Botanical Garden researchers head for mountains to track global warming impact

By Jo Seltzer, special to the Beacon

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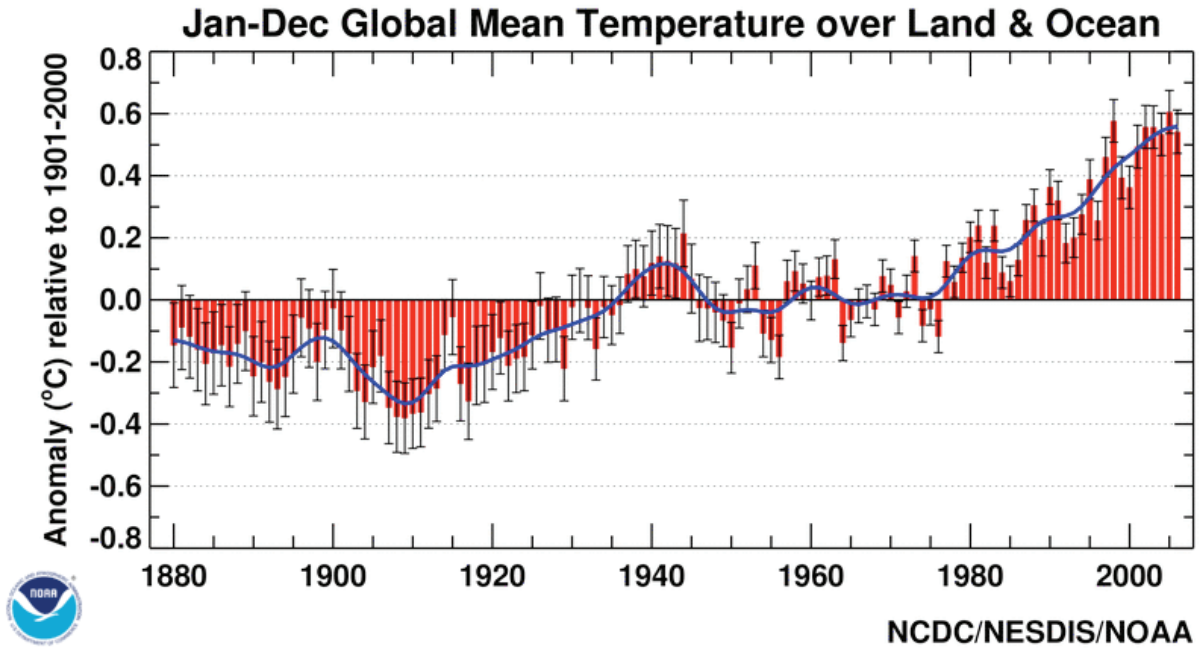
During St. Louis summers, people usually have no trouble answering "Yes" to the question, "Is it hot enough for you." Even though we've recently had weather that reminds many of Michigan in July, our summers and especially our winters have been getting warmer, and at an accelerated pace since the 1970s. Our area has become about 0.8 degrees centigrade (about 1.5 degrees Fahrenheit) warmer in the past 100 years, as has the average temperature of the globe.

The changes in temperature are much more striking other places on earth. And researchers at the Missouri Botanical Garden are trying to learn what that means for plant ecosystems in our state and around the world.



http://www.epa.gov/climatechange/science/recenttc_triad.html

The poles show the most warming. The Himalayas are second in rate of warming, with glaciers melting faster than anywhere else. Unlike the poles, the Himalayas support a complex and abundant flora, and this ecology is being affected by increasing temperature and more rain.

Jan Salick, Curator of Ethnobatany at Missouri Botanical Garden hanging prayer flags at a monastary on a sacred Tibetan mountain.

Photo courtesy of Jan Salick, Missouri Botanical Garden

"Alpine meadows are being pushed off the mountaintop," says Jan Salick of the Missouri Botanical Garden.

Her botanical studies in the high Himalayas are part of a world-wide project to document the exact effects of temperature change on the plant ecosystems between the treeline and the elevations where nothing grows. In the Himalayas, that elevation is presently between 15,000 and 18,000 feet. But the treeline and shrubline are moving up the mountains. Since the beautiful alpine meadows like those we remember from "The Sound of Music" don't grow in the shade of trees, she worries that eventually that entire habitat will be lost in some areas.

Her participation in the GLORIA (Global Observation Research Initiative in Alpine Environments) projects involves a specific protocol. First, the investigator chooses a set of four mountains of increasing summit height. In the Himalayas, the summits might range from 12,000 to more than 18,000 feet. Then, at the boundary between the upper and lower summit, and facing north, south, east, and west, they lay out clusters of 4 permanent sampling areas, 1 meter square. Every single plant in those samples is recorded. In the middle of the cluster, they bury a sensor that will take hourly temperature readings for three years.

Since 2005 she has surveyed 5 sets of mountains in Tibet, 5 in Nepal, 2 in Sikkim, and in the fall will travel to Bhutan.

Someone will return to these sampling sites every ten years, and again record every plant. The worldwide data is constantly pooled and analyzed. 17 GLORIA sites in Europe have already been resampled.

Changes in the High Himalayas

Salick is by training an ethnobotanist, so during her treks she also is looking at how people use the plants, and how the uses are changing. And she talks to people to see how the climate change is affecting them.

Glacial melting has been particularly distressing to many Tibetans. Mountains, which are associated with gods, are sacred to them. With no knowledge of global warning, they wonder if they have offended the gods by insufficient prayer.

They have noticed other changes. Food spoils now. Mosquitoes and flies have moved to higher elevations. Their staple grain, buckwheat, must now grow at higher elevations, where it doesn't do so well. Now they are growing rice, a warm weather crop, but a grain they are not accustomed to eating.

Of course, not all change is bad. French missionaries lived on the border between Tibet and China for 150 years. They needed their wine, and established microclimates to grow grapes. The French have been gone since 1949, but their vines have lived. And now cuttings from these vines are the basis of successful vineyards in the valleys at about 6000 feet above sea level. A Tibetan dessert wine recently won second prize in an international competition, and sells for about $90 a third-liter bottle.

Tibet is also a source of traditional Tibetan herbal medicines. Tibetan doctors always accompany Salick on her treks to teach her the use of the plants she catalogues. These plants are threatened by climate change, but more by their popularity and commercialization.

A case in point is the snow lotus.

This big puffy ball grows at the highest elevations, and takes ten years to flower. It must be harvested just before it sets seed to be effective
against heart problems and "women's ailments." In the past, Tibetans—who have very little heart disease—would harvest a few plants for their own use. Now the Chinese harvest them in large numbers to sell wherever herbal remedies are popular.

"You can purchase Tibetan herbs in downtown St. Louis," says Salick.

Snow lotus

Photo courtesy of Wayne Law, Missouri Botanical Garden

Predictive Modeling in the Andes

Garden researchers Carmen Ulloa and Peter Jorgensen go to the Andes of Ecuador and Bolivia to investigate the impact of climate change on endemic species. They too use the plot approach, somewhat differently from Salick.

Jorgensen studies trees, and therefore explores lower elevations. His permanent plots, in which he and his colleagues tag all trees over 10 cm (4 inches) in diameter, cover as much as 100x100 meters. He wonders if trees with buttress roots, such as the one shown in the photo, can live at

Peter Jorgensen inspects buttress-rooted tree in Ecuador.

Photo courtesy of Carmen Ulloa, Missouri Botanical Garden

higher elevations. He realizes that trees, with lifespans of about 200 years, are unlikely to adapt to changing conditions through Darwinian evolution.

Organisms with short generation cycles (bacteria, insects) can adapt to abrupt changes in their environment through mutation. Since trees can't move, and may not have time to adapt, he fears that many species will become extinct as global warming continues.

Like Salick, Ulloa explores above tree line. She concentrates on a flowering shrub consisting of about 50 species in the same genus. Within her 50 one- km squares in the Andes of Southern Ecuador, she follows linear paths. She collects data on any of the species growing about 15 feet on either side, getting the exact position of each plant using GPS, and recording the elevation.

Of course, all the data is now entered into huge computerized databases, like the Garden's TROPICOS, open to the public.

Ulloa and Jorgensen use their data not only for computer analysis, but for computer modeling. Ulloa, for example, enters her exact data, as well as data on herbarium specimens collected over the past 200 years into a program that can use up to 19 climatic variables. The model that emerges tells her other localities where these plants should grow. She and a team of Garden and Ecuadorian researchers then go to these places to find out if the plants are actually growing there.

Some modeling is more predictive. Jill Preston of the University of Missouri at St. Louis, who collaborates with the Garden, conducted a study of grasses native to the mountains of Central America. There she looked to find the closest place where these grasses could find their ecological niche if

Carmen Ulloa surrounded by Andean sunflower plants.

Photo courtesy of Carmen Ulloa, Missouri Botanical Garden

heat made the present habitat unsuitable. The model predicted that the closest similar niche would be the mountains of Colombia in South America. Could they take root in that location? Possibly, if their seeds were distributed by far-ranging animals such as birds.

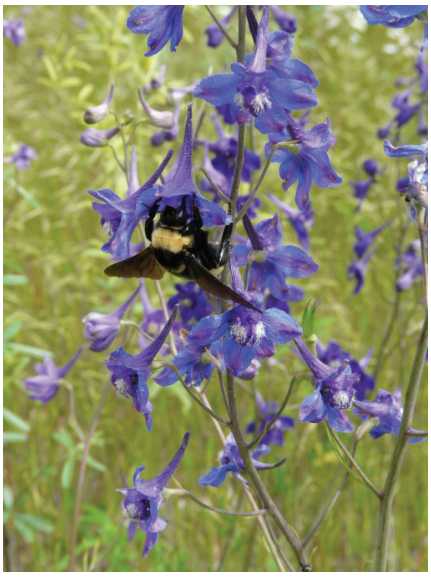
Computer modeling can be used for studying other factors besides temperature. Garden botanists are beginning to use "diversity modeling" to find areas that are particularly rich in endemic (native) species. These areas may become candidates for protection. In these areas, seed collection for seed banks may be especially important, and plants threatened with extinction may be propagated through cuttings.

Local mountains affected

Some of the lowest mountains are the Ozarks here in Missouri. Nicole Miller, a graduate student at Washington U. studies the effects of climate change on native plants in these hills. She is comparing several species that grow only in glades (rocky open spaces in forested areas) with similar species that grow in forests or prairies.

She has herbarium specimens of these local plants collected over 150 years from which to trace trends. She can plot blooming period versus temperature through time to see if the plants have changed their blooming patterns in a manner consistent with global warming. Worldwide, over 80% of plants bloom earlier in spring and later in fall, consistent with shorter winters. Miller of course adds her field collections and observations to the herbarium.

Missouri glades occur only in the Ozarks. Glade plants cannot move north to escape higher temperatures, because there are no glades in the Midwest north of Missouri. So when a glade plant like the delphinium shown in the photo blooms earlier—as it does-- its pollinators must also be around earlier. In this case, all looks to be OK at present.



Bumblebee in Delphinium treleasei. This glade flower is blooming more than 6 days earlier than it was 100 years ago.

Photo courtesy of Nicole Miller

Garden botanists acting proactively

The steep rise in average earth temperature is a relatively new phenomenon, at least in the last couple of centuries. It is of course impossible to predict whether global warming will actually cause an accelerated rate of plant extinction, but botanists are making a huge "better safe than sorry" effort to preserve as many species as possible.