

## Peak time to track global warming for UC

### Researchers install alarm system for alpine ecosystems

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MOUNT ALBION - University of Colorado biologists began installing an alarm system atop this craggy summit Friday, near the Continental Divide west of Boulder.

Like the alarm systems in your car or home, this one is designed to detect intruders.

But in this case, the invaders are tundra plants moving up from lower elevations in response to global warming. The alarm system is a cluster of mountaintop vegetation plots that will be monitored periodically for decades to come.

"They might be an early warning, an indicator of how natural systems will respond," said ecologist William Bowman, director of CU's Mountain Research Station at Niwot Ridge, northwest of Nederland.

To spot changes in tundra vegetation caused by warming, permanent monitoring plots are being established this summer atop three peaks within the city of Boulder watershed, along the Continental Divide.

The peaks - 12,609-foot Albion, 13,150-foot Arikaree and 13,276-foot Kiowa - were selected in part because the watershed is closed to the public, so summit-area vegetation is relatively untrammelled.

Sixteen one-square-meter plots will be staked out in the alpine tundra just below the summit of each peak - four in each of the four cardinal directions. Temperature and vegetation will be monitored periodically.

The National Science Foundation provided \$7,000 this year to install the plots near Niwot Ridge.

Similar mountaintop plots will be set up this summer on peaks in southwestern Colorado's San Juan Mountains - possibly near Red Mountain Pass, said Chris Landry, executive director of the Center for Snow and Avalanche Studies in Silverton.

The Colorado peaks will be part of an international network of long-term alpine monitoring sites called GLORIA, which stands for Global Observation Research Initiative in Alpine Environments. Established in 2001, the program has grown to more than 30 sites around the world, from the poles to the tropics.

On Friday morning, Bowman and his research assistant, John Murgel, drove five miles on a rugged dirt road, then hiked three miles to the Albion summit. There they began the somewhat tedious task of counting, naming and recording every plant in their newly established tundra plots.

On Colorado's highest peaks, the alpine tundra community is a ground-hugging mix of some 350 species of grasses, sedge, wildflowers and other forbs, moss, lichen and low shrubs such as dwarf willow and birch.

Sixteen plant species were found in the first four one-meter-square Albion plots checked Friday. They included the buttercup-like alpine avens; the alpine fescue, a common grass; the nailwort, a moss-like "cushion" plant; dwarf sunspot, a miniature sunflower; *Carex rupestris*, sometimes known as the curly-leaf sedge; and alpine parsley, a forb.

The snows of Arapaho Glacier gleamed to the west. The Denver metropolitan area was lost in haze to the east. The only sounds were the roar of a waterfall, the chirp of pikas and birds, the buzz of black flies, the drone of distant airplanes, and Bowman's voice as he recited the Latin scientific name of each plant while Murgel recorded it in a notebook.

Climate models suggest that by 2100, Colorado could warm 3.6 to 7.2 degrees Fahrenheit, largely due to the buildup of heat-trapping "greenhouse" gases emitted when fossil fuels are burned.

In some parts of the West, conifer forests are expected to gradually move to higher elevations as the climate warms. But University of Wyoming tree line researcher William Baker said that's unlikely to happen in Colorado, unless the warmth is accompanied by additional moisture.

"Across most of that tree-line area, it's a pretty severe place for them, and they need more moisture to be able to regenerate and really grow, and particularly to move up into the alpine," Baker said.

Tundra plants will likely provide a better climate-warming red flag, Bowman said Friday.

Along the tundra-forest boundary in the Front Range, early indications of a response to warming could include upward migration of shrubs - various willows and blueberry, for example - and non-native weeds such as dandelions.

The number of tundra species might increase initially, as intruders move into previously inaccessible areas. But as the decades pass, extinction of alpine plants is possible, accompanied by a decline in alpine species, Bowman said.

That decline, in turn, could affect wildlife that rely on tundra plants for sustenance.

Group assesses climate change

The Global Observation Research Initiative in Alpine Environments, or GLORIA, assesses and predicts losses in biodiversity and other threats to fragile alpine ecosystems, which are experiencing accelerating climate changes. In Colorado, to spot changes in tundra vegetation caused by warming, monitoring plots are being established this summer atop three peaks within the city of Boulder watershed, along the Continental Divide.