National Parks in Peril
The Threats of Climate Disruption

State Fact Sheet: Montana, Idaho, Wyoming

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 Montana, Idaho, and Wyoming, Glacier and Yellowstone national parks are among the 25 parks most at risk. Glacier is vulnerable to a loss of ice and snow, a loss of water, more downpours and floods, a loss of plant communities, a loss of wildlife, and a loss of fishing. Yellowstone is vulnerable to a loss of ice and snow, a loss of water, more downpours and floods, a loss of plant communities, a loss of wildlife, overcrowding, and a loss of fishing. Other parks in these states, including Grand Teton National Park and Craters of the Moon National Monument and Preserve, 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 in the North and in mountain ranges are losing ice and snow—one of the most obvious effects of a changed climate on our national parks. The Intergovernmental Panel on Climate Change reported in 2007 that glaciers are melting worldwide in response to higher temperatures since 1970. In the United States, glacial melting is concentrated in our national parks, a handful of which contain the vast majority of the nation's glaciers.

Glacier was designated a national park in large part to preserve the glaciers after which it was named. Scientists have documented rapid melting of the park's glaciers and linked the melting to higher temperatures. The acreage of Grinnell Glacier, for example, shrank by a quarter between 1993 and 2004. Observing this kind of melting, researchers in 2003 projected that by 2030 all glaciers in the park would be gone if current emission trends continue. But since then the glaciers actually have melted much faster than expected. Between 2005 and 2007, for example, Grinnell Glacier lost an additional nine percent of its acreage. In October 2007, the U.S. Geological Survey's Dan Fagre said, “[W]e're about eight and a half years ahead of schedule … Our initial projection has proved too conservative. They're going faster than we thought.”

As glaciers in national parks melt, scenery is affected, and so is visitor enjoyment; eventually, tourism could be, too. The ecosystem effects can be significant, as well. When glaciers disappear and produce no more meltwater, rivers and streams lose reliable late-season flows that are not dependent on the vagaries of the previous winter's snowpack or that

the ROCKY MOUNTAIN CLIMATE Organization

NRDC
THE EARTH'S BEST DEFENSE

To read the full report on the impacts of global warming on national parks, visit www.nrdc.org/policy or www.rockymountainclimate.org

For more information, please contact:
Theo Spencer at NRDC
(212) 727-2700
Tom Easley at RMCO
(303) 861-6481

September 2009

summer's rainfall. In Glacier, a reduction in glacial runoff has dried up streams and scenic waterfalls and jeopardized the park's aquatic and riparian life. At particular risk are Glacier's native bull trout, a threatened species, which spawn in the fall and need strong late-season stream flows to get to their spawning grounds.

Another Wyoming park that could experience a loss of glaciers is Grand Teton National Park.

Snow-covered mountains are in many parks, where they contribute to some of the most spectacular scenery in the nation. But higher temperatures, less snowfall, and earlier snowmelt are already leading to less snow in parks. One study has documented that springtime snowpack levels have declined across most of the West between 1950 and 1997 as a result of higher winter temperatures. Another study attributed about half of the observed reduction in snowpack to the effects of human emissions of heat-trapping gases. Scientists project that springtime peak snowpack levels will continue dropping across the West. In the future, sadly, visitors to Glacier, Grand Teton, and Yellowstone will be less likely to see snow-capped mountains in summer.

Reduced snow likely will decrease opportunities for snow-dependent outdoor winter recreation in national parks. Yellowstone is the most popular national park for snow-dependent recreation. It is the only park in the lower 48 states whose interior roads are mostly closed in winter to conventional motor vehicles and instead groomed for travel by over-snow vehicles—snowcoaches and snowmobiles. There has been pitched controversy for more than a decade over whether and to what extent snowmobiles should be allowed in the park, or whether motorized access to the park's interior should be only by snowcoach. Continued, extensive public access to the park in winter can be provided through an expanded fleet of cleaner, quieter, and modern snowcoaches, which disturb wildlife less and so afford visitors more opportunities for viewing wildlife. The park also is open, and will remain so, to cross-country skiers, many of whom ski into the park's interior from the end of plowed roads, with others entering on snowcoaches before beginning to ski. What is not controversial, in any event, is that Yellowstone in winter is a special wonderland that offers unique enjoyment to all park visitors. That special experience, however, depends on the presence of adequate snow. Already, the National Park Service has sometimes had to delay the opening of the winter over-snow season, traditionally in mid-November, until the middle of December or even January. In the Yellowstone area so far, as across North America, winter temperatures have gone up more than in other seasons and the largest increases in winter have been in nighttime low temperatures, which are important for building and maintaining snow cover. Snow-dependent winter recreation in the park, in any form, is likely to be further constrained as winters continue getting warmer.

Opportunities for snow-based winter recreation are also likely to be reduced in Grand Teton and the adjacent John D. Rockefeller, Jr., Memorial Parkway, also in Wyoming, which offer cross-country skiing, snowshoeing, and some snowmobiling.

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.

National parks losing glaciers will also lose meltwater from the glaciers, which normally is a reliable source of water in late summer and often is important to ecosystems. Among parks suffering a loss of water as glaciers shrink could be Glacier, Grand Teton, and Yellowstone.

With less water in western rivers, there will be fewer opportunities for boating, rafting, and kayaking, including in Grand Teton.

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 Montana, Idaho, Wyoming, and elsewhere are at risk, as the forecast is for more downpours everywhere. An extreme downpour in Mount Rainier National Park in 2006 illustrates the risk—it caused so much flooding that the entire park was closed for a full six months.

Loss of plant communities

An altered climate can lead to fundamental changes in the natural plant communities of parks, including a disruption of mountain forests, tundra, meadows, and wildflowers.

A recent U.S. government report and the Intergovernmental Panel on Climate Change point out that rising temperatures increase outbreaks of insects in forests. One such large outbreak, by mountain pine beetles, is killing most large lodgepole pines in Rocky Mountain National Park, as it is across Colorado and southern and western Wyoming. Mountain pine beetles are unusual parasites in that they kill their hosts—in this outbreak, primarily mature lodgepole pines. When conditions are right, large outbreaks can occur, killing most large trees in a forest. Much of today's western lodgepole is vulnerable to such outbreaks, in part because widespread fires and logging in the 19th Century and human fire suppression since then have increased the proportion of mature trees that beetles favor. The changing climate is also making it possible for bark beetles to spread faster and higher. Hotter and drier conditions have stressed trees, making them more vulnerable to beetle attacks. Longer, hotter summers have extended reproductive and growth periods, while fewer cold snaps and higher winter temperatures have permitted increased bark beetle survival in winter, spring, and fall, and infestation of higher elevations. As the report from a recent scientific symposium put it, "Mature forests are the loaded gun for severe bark beetle infestations, and weather is the trigger." One key way in which the current bark-beetle epidemics in the West differs from previous ones is that the beetles now are able to proliferate in high-elevation forests that used to be too cold to sustain epidemic-level populations. In national forests near Yellowstone in the 1970s, most bark beetles at 8,000 to 9,000 feet in elevation apparently took three years to complete a generation. With warmer temperatures, though, by 2006, most apparently were doing so in a single year. In the Yellowstone region, the unprecedented spread of mountain pine beetles to high elevations is disrupting the ecosystem in a unique way—ultimately threatening the park's grizzly bears.

Ultimately, though, the forests themselves are not being lost. Post-outbreak forests will recover much as Yellowstone National Park's forests are recovering after large fires in 1988. In Rocky Mountain National Park, researchers from Colorado State University have confirmed that even in areas of heavy beetle infestation, all lodgepole pines under four inches in diameter and some mature ones have survived. The smaller, younger trees now are likely to grow more rapidly without competition from mature trees. Other tree species may move into what have been nearly single-species forests, creating different types of mixed forests. Still, to the extent that the current bark-beetle epidemic has spread higher, and perhaps faster and wider than previous outbreaks, it illustrates how ecosystems can be changed, on a landscape-wide scale, when one natural force (the beetle) is no longer held in natural check by another (cold weather).

Another development in western forests recently linked to a changed climate is a rapid dieback of aspen trees that scientists have labeled "sudden aspen decline," which could put at risk the scenic

aspen groves of Glacier, Grand Teton, and Yellowstone. Beginning in 2004, people noticed that aspen trees in Colorado were dying in large numbers and that the dead trees were not regenerating as usual through new trees growing from the roots of the old. This aspen dieback has increased rapidly, with the affected acreage in Colorado having increased four-fold between 2006 and 2008. Research by the U.S. Forest Service has identified the hotter and drier conditions that represent an altered climate in the interior West as likely causes of the sudden aspen decline.

A particularly ominous finding is from a team of scientists who recently found in undisturbed western forests that trees of all types and ages are dying faster than they used to. The increase in "background" tree mortality—not caused by fires, insects, wind, or any other obvious agent of forest change—was documented through examinations of census records of all individual trees in 76 undisturbed forest stands with counts of all living trees as far back as 1955. In studied forests, eighty-seven percent of the plots had experienced an increase in the rate of tree deaths; in interior West forests, like those of Glacier, Grand Teton, and Yellowstone, the dieback rate doubled in 29 years. The researchers suggested that higher temperatures and drier conditions—manifestations of a changed climate—may be the reasons for the accelerated tree deaths.

Alpine tundra—a mountain ecosystem that is treeless because conditions are too harsh for tree growth—may be especially vulnerable to a warming climate. Temperature increases have been greater atop mountains that at lower elevations. As mountaintop temperatures warm, plants adapted for survival there may not be able to tolerate the changed conditions and may have no nearby higher, cooler environments in which to disperse. At the same time, forests may move upslope and overtake the tundra as mountaintop conditions become less harsh and trees have a chance to survive there. Observations in Glacier have detected what could be the first signs of changing plant communities above and at mountain treelines. In one study, scientists recorded 31 percent to 65 percent declines in abundance of seven tundra plants from 1989 through 2002. In a second, repeat photography has documented that trees just below timberline have begun to grow more upright and have filled in gaps in forest edges at timberline.

Mountain meadows exist where the combination of heavy snow cover in the winter and a short growing season in the summer makes it impossible for tree seedlings to survive. Global warming is likely to reduce snow cover and extend the growing season, shrinking alpine meadows. Scientists have already detected that a loss of mountain meadows is underway in Glacier.

In work that suggests what could happen in national parks in mountains across the West, researchers at the Rocky Mountain Biological Laboratory near Crested Butte, Colorado—the official wildflower capital of the state—have documented how higher temperatures suppress the growth of mountain wildflowers. Using electric heaters to raise summer temperatures of test plots by 4ºF for more than a decade, they have observed a reduction in wildflowers and their replacement by sagebrush, normally found in lower-elevation, dryer areas. Another study shows that, paradoxically, earlier snowmelt—a result of warmer winters—actually leads to more wildflowers being lost to frost. With earlier snowmelt, the growing season starts earlier and flower buds open sooner, leaving them exposed to mid-spring frosts. From 1999 through 2006, the percentage of wildflower buds lost to frost doubled, compared to the previous seven years.

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.

In the Yellowstone ecosystem, including Yellowstone and Grand Teton, the fate of grizzly bear populations could depend on that of a much smaller creature—mountain pine beetles—which are infesting and threatening to eliminate high-altitude whitebark pines and their nuts, the most important food source for grizzly bears in this region.

* * *

YELLOWSTONE CASE STUDY:
Global Warming, Bark Beetles, Whitebark Pine, and Grizzly Bears

By Dr. Jesse A. Logan, contributing author to *National Parks In Peril*

I consider the large-scale bark beetle mortality occurring in lodgepole pine forests across the West interesting and unusual-- but I have no doubt that lodgepole forests will remain on the landscape for generations. The current mortality in whitebark pines, though, breaks my heart. We are witnessing the catastrophic collapse of high mountain ecosystems as a result of human-caused climate change, and grizzly bears could pay the price.

The grizzly bear is the most emblematic symbol of America's remaining wildlands. Unfortunately, in one of its last strongholds, the greater Yellowstone ecosystem, its very existence is in peril. The most challenging of its many threats there is a loss of critical food resources. Most important in the grizzly diet are the large and nutrient-rich seeds of whitebark pine, as the bears depend on them in the fall to prepare for hibernation. Nutritionally stressed bears in years with poor whitebark nut supplies have a lowered over-winter survival rate, and, more importantly, lower cub birth rates as embryos will be reabsorbed if pregnant females lack sufficient fat entering hibernation. Without enough whitebark pine nuts, grizzly bears are also more likely to get into human conflicts as they search for other foods.

In recent years, a new threat has erupted to this critical element in the grizzly diet: the expansion into high-elevation forests of a small, native bark beetle in response to a warming climate.

The mountain pine beetle is a native insect that has co-evolved with some pine forests. Trees killed by the beetles (and fire) open up the forests to new growth; otherwise, some types of trees, especially lodgepole pine, would be replaced by shade-tolerant spruce and fir. But whitebark pines are different from lodgepoles. Whitebarks live for centuries, not decades, and are restricted to high elevations (with one of their adaptations being their large, highly nutritious seeds). Whitebark pines do not depend on catastrophic forest disturbances to survive; instead, they are threatened by them. One hypothesized reason for the restriction of whitebark pines to high elevations is that they are poorly defended against the insect pests and pathogens of lower elevations. Mountain pine beetles have not before been a major threat to whitebark pine survival; their defense has been the high-elevation climate, historically too cold for long-term survival of large beetle populations.

Unfortunately, things have dramatically changed in response to climate warming since the mid 1970s. Computer simulations had predicted mountain pine beetle outbreaks into high-elevation systems, but even the modelers were surprised by how quickly and how far beetles have now spread into whitebark pines. Significant mortality is occurring across the entire American distribution of whitebark pine, with no sign of it diminishing. When added to another stress—from a pathogen, white pine blister rust—the spread of bark beetles into higher elevations puts in question the continued existence of these ecosystems and of Yellowstone's grizzly bears.

Given the likelihood of continued warming, what, if anything can be done to protect whitebark pines and the grizzlies that depend on them? First, we need to better understand mountain pine beetle infestations of whitebark pine, which differ from the host/insect interactions of other pine species.

Understanding the unique aspects of mountain pine beetle in whitebark pines may let us tip the scale to favor the host. Second, we need better tools to evaluate the extent of mortality. Whitebark pine habitats are in the most remote and wild places (often designated wilderness areas) in the Rocky Mountains, where mortality goes almost undetected. Advanced technology, such as satellite imagery combined with traditional aerial photography and ground surveying, is needed. Third, management tools (e.g., pheromone strategies) need to be fine-tuned for high-elevation environments. All of these approaches need to be integrated across large, remote, and inhospitable landscapes.
Dr. Logan, an entomologist, retired in 2006 from the U.S. Forest Service.

* * *

Glacier and several parks in Alaska are home to the Canada lynx, a threatened species in the contiguous United States under the Endangered Species Act. One team of researchers has documented that most areas where lynx now occur have four months of snow cover and average January temperatures under 17°F. Just a 4° to 7°F increase in average annual temperatures could reduce the overlap of those two climatic conditions and the types of forests where the cats live to eliminate about half of the suitable habitat in the contiguous United States. Across all of North America, about 10 percent of lynx habitat could be eliminated.

At Rocky Mountain National Park, the National Park Service has expressed concern that the park's bighorn sheep population could decline over time due to loss of open alpine habitat as forests move upslope. Other parks where forests could encroach on bighorn sheep habitat include Glacier, Grand Teton, and Yellowstone.

Pikas, which look like hamsters but are more closely related to rabbits, are mountaintop residents unusually sensitive to high temperatures, making them candidates as "early sentinels" to a changed climate. Researchers recently surveying 25 sites in the Great Basin (between the Rocky Mountains and the Sierra Nevada) known to have previously had pika populations failed to find any pikas in nine sites—primarily those at lower, hotter elevations. The risks to pikas could be greater in the lower-elevation areas where they occur, including Craters of the Moon National Monument and Preserve (in Idaho). As the climate continues getting hotter, this raises concerns for the future of the species at higher elevations parks, also, such as Glacier, Grand Teton, and Yellowstone. The U.S. Fish and Wildlife Service is now considering whether the species qualifies for protection under the Endangered Species Act because of the threats of climate change.

Researchers from Yale University studied the possible effects of climate change on mammals in eight national parks, including Glacier and Yellowstone. They projected that a doubling of atmospheric levels of heat-trapping gases could change habitat in the parks enough to eliminate some species. They also projected that many new species (as many as 19 new species in Yellowstone and 45 in Glacier) might move into these parks as habitats change and became suitable to them. 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.

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 Rocky Mountains 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. Affected parks could include Glacier, Grand Teton, and Yellowstone. About 90 percent of bull trout, which live in Montana rivers in some of the country's most wild places, are projected to be lost due to warming. At Glacier, fishing for bull trout is banned due to their fragile status.

More Overcrowding

As temperatures soar with a changed climate, to escape oppressive heat enough people may flock to cooler northern and mountain parks to overcrowd them. In nearby Rocky Mountain National Park, a survey of park visitors suggests that under the climate conditions projected by as soon as 2020 enough people could come more often and stay longer to increase the number of visitor days by more than one million a year—nearly a one-third increase. Such overcrowding could also be a significant problem at Yellowstone and Grand Teton.

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. At Yellowstone, the extreme heat of July 2007 led the National Park Service to close 232 miles of rivers to mid-day fishing. In Yellowstone's Firehole River, temperatures topped 80°F for several days and as many as a thousand trout died in the largest documented fish kill in the park's 135 year history. In the future, if populations of other trout species decline as precipitously as scientists project, anglers might face more restrictions on trout fishing at Glacier, Grand Teton, Yellowstone, and Bighorn National Recreation Area.

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.