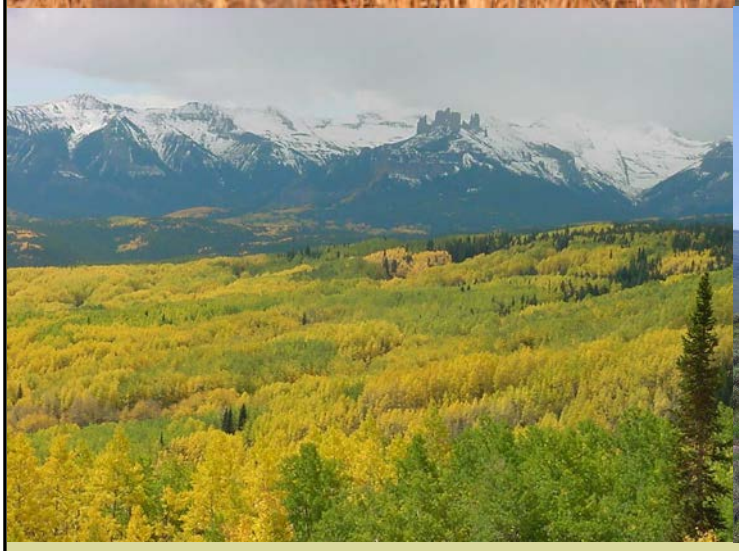
EXECUTIVE SUMMARY: GUNNISON BASIN CLIMATE CHANGE VULNERABILITY ASSESSMENT

For the Gunnison Climate Working Group






December 31, 2011

Prepared by

The Nature Conservancy
Colorado Natural Heritage Program
Western Water Assessment, University of Colorado, Boulder
University of Alaska, Fairbanks

Southwest Climate Change Initiative

Climate change is already changing ecosystems and affecting people in the southwestern United States. Rising temperatures have contributed to large-scale ecological impacts, affecting plants, animals, as well as ecosystem services, e.g., water supply. The climate of the Gunnison Basin, Colorado, is projected to get warmer over the next few decades as part of a larger pattern of warming in the western United States. Natural resource managers need to understand both past and potential future impacts of climate change on land and water resources to help inform management and conservation activities. The goals of this vulnerability assessment are to identify which species and ecosystems of the Gunnison Basin, Colorado, are likely to be most at risk to projected climatic changes and why they are likely to be vulnerable. This report is intended to help natural resource managers set priorities for conservation, develop effective adaptation strategies, and build resilience in the face of climate change.

Vulnerability is the degree to which a system or species is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. In this report, we focus on exposure and sensitivity to describe vulnerability. Exposure is the character, magnitude, and rate of climatic change a species or system is likely to experience. Sensitivity is the degree to which a system or species is affected, either adversely or beneficially, by expected climate variability or change. Vulnerability ratings of ecosystems are defined as the proportion of the ecosystem at risk of being eliminated or reduced by 2050 as a result of climate change. For species, vulnerability ratings are defined as the species' abundance and/or range extent within the Basin likely to decrease or disappear by 2050.

This report summarizes the results of a landscape-scale climate change vulnerability assessment of the Upper Gunnison Basin (above Blue Mesa Reservoir; referred to as Gunnison Basin in this report) to determine the relative vulnerability of 24 ecosystems and 73 species of conservation concern, using methods developed by Manomet Center for Conservation Science and NatureServe. The report also summarizes the results of a social vulnerability and resilience assessment of ranching and recreation sectors in the Basin.

Gunnison Climate Working Group

The assessment was developed for the Gunnison Climate Working Group, a partnership of public and private organizations working to build the resilience of species and ecosystems so that they continue to provide benefits to people of the Gunnison Basin. The Working Group goals are to understand the potential threats posed by climate change, identify strategies to reduce adverse impacts, and promote coordinated implementation of these strategies. The Working Group includes representatives from: Bureau of Land Management, Colorado Natural Heritage Program, Colorado Parks and Wildlife, Gunnison County, Gunnison County Stockgrowers Association, National Park Service, National Center for Atmospheric Research, Natural Resources Conservation Service, Rocky Mountain Biological Laboratory, The Nature Conservancy, US Fish and Wildlife Service, US Forest Service, Upper Gunnison River Water Conservancy District, Western State College and Western Water Assessment, University of Colorado, Boulder.

The Working Group is collaborating with the Southwest Climate Change Initiative (SWCCI), whose aim is to provide climate adaptation information and tools to conservation practitioners in Arizona, Colorado, New Mexico and Utah. The Gunnison Basin is one of four SWCCI landscapes developing and testing ways to sustain natural resources in a changing climate. Collaborators include: Climate Assessment for the Southwest (University of Arizona), National Center for Atmospheric Research, The Nature

Conservancy, Western Water Assessment (University of Colorado, Boulder), Wildlife Conservation Society, US Forest Service, and the University of Washington.

Changing Climate

Seasonal and annual temperature and precipitation changes were examined and used in assessing the vulnerability of species and ecosystems. The average annual temperature of the Upper Gunnison Basin is projected to increase by approximately 3°C (5.4°F) from the late 20th century to the middle 21st century. Average summer temperatures are projected to increase by approximately 4°C (7°F). Climate projections show no distinct trends in average annual or seasonal precipitation, but they reveal several ecologically important changes, including a 10-25% decrease in average annual runoff, more precipitation falling as rain rather than snow, earlier snowmelt and spring runoff peaks, and changes in the seasonality of flooding. Rising temperatures are projected to bring about these hydrologic changes no matter how precipitation patterns change in the basin (precipitation projections are considerably less certain than temperature projections). These changes underscore the critical need to assess and prepare for ongoing and projected climate change impacts to ecosystems and species in the Gunnison Basin.

The timeframe for this vulnerability assessment is the mid-21st century (2040-2069), as near-term projections of climate change scenarios are largely based on past greenhouse gas emissions and thus have a higher degree to certainty than longer-term horizons.

Ecosystems

Twenty-four ecosystems (17 terrestrial and seven freshwater) were evaluated for their relative vulnerability to climate change in the Gunnison Basin. Fifty percent (12) of the 24 ecosystems were ranked as vulnerable to climate change. Five of the 17 terrestrial ecosystems evaluated were ranked as *highly* vulnerable and five were ranked as *moderately* vulnerable. Four of the seven freshwater ecosystems evaluated in this assessment were ranked as vulnerable to climate change (one *highly* vulnerable and three *moderately* vulnerable).

Five terrestrial ecosystems—mesic alpine, xeric alpine, bristlecone pine, Douglas-fir, and low-elevation riparian—were rated *highly* vulnerable to climate change. The alpine ecosystem is likely to be highly susceptible to rising temperatures and a shorter duration of snow cover. Warmer temperatures and a longer growing season in the alpine may allow shrubs and trees to encroach. For many species, a range shift in response to warmer temperatures is expected, but with no higher areas available for alpine species, a range shift may not be possible. The bristlecone pine ecosystem is limited in distribution and, while higher habitat may become available as the climate changes, bristlecone pine recruits very slowly and may not be able to successfully colonize these areas. Moreover, bristlecone pine may become more susceptible to white pine blister rust. Douglas-fir forests, occurring primarily on cold north-facing slopes, may be significantly vulnerable to increased frequency and duration of insect attacks associated with warming. Low-elevation riparian ecosystems are vulnerable to changes in timing of snowmelt, flooding, and increased invasive species.

Five terrestrial ecosystems – spruce-fir, lodgepole pine, aspen forests, mid-elevation riparian, and irrigated hay meadows – were rated *moderately* vulnerable. Increased droughts and warmer temperatures may increase mortality of spruce-fir forests from bark beetles and root diseases. Lodgepole pine is also

vulnerable to pest attacks, particularly mountain pine beetle, as conditions become warmer, especially in winter. Drought may increase the frequency and severity of stand-replacing fires and lethal insect outbreaks in lodgepole pine forests, reducing the integrity and extent of this type. Aspen is particularly sensitive to drought; long-term droughts may reduce the size and/or impair the ecological functioning of aspen stands, especially at lower elevations. Mid-elevation riparian ecosystems and hay meadows are vulnerable to increased invasive species, drought, and decreased base flows.

Of the seven freshwater ecosystems assessed, one – montane groundwater-dependent wetlands – was rated *highly* vulnerable. These wetlands are already adversely affected by water development, grazing, and invasive species, and these stresses are expected to be exacerbated by climate change. Three freshwater ecosystems—mid-sized streams, rivers and reservoirs/associated wetlands—were rated *moderately* vulnerable. Mid-sized streams and rivers were rated highly vulnerable to changes in timing and magnitude of snowmelt and decreases in base flows. Reservoirs were rated highly vulnerable to invasive species and to the fact that they are restricted to specific hydro-geomorphic settings (i.e., they cannot move). High-elevation freshwater ecosystems were ranked *low to moderately* vulnerable, based on their current good condition, high level of protection and management, and high level of connectivity with other systems. Unlike their terrestrial high-elevation counterparts that are vulnerable to rising temperatures, drought, insect outbreaks and damaging wildfire, these ecosystems are expected to remain cold enough to resist pathogens and invasive species.

Key factors contributing to the vulnerability of terrestrial ecosystems include increased pest attacks, increased invasive species, barriers to dispersal ability, fire and drought. Key factors contributing to the vulnerability of freshwater ecosystems include decreasing base flows, dependence on timing and magnitude of snowmelt, and restriction to specific locations on the landscape.

Species

Seventy-four percent (54 out of 73) of the species of conservation concern analyzed were rated vulnerable to projected climate change in the Gunnison Basin: 43 (of 50) plants and 11 (of 23) animals. Most of the species rated as vulnerable occur within the freshwater, alpine, spruce-fir and sagebrush ecosystems. The most vulnerable groups are plants, amphibians, fish, and insects; the least vulnerable groups are mammals and birds. This trend is not surprising, given the comparatively limited dispersal ability of plants and small animals such as amphibians and insects, and the dispersal-limiting restriction of fish to aquatic habitats. More mobile species – birds and mammals – scored as less vulnerable overall. Only four out of 10 birds and three out of nine mammals rated *highly* vulnerable. The most vulnerable birds are Boreal Owl, White-tailed Ptarmigan, Brown-capped Rosy-finch, and Gunnison Sage-grouse. The first three of these species thrive in cooler environments of high elevations, habitats likely to become degraded as conditions become warmer. Sage-grouse require mesic conditions for brood-rearing; these habitats are predicted to become less suitable for this critical life stage.

The most vulnerable mammals are lynx, snowshoe hare, and American pika – all high elevation species with vulnerability scores driven by their limited capacity to adapt to warmer temperatures. These limitations varied from physiological (overheating), mismatches of seasonal coloration due to novel conditions (generally limited or delayed snow), increased competition, and declining habitat area. Over half the birds and two-thirds of the mammals are *presumed stable* or *likely to increase* with predicted climate changes. The wide-ranging bighorn sheep, which has good dispersal ability, is *likely to increase*.

In addition to its dispersal abilities, this species may be favored if increased fire frequency creates more open habitat.

Forty-three of the 50 plant species of concern assessed were rated vulnerable (*extremely, highly* to *moderately* vulnerable) to climate change. Examples include Gunnison milkvetch, the moonworts, round-leaf sundew, Colorado wood-rush, and Avery Peak twinpod. Most of these species have not been well studied, so much uncertainty exists with respect to their habitat requirements and climate adaptations. Factors most likely to contribute to the vulnerability of plants include: poor dispersal capability, restriction to cool or cold environments, limited physiological thermal niche, restriction to uncommon geologic features or substrates, and dependence on ice and snow.

Social Sectors

Climate change will likely affect both livelihoods and ecosystems in complex and interconnected ways. In order to develop effective strategies for reducing the adverse effects of climate change, land and water managers need to understand how ecosystems and livelihoods might respond to changes and what types of opportunities and challenges arise from these dynamics. The ranching community has adaptive strategies for dealing with extreme and variable climate, a strong social network, and a long history in the region. However, they are vulnerable to climate change because they depend on public lands and have multiple stressors that challenge their ability to continue operating solely as ranchers. Increased duration and intensity of droughts may place additional stress on area ranches. Current land ownership patterns may make it difficult to expand or change operations in response to climate variability and change. Recreation businesses are dependent on regional and national economic conditions that are not under their control. Climate impacts in other locations may increase recreation pressure in the Gunnison Basin.

Data Gaps

We do not know precisely how the climate will change or how ecological or human systems will respond to climate change in the Gunnison Basin. We also lack complete understanding of inter-specific interactions, genetics, and adaptive capacity of species to climate change. Specifically, life history information and relationships among rare plants, symbiotic species (e.g., mycorrhizae and pollinators), and seed dispersers are poorly understood. Rapid adaptation is possible in some plant species, but there are few data on the subject, especially for the at-risk plants in the Basin and their close relatives. Data gaps also include indirect effects of climate change (i.e., climate change effects on one species that drive changes in other species) and interactions between changing climate and other stressors (e.g., habitat fragmentation). Though recent studies have produced abundant information about the response of some species to the warming temperatures over the past few decades, information about climate-related changes in phenology, distributional shifts, and alteration of habitats of the majority of the Basin's plant and animal species is lacking.

Conclusions and Recommendations

This vulnerability assessment is a first attempt at identifying ecosystems and species of the Gunnison Basin likely to be affected by climate change and why they are at risk. It shows that many of the natural features of the Basin are susceptible to loss, degradation or other changes induced by warming temperatures. Climatological, ecological, hydrological and socio-economic projections suggest that the

natural environment of the Basin will change significantly over the next several decades, impacting ecological systems, species and livelihoods.

Climate change projections are highly dependent on emissions scenarios – the volume of greenhouse gases produced by society – for the next several decades. Moreover, the spatial resolution of global climate models is limited. Therefore, uncertainty remains about future local climate, and, accordingly, about how species fitness, population stability, and ecosystems will be affected. While it is important to fill key data gaps and reduce uncertainty about climate change impacts, the climate is already changing, and its ecological effects are already emerging. Given the current high rate of greenhouse gas emissions – far higher than projected only a few years ago – these changes are likely to accelerate and to cause significant changes in ecosystems and the local economy. Accordingly, we need to begin taking action, building on what we currently know, to help to build resilience of the species, ecosystems, and people facing a changing climate.

This report provides a scientific foundation for the Gunnison Climate Working Group's next step to develop adaptation strategies to help species, ecosystems and people adjust to a changing climate in the Gunnison Basin. These adaptation strategies may change the priority, rate, timing, or location of specific actions in the management of natural resources, ranches, and recreation, etc. An important next step will be to integrate the ecosystems and species results with the social vulnerability/resilience assessment. This step will help the Working Group develop a robust set of strategies to reduce the adverse effects of climate change on people and ecosystems, especially where climate change impacts are inter-related. Finally, planning should not stand in the way of natural resource managers and private landowners from taking action that will begin to build resilience. Some high priority strategies have begun to emerge through planning, such as this vulnerability assessment. Implementing these "no-regrets" strategies should continue as the Working Group works to refine and determine additional high-priority strategies.

For the Gunnison Basin Climate Change Vulnerability Assessment Report (10MB), please see: http://conserveonline.org/workspaces/gunnisonclimatechange/documents/gunnison-basin-climate-change-vulnerability/view.html.

Citation: Neely, B., R. Rondeau, J. Sanderson, C. Pague, B. Kuhn, J. Siemers, L. Grunau, J. Robertson, P. McCarthy, J. Barsugli, T. Schulz, and C. Knapp. Editors. 2011. Gunnison Basin: Climate Change Vulnerability Assessment for the Gunnison Climate Working Group by The Nature Conservancy, Colorado Natural Heritage Program, Western Water Assessment, University of Colorado, Boulder, and University of Alaska, Fairbanks. Project of the Southwest Climate Change Initiative.