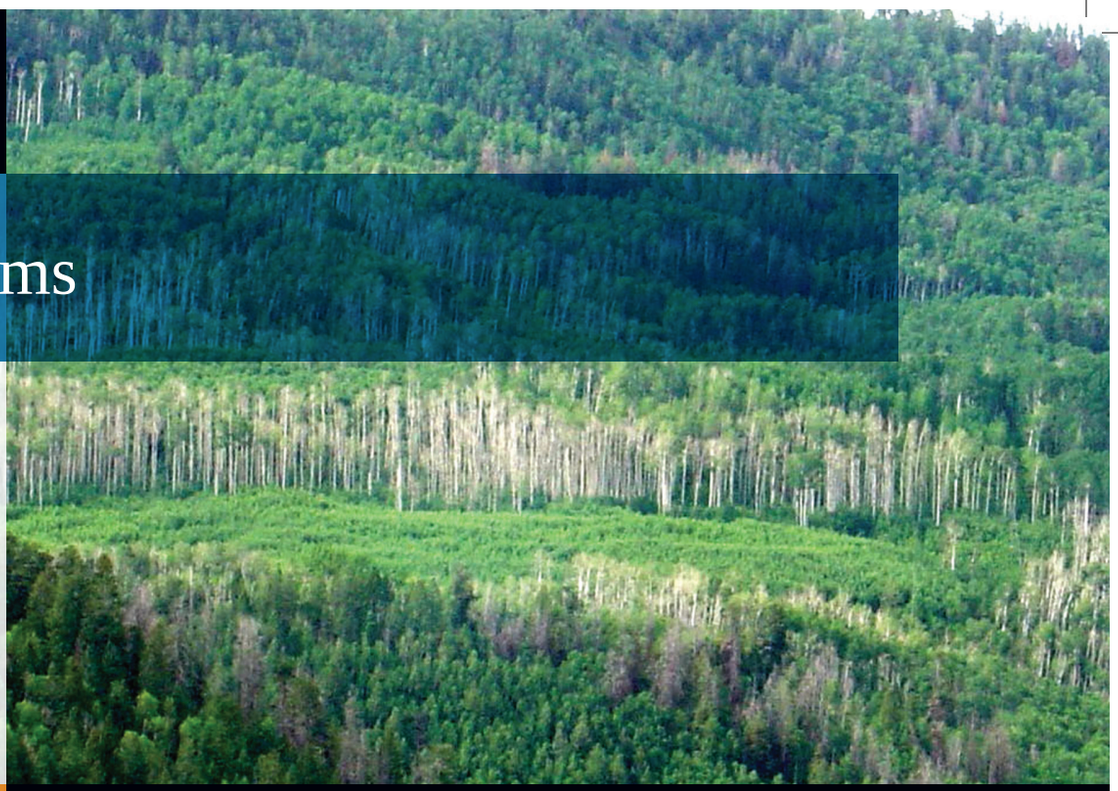
IMPACT

Natural Ecosystems

"Recent environmental changes have led to both earlier and later timing of . . . phenological events and have exceeded the ability of some species to adapt to such changes."



Mountain pine beetles have killed thousands of pine trees in the Southwest.

Key Messages

1

Observed changes in climate are strongly associated with some changes in geographic distributions of species that have been observed since the 1970s.

2

Observed changes in climate are strongly associated with some observed changes in the timing of seasonal events in the life cycles of species.

3

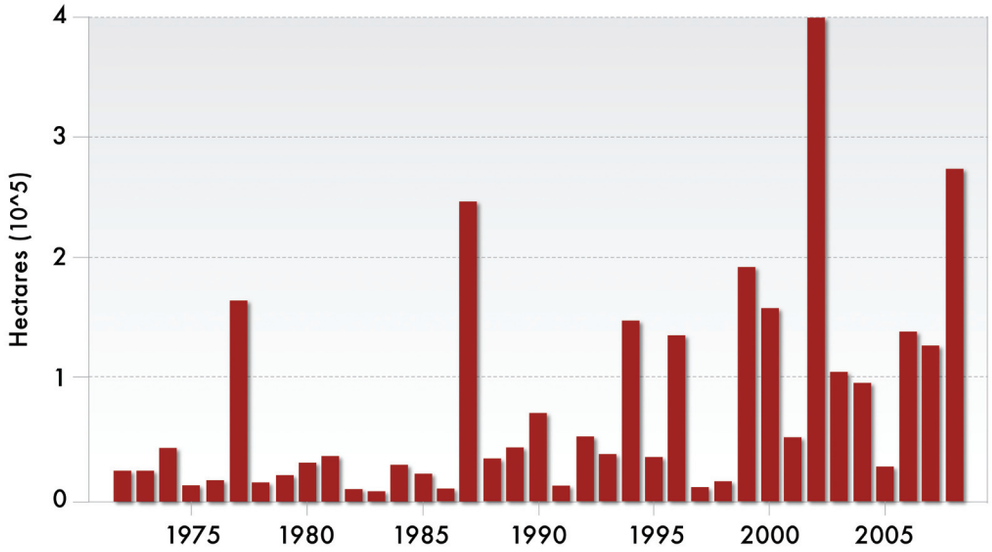
Some disturbance processes that result in mortality or decreases in the viability of native plants are strongly associated with observed changes in climate. Among those disturbances are wildfires and outbreaks of forest pests and pathogens.

The eighth chapter of the *Assessment of Climate Change in the Southwest United States* addresses the observed changes in climate that are strongly associated with observed changes in geographic distributions and recurring phenomena of biological species such as timing of blossoms or migrations of birds in southwestern ecosystems. "Natural Ecosystems" also examines disturbances such as wildfires and outbreaks of forest pathogens and discusses issues associated with how carbon is stored and released in southwestern ecosystems, in relation to climate-change threats.

For more information about *Assessment of Climate Change in the Southwest United States*, see: www.swcarr.arizona.edu, www.cakex.org, www.islandpress.org/NCAreports.
This fact sheet developed by Institute of the Environment, University of Arizona.

Phenology

Variability in weather, climate, and hydrology largely drive phenology, the timing of seasonal events in the life cycle of plants and animals. The differences in phenological changes in response to a changing climate may reduce abundance, population growth rate, and local persistence of individual species. Recent environmental changes have led to both earlier and later timing of phenological events and have exceeded the ability of some species to adapt to such changes. In the Southwest, changes in the phenology of bird species corresponding to climate change include earlier egg-laying by Mexican jays, earlier appearance of American robins, and earlier arrival of migratory birds to their breeding range.



Area of large wildfires (greater than 1,000 acres) that burned lands dominated by forest and woodland and managed by the US Bureau of Indian Affairs, US National Park Service, and US Forest Service in Arizona, California, Nevada, New Mexico, and Utah. Area is shown in 100,000-hectare (247,105-acre) increments on the left axis.

Non-native species

Responses to climate change will vary by species. However, if changes in climate increase the probability of non-native plant invasion, then their generally high reproductive capacity and dispersal rates, rapid growth, and ability to adapt to short-term environmental variability may increase the probability that they will become established and persist, in some cases quite rapidly. Increases in CO_2 may increase the biomass of annual non-native grasses and generally benefit invasive plants more than native plants. The Southwest currently has a pronounced cycle of fire in regions dominated by invasive non-native grasses, and climate change is likely to increase the number and intensity of such fires.

The amount of habitat for a native cutthroat trout is projected to decrease by as much as 58 percent in response to increases in temperature and competition with other species.

Forests

Geographically widespread and rapid increases in rates of mortality of coniferous trees have been documented in old forests throughout the West. Annual mortality has at least doubled since 1995. Mortality rates of all major genera of trees have increased, suggesting that non-climatic factors, such as species type, life history traits, and forest stand density are unlikely to be the primary cause of the mortality.

Scientists estimate that since 1980, levels of southwestern tree mortality have been higher and more spatially extensive than during the ninety-year record. At a number of sites across the Southwest, rapid and nearly complete mortality of pinyon pine was attributed to drought accompanied by unusually high temperatures from 2000 to 2003. Most of the mortality occurred in response to outbreaks of bark beetles, which have been correlated with shifts in temperature and precipitation. Higher temperatures lead to water stress and can greatly increase the probability that pinyon pine will die in response to bark beetles. Bark beetle populations are expected to increase as temperature and the incidence of drought increases, albeit with considerable variability over time and geographic area.

Fire

The area of forest and woodland burned in the West by wildfires that were actively suppressed was more than five times larger during the period 1987–2003 than during 1970–1986, and was associated with increases in temperature and earlier spring snowmelt. Forests and woodlands in the six southwestern states accounted for a third of the increase in fires that exceeded 494 acres in the western United States. The area burned in the Southwest increased more than 300 percent relative to the area burned during the 1970s and early 1980s.

If fuels are available, the area of forest burned may increase substantially as temperature and evapotranspiration increase. The National Research Council projected that if temperature increases by 1.8°F, there will be a 312 percent increase in area burned in the Sierra Nevada, southern Cascades, and Coast Ranges of California; a 380 percent increase in the mountains of Arizona and New Mexico; a 470 percent increase on the Colorado Plateau; and a 656 percent increase in the southern Rocky Mountains.

Information from: Fleishman, E., J. Belnap, N. Cobb, C. A. F. Enquist, K. Ford, G. MacDonald, M. Pellant, T. Schoennagel, L. M. Schmit, M. Schwartz, S. van Drunick, A. L. Westerling, A. Keyser, and R. Lucas. 2013. "Natural Ecosystems." In *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*, edited by G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy, 148–167. A report by the Southwest Climate Alliance. Washington, DC: Island Press.