but skunky smell), chickweeds (*Lidia obtusiloba*, cushion plant with tiny flowers - specializes in rocky exposed ridges), bluebells (*Mertensia lanceolata*, pretty blue flowers) and featherleaf fleabane (*Erigeron pinnatisectus*, purple petals with golden center).

The only rare plant found in the plots was Altai chickweed (*Stellaria irrigua*) in the talus under rocks. It's ranked G4 S2, or rare in the state by the Colorado Natural Heritage Program. Townsend's Easter daisy (*Townsendia rothrockii*), ranked G2 S2, was found near the project, but not in the plots. Common dandelion (*Taraxacum officinale*) was the only invasive non-native species observed.

Funding Acknowledgement

Funding this type of project is very difficult and we are grateful to our sponsors. Cash support was provided by San Juan Public Lands (USFS/BLM), The Nature Conservancy, Colorado Native Plant Society, Mountain Studies Institute, American Alpine Club, and Colorado Mountain Club. In-kind services were contributed by the Mountain Studies Institute, Julie Crawford, Fort Lewis College, and Truman State University.

Additional Photos

Left: Project Area. **Right:** Julie Crawford and student reading gridded quadrat in corner of a plot.

Left: Peggy Lyon (right) and student **Right:** Koren Nydick (left) and Michael Kelrick

Left: Peggy Lyon (left) and Julie Crawford (right) identify plant species in the plot.
Right: Kyle Skaggs (left) and Lindsey Lennek (right) laying out the summit area and plots.