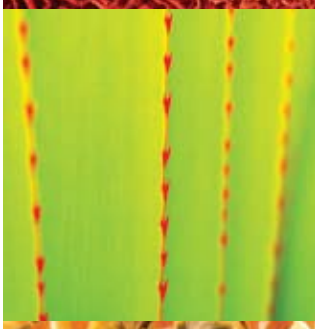
Erratum to Case Study: Desert Arid

Under “For More Information”

Fourth bullet, correct URL is: http://globalchange.gov/publications/reports

ECOREGION: DESERT ARID



In 1849, a group of pioneers seeking the fabled western gold mines became lost in a dry and hot desert valley on the border between Nevada and California. Although only one of them died before they were rescued, this desert area of exceptional heat has been known since as "Death Valley."[1] Death Valley is part of the dry mountainous Southwest ecoregion, which includes the Mojave, Sonoran, Great Basin, and Chihuahuan deserts, as well as the Colorado River and Rio Grande basins and the surrounding mountain ranges. These arid lands of the United States lay nestled between the mountain ranges of the Southwest, in part because the high mountain peaks tend to block moisture from both the Pacific and the Gulf of Mexico.[2]

Many different habitats exist throughout this mountainous desert region, including arid places nearly devoid of vegetation; cold **steppe** lands with low-lying shrubs; dry grasslands; savannas with short, thorny trees; and alpine woodlands.[3] Mountain peaks tend to experience more rainfall, leading to isolated alpine meadows and moist forest habitats surrounded by low-lying deserts.[4] The arid Southwest experiences extreme temperature fluctuations, intense winds, seasonal precipitation, and wildfires.

Despite the lack of water, many areas of the arid Southwest ecoregion are home to an extraordinary variety of species. Some plant species avoid the heat and lack of water by remaining in seed form during the driest parts of the year. Then, when the rainy season arrives, the plants quickly burst into full bloom before producing seeds that remain dormant until the next rainfall.[5] Other plants, such as cacti, survive the whole year by storing great quantities of water during the rainy season, which they gradually deplete during the dry season.[6] Animals also exhibit unusual adaptations in order to survive the high temperatures and lack of water. Snakes, bats, and rodents hide in cool underground areas during the day and only come out at night in order to escape the heat.[7] Other animals dissipate the heat with adaptive mechanisms. For example, jackrabbits have large ears that help radiate heat away from their bodies while turkey and black vultures urinate on themselves to cool down.[8]

IMPACTS OF CLIMATE CHANGE

Climate models predict that the average temperatures in the Southwest could rise by 7 to 12°F (3.9 – 6.7 °C) by 2090.[9] The higher temperatures will create water stress by increasing evaporation rates, and may also cause migrations of species already living near their heat tolerance range. For example, tree species living on mountain slopes are expected to migrate up in elevation, by approximately 350 feet per degree Fahrenheit.[10] Species such as the bristlecone pine will be trapped on mountain tops and will not be able to migrate away from the rising temperatures.[11]

It is less certain how precipitation will change, but it is likely that climate change will increase stress on arid region water systems.[12] Arid regions are dependent on snowmelt from the mountains, which feeds large rivers such as the Colorado and also causes temporary streams to flow through the desert. Climate change is projected to cause decreases in **snow pack**, less snowfall, and earlier snowmelt, all of which may contribute to declining water availability in the Southwest. In fact, scientists have already documented earlier snowmelt as well as smaller snowpacks in some areas. Decreases in river and stream flow through arid regions will put extreme pressure on plants and animals that depend on these sources of water.

Since arid ecosystems have adapted to existing patterns of water availability, they are likely to be profoundly affected by any decrease or change in precipitation. For example, warmer and drier conditions may cause deserts to replace grasslands. Loss of these rangelands would be coupled with regional declines in biodiversity, especially grassland birds.[13] In addition, droughts increase the fire potential in grasslands and woodlands, especially when dry periods follow wet winters.

SPOTLIGHT ON A SPECIES

The Devil's Hole pupfish, *Cyprinidon diabolis*, live in the arid Southwest ecoregion and may be affected by climate change. The story of this fish provides a glimpse into how an often overlooked aspect of ecosystems, underground water sources, will be affected by climate change.

Devil's Hole is a limestone cavern with an opening approximately 60 feet long and 10 feet wide in Death Valley National Park in Nevada.[14,15] Due to the canyon's formation over many years, it is connected to an extensive network of underground corridors and filled by underground water tables. No one knows for sure exactly how the pupfish arrived in this cavern, but the fish is thought to have inhabited this cave for tens of thousands of years.[16]

The water filling Devil's Hole stays at a high temperature of about 92 °F (33 °C) and has a low oxygen content.[17] Thus, pupfish inhabit this cavern near the upper limit of their temperature tolerance and the lower limit of their oxygen tolerance, which are both important factors for the pupfish's reproduction. Scientists have learned that another crucial element for the pupfish's survival is the presence of shallow water.

Much of the pupfish's food and its areas for spawning are located in shallow water. Through increasing temperatures and decreasing the water table, climate change may threaten the small pupfish population's ability to survive. A warmer climate may push the temperature range above the point at which pupfish eggs can survive. In addition, higher temperatures and less precipitation may lower the water table. While the water table has been decreasing slowly for thousands of years, climate change may accelerate this process. This lowering of the water level may shrink the shallow areas in which the pupfish spawn dry and decrease their chances of survival.[18]

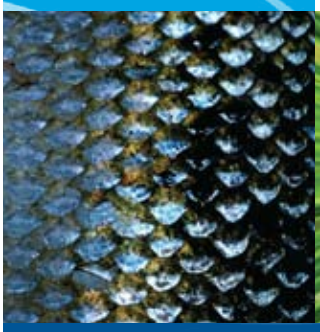
PROFILING A CLIMATE STEWARD

Every spring, thousands of people flock to the deserts of the southwestern United States to observe the beautiful blooming of desert plants. The blooming season usually occurs from March until June, with the peak time depending upon many variables such as that year's temperature, rainfall, and/or snowfall. Significant changes in climate will affect the blooming and leafing of plants in all ecosystems, especially the desert.

Desert ecosystems are particularly vulnerable to climate change. Warmer temperatures and decreased rainfall can adversely affect these fragile ecosystems that are often biodiversity "hotspots," home to many rare plants and animals. Unfortunately, current climate models predict that in the coming decades, the deserts of the American Southwest will become drier.[19] In order to detect and monitor the impacts of climate change on desert ecosystems, climate scientists require continuously gathered data on changes in flora and fauna.

The study of phenology, literally "the science of appearance," is an effective way to make climate change real to students, teachers, and the public. Plants provide an easily accessible context for observing environmental change. In Project BudBurst (www.budburst.org), a national field campaign studying the impacts of the changing climate on plant phenology, students and other volunteers make important phenological observations, including the dates of first leaf / budburst, first flower, last flower, and seed dispersal.

BudBurst/First Leaf reports during 2008 Project BudBurst




These observations are reported to a national database helping scientists track changes in the timing of these events and leading to a better understanding of how the environment is and will react to the changing climate.

Participation in Project BudBurst is simple and requires no special materials or instrumentation. Students can observe plant species in their own backyards or schoolyards, making it especially suitable for urban students and those who do not have ready access to natural areas, nature preserves, and other natural settings. The Project BudBurst Web site (www.budburst.org) has all the information needed to participate. Scientists in the USA National Phenology Network (USA NPN) are interested in data collected by Project BudBurst participants.

If you join Project BudBurst, you will contribute to an ongoing scientific research project that studies the effects of climate change on the lifecycle of plants—including those in desert ecosystems.

FOR MORE INFORMATION

- The U.S. Environmental Protection Agency's climate change site includes detailed information on climate change, impacts, and actions. www.epa.gov/climatechange/
- The Southwest Regional Assessment for the U.S. Global Change Research Program was supported by the National Oceanic and Atmospheric Administration and the U.S. Geological Survey. http://www.ispe.arizona.edu/research/swassess/index.html
- The U.S. Global Change Research Program and U.S. Geological Survey conducted a Web workshop in 1997 on the impacts of climate change and land use in the Southwest. http://geochange.er.usgs.gov/sw/impacts/biology/rmnp/
- The Intergovernmental Panel on Climate Change (IPCC) is the definitive source of unbiased climate change science. www.ipcc-wg2.org/index.html
- Robert Merideth, Diana Liverman, Roger Bales, and Mark Patterson. 1998. *Climate Variability and Change in the Southwest*: Final Report of the Southwest Regional Climate Change Symposium and Workshop sponsored by the U.S. Department of the Interior and the U.S. Global Change Research Program. Tucson, AZ: The University of Arizona.
- Robert Merideth. 2001. *A Primer on Climate Variability and Change in the Southwest*. Tucson, AZ: University of Arizona's Udall Center for Studies in Public Policy and Institute for the Study of Planet Earth. Sponsored by the National Park Service.

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Blooming Saguaro Catcus (Page 3): Photograph by Mrs. W.D. Bransford, Lady Bird Johnson Wildflower Center