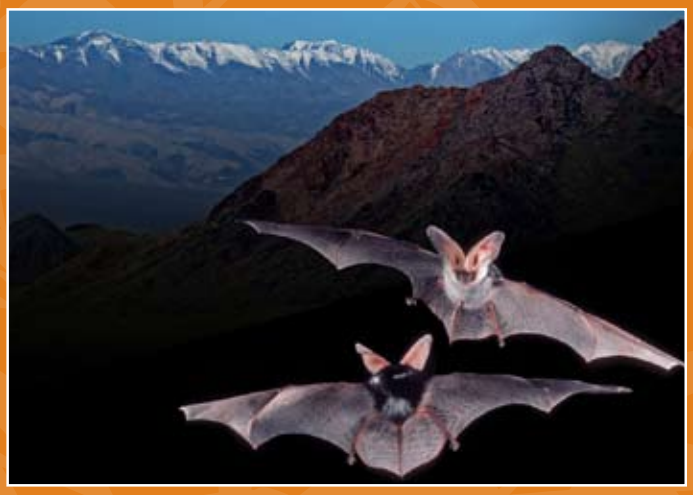
Using Mountains to Understand Biodiversity

by Christy M. McCain, Curator of Vertebrate Zoology

Coloradoans are lucky people. We live surrounded by one of the most beautiful mountain landscapes the world has to offer. We commune with peregrine falcons, mountain lions, Roosevelt elk, mountain chickadees, American pika, yellow-bellied marmots, astounding aspen groves, majestic stands of spruce, and precipitous peaks of rock and snow. Our mountains are not only a wondrous beauty, but they can teach us innumerable lessons about the biological processes on the globe.



Where do our mountains harbor the most species? Do most species of birds, mammals, and plants live at mountain bases where grasslands, deserts, and open forests predominate, or at mid-elevations with mixed conifer forests of ponderosa, Douglas fir, aspen, and willows, or at mountain tops with their showy subalpine firs and Engelmann spruce, open tundra, and stunted juniper? It turns out that most species live at mid-elevations in the Rocky Mountains. And this is true for many mountains around the world, although not all.

I study biodiversity on mountains, here in the Rocky Mountains, in the Costa Rican tropical mountains, and all around the globe. I am interested in understanding where biodiversity is high and where it is low, and why. One fundamental question in ecology is "What are the patterns of biodiversity on earth and what mechanisms produce them?" Paradoxically, researchers have been interested in this question for decades, yet no accepted general explanation for the distribution of biodiversity has surfaced. The need to document and understand what is producing biodiversity patterns is particularly urgent do to current unprecedented rates of global habitat destruction, pollution, and climate change.

My research aims to improve our understanding of mountain biodiversity and underlying mechanisms of diversity, abundance, and distribution of organisms in a search for general theories of biodiversity. So far my research on vertebrates—rodents, bats, birds, amphibians, reptiles—on mountains, has found that

where diversity is greatest depends on the ecology of the group and the climate of the mountain. Generally, most species live at elevations where the climate is both warm and wet. The warmest, wettest parts of tropical mountains tend to be at low elevations dominated by tropical forests. In the mountainous western US, the warmest, wettest conditions tend to occur at mid-elevations above deserts and dry grasslands.

Mountain biodiversity is strongly tied to climate. Therefore, how species are able to respond to current and future changes in climate is of utmost importance. Species can respond in three general ways: they can expand where they live on the mountain, they can retain their original distribution, or their distribution on the mountain can contract. In the latter case, if a species finds less and less suitable habitat in which it can survive, then the likelihood of extinction dangerously increases. My new work in the Colorado Rockies seeks to compare historical distributions of small mammals—like red-backed voles, mountain shrews, yellow-bellied marmots, and bushy-tailed woodrats—to current distributions to detect how species have responded to human disturbances and changes in temperature and precipitation. Data on where species occurred historically comes from specimens deposited in natural history collections at the University of Colorado Museum of Natural History and elsewhere since the late 1800's. We are re-trapping these species each summer to determine their current distributions, population sizes, and important ties to climate, food resources, and habitat. From these studies, I hope to have a better understanding what factors are most important to determining Rocky Mountain biodiversity, and how species have responded and will continue to respond to global changes.