

NATIONAL PARKS IN PERIL

THE THREATS OF CLIMATE DISRUPTION

State Fact Sheet: Arizona, Nevada, and Utah

Human disruption of the climate is the greatest threat ever to our national parks.

At risk are nearly every resource and value that make our national parks so special. In *National Parks in Peril*, the Rocky Mountain Climate Organization and the Natural Resources Defense Council identify 25 national parks as having the greatest vulnerabilities to human-caused climate change. In Arizona, Nevada, and Utah, **Lake Mead** National Recreation Area and **Saguaro** and **Zion** national parks are among the 25 parks most at risk. **Lake Mead** is vulnerable to a loss of water, more downpours and floods, a loss of plant communities, intolerable heat, and more air pollution. **Saguaro** is vulnerable to a loss of water, more downpours and floods, a loss of plant communities, a loss of wildlife, intolerable heat, and more air pollution. **Zion** is vulnerable to a loss of ice and snow, a loss of water, more downpours and flooding, a loss of plant communities, a loss of wildlife, a loss of cultural resources, intolerable heat, a loss of fishing, and more air pollution. Other parks in these states, including **Arches**, **Bryce Canyon**, **Canyonlands**, **Capitol Reef**, **Grand Canyon**, and **Great Basin** national parks; **Dinosaur National Monument**; and **Glen Canyon** National Recreation Area face similar vulnerabilities.

Many of these impacts are already happening, as human activities—the emission of heat-trapping gases—are now changing the climate. To preserve our national parks for ourselves and future generations, we need to both stop changing the climate and take actions to preserve the resources and values that make our parks special. For detailed recommendations, see the full report, *National Parks in Peril*.

Loss of Ice and Snow

As the climate gets hotter, national parks losing snow and ice—one of the most obvious effects of a changed climate on our national parks. Scientific forecasts for future springtime peak snowpack levels across the West are shocking, with projected declines of 30 percent in the higher and colder mountains of the Colorado River basin. These projections typically are for snowpacks as of April 1, around the time of peak snow levels. In some parks, such as Arches, Bryce Canyon, Capitol Reef, Canyonlands, and Zion, snow does not linger that long, but with less snow in winter fewer visitors would get to see the parks at their scenic best.

Loss of Water

In the West, a changed climate likely will bring less snowfall, earlier snowmelt, and hotter and drier summers, reducing water availability, especially in the summer when it is most needed by wildlife, plants, and entire ecosystems. A changed climate is expected to make the Colorado Plateau especially hotter and drier. This region of uplifted land, named after the Colorado River that cuts through it, spans much of Utah, Colorado, New Mexico, and Arizona, and is home to many of the country's greatest natural and cultural wonders. It also contains our greatest concentration of national parks—about two dozen, with the

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the exact number depending on the particular boundary used for the Colorado Plateau.

But dramatic changes are underway on the plateau as temperatures rise and water supplies shrink. The Colorado River basin, which includes the Colorado Plateau, has experienced more warming since the 1970s than any other part of the United States outside of Alaska. According to an analysis done by the Rocky Mountain Climate Organization and published in a joint report with Natural Resources Defense Council, the average temperature in 2003-2007 across the Colorado basin was 2.2°F hotter than the basin's 20th-century average. In comparison, the entire 11-state American West averaged 1.7°F hotter, and the planet as whole 1°F hotter. The Colorado River, the major water source of not just this region but also the entire Southwest, is in its most severe drought in more than a century of record keeping—consistent with scientific projections that human-caused climate change will dry out this region more than any other in the country. As atmospheric circulation patterns change and storm tracks move northward, naturally low precipitation levels in the arid Southwest may drop by 40 percent or more under a high-emissions future. Scientists have estimated that flows in the Colorado River could be diminished by 4 percent to 18 percent by 2050—enough, in this arid, fast-growing region, to have enormous consequences on national parks, ecosystems, and people.

Saguaro, south of the Colorado Plateau, is similarly vulnerable to water losses.

Zion illustrates the vulnerability of the Colorado Plateau parks to a loss of water. Spectacular Zion Canyon in the heart of the park was formed through the erosive power of a rapidly flowing North Fork of the Virgin River, which is still cutting into rock layers and continuing to shape the canyon. At the upper end of the canyon, in the Narrows of the Virgin River, the river cuts through a high layer of firm sandstone, where it has created the most accessible large slot canyon in the national park system. Below the Narrows, the river is eroding a softer, lower formation, undermining the overlaying sandstone and causing it to collapse, widening the main body of the canyon. Unlike most of the rivers in the West, including those flowing through most national parks, the North Fork of the Virgin River is undammed and so its flows are not determined by releases from reservoirs. If the river's natural flows are diminished, it will not be as powerful and will no longer continue shaping the canyon's geology as it has.

The hotter and drier conditions of the Colorado Plateau are already having dramatic effects on the piñon-juniper forests that are the region's dominant wooded ecosystem. Sustained heat and drought in the early years of this century weakened piñon pines so much that an infestation by a piñon bark beetle has caused widespread regional forest die-back. This region has known drought before and trees have died before, but more trees died in the recent drought than during an even drier period in the 1950s. The difference, researchers say, is that this century's higher temperatures increased the forest die-off. "This recent drought episode in southwestern North America," they write, "may be a harbinger of future global-change type drought throughout much of North America and elsewhere, in which increased temperature in concert with multidecadal drought patterns . . . can drive extensive and rapid changes in vegetation." Included in the Colorado Plateau parks that have experienced or are at risk of losing piñon forests are Arches, Bryce Canyon, Canyonlands, Capitol Reef, Glen Canyon, Grand Canyon, Great Basin, Lake Mead, and Zion.

With less water in western rivers, there will be fewer opportunities for boating, rafting, and kayaking. Hundreds of thousands of visitors each year go whitewater rafting and kayaking through some of the West's most dramatic landscapes, including Canyonlands, Grand Canyon, and Dinosaur National Monument. Almost 10 million visitors a year go to Lake Mead and Glen Canyon, most to enjoy boating on the reservoirs.

In 2005, after five straight years of severe drought in the Colorado River basin, Lake Powell had fallen to its lowest level of storage since 1969 (when it was still being filled for the first time) and Lake Mead had fallen to its lowest level since 1967. The number of people visiting Lake Mead fell by 1.2 million, or 13 percent. The National Park Service spent \$20 million to extend boat ramps to the new, lower edge of the reservoir; a concessionaire spent \$2 million to move a marina 12 miles; and at Boulder Beach people had to walk a half mile to reach restrooms left behind by the receding waterline.

More downpours and floods

With a changed climate, more precipitation now comes in downpours. The amount of rain falling in heavy storms increased by 20 percent over the past century, while there has been little change in the amount from light and moderate storms. In its recent report, the U.S. Global Change Research Program says there is at least a 90 percent likelihood that heavy downpours will become even more frequent and intense. With an increase in downpours, flooding also is likely to increase. Virtually all national parks in these three states and elsewhere are at risk, as the forecast is for more downpours everywhere.

Loss of plant communities

An altered climate can lead to fundamental changes in the natural plant communities of parks, including a disruption of desert ecosystems.

One type of threat comes from invasive plants, which may adapt to changed conditions better than native species, reproduce quickly, and crowd out native plants. In Saguaro, buffelgrass, an introduced African species, is the invader, and the native saguaros could be the victim. Buffelgrass thrives in heat, is spreading prolifically and crowding out native plants, and has created conditions ripe for wildfire in an ecosystem that naturally is fire-free. When ignited, buffelgrass burns at very high temperatures and promotes rapidly spreading fires; it also re-grows quickly after fires. The hotter and drier conditions of a changed climate also may contribute to the likelihood of wildfires in the desert. Saguaros, like some other species native to the Upper Sonoran Desert, have not evolved with fire and are particularly vulnerable to it. Other native species, including desert tortoises, are also at risk from the disruption of the ecosystem. In Saguaro, despite aggressive attempts by the NPS and volunteers to control buffelgrass, infested areas are doubling in size every two years. If this were to continue, most of the park would be infested within a decade. The result could be the transformation of the park's desert ecosystem into savannas of grass and mesquite—and the elimination from the park of the saguaros for which it is named. As a U.S. Geological Survey scientist says, "Buffelgrass is the worst environmental problem we face in the Sonoran Desert. We're getting ready to see the unhooking of a unique American ecosystem."

Loss of wildlife

For many Americans, the highlight of a trip to a national park is the wildlife they see. But a changed climate could mean less of the wildlife species now in the parks. Some species may go completely extinct, and, local populations in particular parks may be eliminated or decline sharply.

Researchers from Yale University studied the possible effects of climate change on mammals in eight national parks projected that a doubling of atmospheric levels of heat-trapping gases could change habitat in Zion enough to eliminate one species and to add 41 species. A major caveat here, though, is that the researchers did not consider whether there would be geographic or other barriers to species moving into parks. Should as many new species move into parks as the researchers

projected, there would be substantial new competition for habitat and food, creating another stress on the native local wildlife.

Of 80 separate populations of desert bighorn sheep in California about 65 years ago, 30 no longer exist. Scientists have determined that the local extinctions occurred most often in the hottest, driest areas of its former range, as the bighorn has been limited to higher (and therefore cooler) and wetter areas. The probabilities of additional local extinctions are projected to go up the more that California's desert climate becomes even hotter and drier. This warrants monitoring of desert bighorn populations in Arches, Canyonlands, Capitol Reef, Grand Canyon, Great Basin, and Zion.

Reductions in the number of saguaros in Saguaro—let alone their possible elimination—would remove nesting sites for elf owls and gilded flickers and food sources for white-winged doves—all species found in this country only in the extreme Southwest.

An altered climate is likely to reduce inland populations of cold-water fish species, including trout and salmon. For trout in the interior West, a hotter climate is the single greatest threat to their survival; when water temperatures reach the mid-70's, trout can die. Under a high-emissions future, streams in the West could warm up enough to reduce trout habitat by 50 percent or more by the end of the century; losses in some regions of the West could exceed 60 percent. Trout in Canyonlands, Great Basin, and Zion streams are vulnerable to this threat.

Loss of cultural resources

By preserving some of the best of our historical and cultural resources—buildings, landscapes, archaeological sites, and artifacts—America's national parks provide information about the past and provide important links to the present. Many of these resources are at risk from the possible effects of a climate disrupted by human activities.

Increased downpours, flooding, and erosion likely will increase damage to historic structures and cause a loss of artifacts. This is particularly true in arid areas, where the land is dry and hard enough that downpours are not absorbed into the soil but instead produce floods and erosion. The National Park Service identified in a "Vanishing Treasures" program irreplaceable cultural resources that are "rapidly disappearing from the arid West," often because they are "in immediate, imminent danger from natural erosive factors." Parks containing the vanishing treasures include 16 in Arizona and nine in Utah, including Zion.

Intolerable Heat

As the world continues to heat up, heat itself will become a real problem in areas that are already hot to begin with and could get much hotter. People visiting national parks in these areas will particularly feel the heat, since they typically are outdoors, not in air-conditioned buildings. These parks may simply become intolerably hot for long stretches of the year for many people.

At Lake Mead, temperatures averages 98°F in June, 105°F in July, 103°F in August, and 97°F in September. Arches and Zion both have an average high temperature of 100°F for July. In Arches, the average high is 97°F in August. In Zion temperatures average over 90°F in June, August, and September. At Saguaro, the average highs in both June and July are 98°F and are over 90°F in August and September. In Grand Canyon, summer temperatures at Phantom Ranch—the most popular hiking destination at the bottom of the canyon—typically exceed 100°F.

These parks already are too hot for many people during the summer, when the number of people visiting the parks declines while it is going up in most parks. If these hot parks get even hotter because of human-caused changes to the climate, they would be intolerably hot for many people for longer stretches. Climate models project that these parks are likely to get substantially hotter, especially in a higher-emissions future. Stretches of the country that include Lake Mead and Saguaro are projected to average more than 100 days a year over 100°F and to average 90°F or hotter for half or more of the entire year.

Loss of fishing

Anglers have long enjoyed fishing amid the natural settings of our national parks. But now a changed climate threatens to reduce fish populations and recreational fishing opportunities in the parks. Populations of trout, a cold-water fish, are threatened with widespread declines because of hotter water temperatures. In the future, if populations of trout species decline as precipitously as scientists project, anglers might face more restrictions on trout fishing at Canyonlands, Great Basin, and Zion.

More air pollution

A hotter climate is projected to worsen concentrations of ground-level ozone, a component of smog created when pollutants mix in sunlight. Ground-level ozone has been firmly established to harm people's health, and the U.S. Environmental Protection Agency has set air quality standards at the levels necessary to prevent adverse health effects.

Many people think of ozone as a big-city air pollution issue, but it is a problem in many national parks, affecting both the enjoyment and the health of visitors. In 2005-2007, Saguaro and Zion were among 11 national parks with permanent air-quality monitoring stations that had levels of ozone violating the national health-based air quality standards for ozone, as recently strengthened by EPA. Based on monitoring with portable equipment, monitoring sites near Lake Mead, and other methods, the NPS thinks that park in 2005-2007 also violated the ozone standard. Because future climate-change driven increases in ozone levels are expected to be greatest where ozone levels already are high, these parks are at risk of continued, perhaps worsened, levels of unhealthy air.

For documentation of the sources used for this fact sheet, please see the full report, *National Parks in Peril: The Threats of Climate Disruption*, at www.nrdc.org/policy or www.rockymountainclimate.org.