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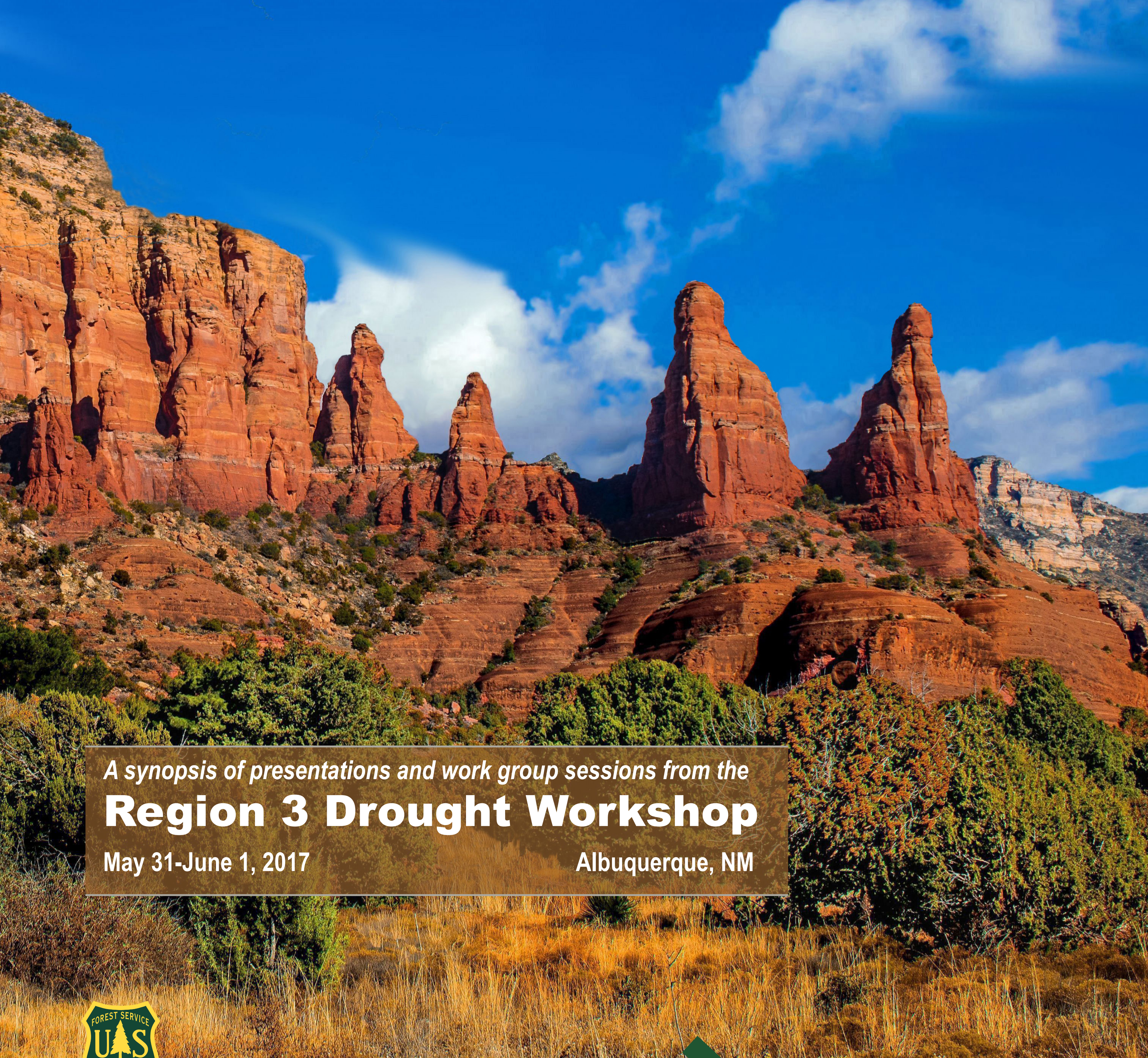
Drought Impacts in the Southwestern Region



A synopsis of presentations and work group sessions from the

Region 3 Drought Workshop

May 31-June 1, 2017 **Albuquerque, NM**

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Office of Sustainability and Climate

USDA Southwest Climate Hub
U.S. DEPARTMENT OF AGRICULTURE

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in the Southwestern Region

Background

The National Drought Resilience Partnership is an effort to promote stronger drought resilience on federal lands. As a part of this effort, the U.S. Forest Service conducted a series of focused workshops across the country to understand the management opportunities and constraints imposed by drought conditions, as well as the challenges of floods and changing precipitation patterns on forest and rangeland resources.

In June 2017, the Forest Service hosted a two-day drought adaptation workshop in the Southwestern Region in Albuquerque, New Mexico. Workshop participants came from the Regional Office, Washington Office, Southwestern Region national forests, universities, and key water resource agencies.

Topics covered in the workshop included an overview of drought conditions and climate trends in the Southwest, and the impacts of drought on forest and rangeland ecosystems, recreation, aquatic ecosystems, and external infrastructure. This fact sheet summarizes presentations and work group recommendations, and provides additional research as supporting documentation.

Drought in the Southwestern Region

Drought is a normal phenomenon in the Southwestern Region (Arizona and New Mexico). During the last century and beginning of this century, large and notable droughts occurred in the early 1900s, throughout the 1950s, and early 2000s (Weiss et al. 2009). The multi-decadal droughts of the 1100s were the worst drought period in the paleo records, and the late 16th century drought was the most severe drought over the past 500 years (Cook et al. 2004, Meko et al. 1995).

Temperatures in the Southwestern Region are predicted to increase significantly in the 21st century, including a mean annual temperature increase of 5 to 8 degrees Fahrenheit (Coe et al. 2012). The Southwest is expected to see increases in summer temperatures, become drier, and experience more aridity during La Niña conditions (Dominguez et al. 2010). Nationally, increases in summer temperatures are projected to be the greatest in the Southwest (Coe et al. 2012).

Types of drought include:

- ***Meteorological*** **– degree of dryness in weather over a defined period of time;**
- ***Agricultural*** **– links meteorological drought with agricultural impacts;**
- ***Hydrological*** **– precipitation deficits, with emphasis on effects on the hydrological system (e.g., water storage and flux); and**
- ***Socio-economic*** **– demand for economic goods exceeds supply as a result of weather/climate-related shortfall in water supply (Wilhite and Glantz 1985).**

In terms of forested and rangeland ecosystems, *ecological drought* is an episodic deficiency in water availability that drives ecosystems beyond thresholds of vulnerability, affects ecosystem services, and triggers feedbacks in natural and human systems (Crausbay et al. 2017).

There is increasing discussion of *snow drought,* defined as a lack of winter precipitation or a lack of snow accumulation during near-normal winter precipitation (Harpold et al. 2017).

Humans also contribute to or alleviate drought by modifying hydrological processes (e.g., through land use, irrigation, and dam building) (Van Loon et al. 2016).

Figure 1 - Cumulative drought severity index, calculated using weighted monthly frequencies of Palmer Drought Severity Index values, reported for the periods 1960–1986 and 1987–2013. This indicates the duration and intensity of the long term drought effects, based on historical precipitation and temperature, and shows that droughts in the region became more frequent and severe between these time periods. [Click here for more information and interactive maps.]

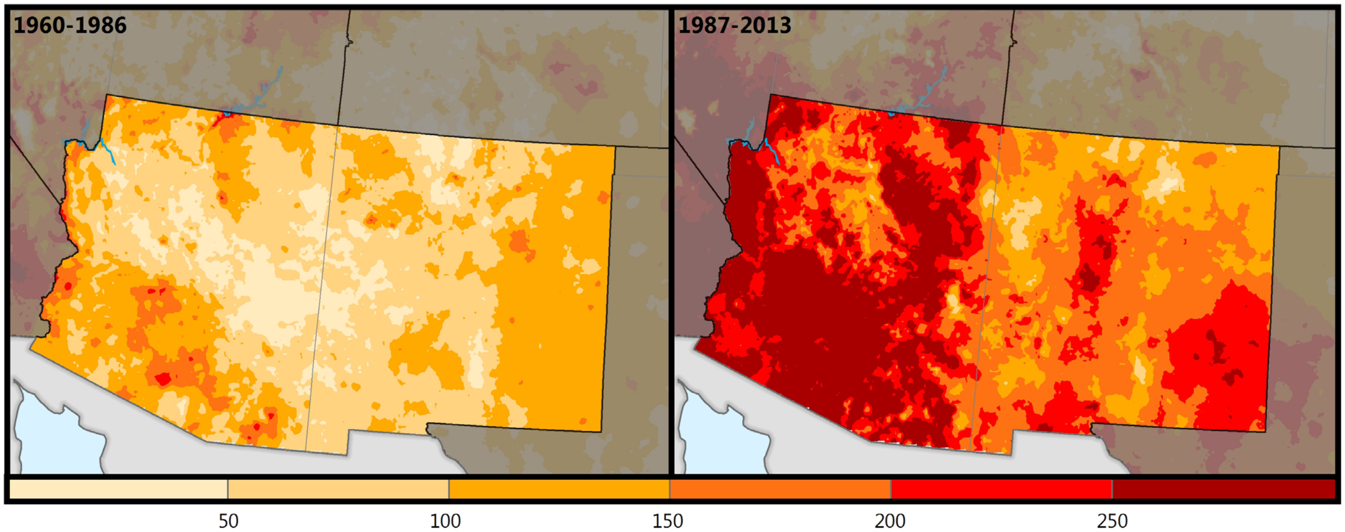
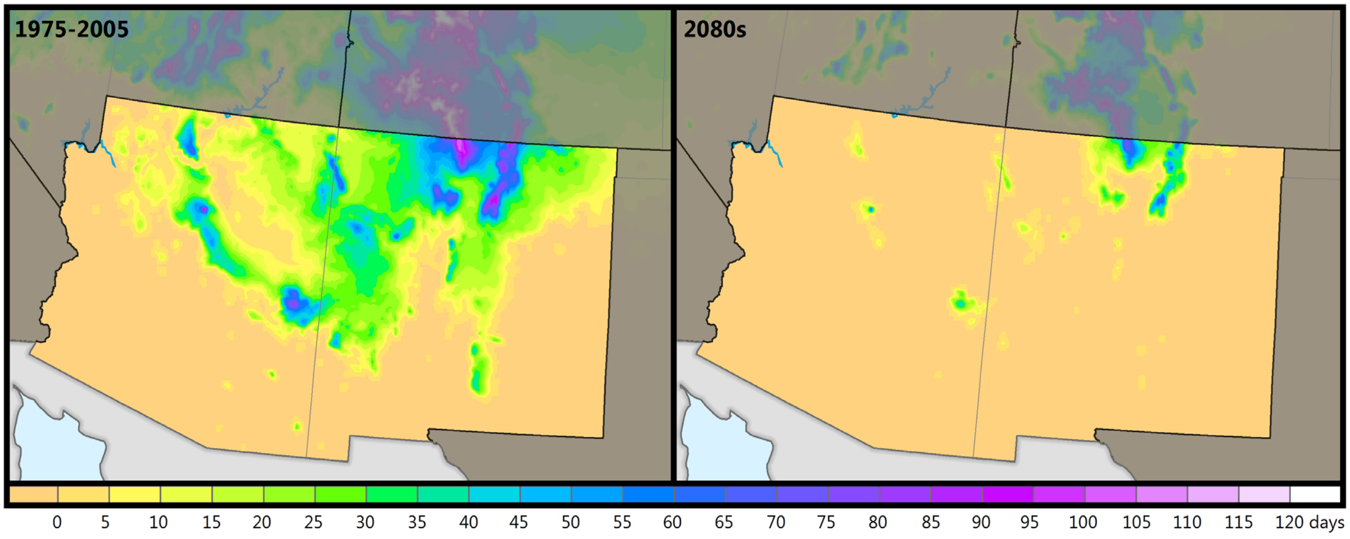


Figure 2 - Historical and projected snow residence times in days. The maps compare the average length of time that snow remains before melting (in days) between 1975 and 2005 versus a projected map of 2080. [Click here for more information and an interactive version].



Arizona and New Mexico have diverse precipitation sources with their own seasonality and large variations of precipitation across years (Weiss et al. 2009). The majority of precipitation falls in the summer and winter. The North American monsoon accounts for as much as 50 percent of the annual rainfall to this region between July and September (Sheppard et al. 2002). By the end of this century, Garfin et al. (2009) project a decrease in annual precipitation by 6 percent for the Southwest.

Warmer temperatures during the 2000s intensified drought conditions by increasing atmospheric demand for evapotranspiration (Weiss et al. 2009). Droughts are projected to become more severe under warmer temperatures, as soil moisture decreases with greater atmospheric demand for evaporation and transpiration (Gershunovet al. 2013) (see Figure 1).

Forest Ecosystems

For the Southwestern Region, drought is best understood as a combination of moisture deficit, temperature stress, and an added component of disturbance (Allen et al. 2010).

Cascading ecological effects of drought are seen in Southwestern forest ecosystems (D. Falk, n.d.) (Figure 3). The primary direct effects of drought include limited areas of tree mortality and potential range shifts of species as new locations become climatically favorable for regeneration. Altered disturbance regimes such as wildfire or insects are secondary effects of drought that can lead to rapid changes across large landscapes.

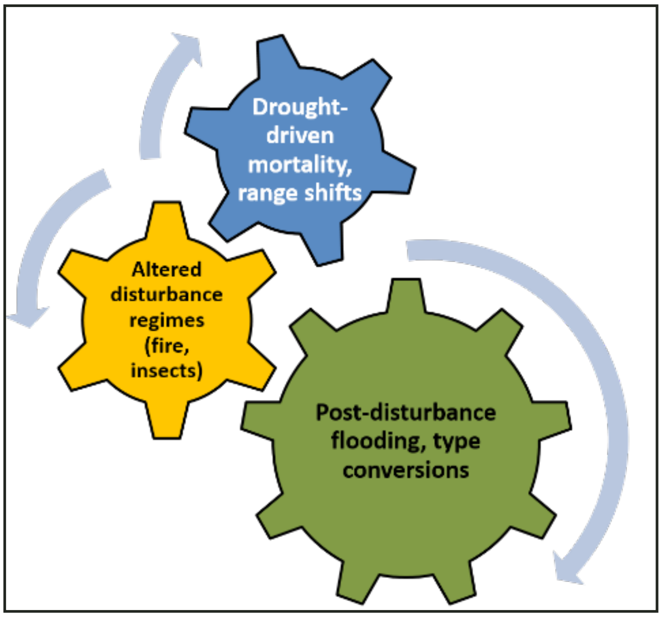
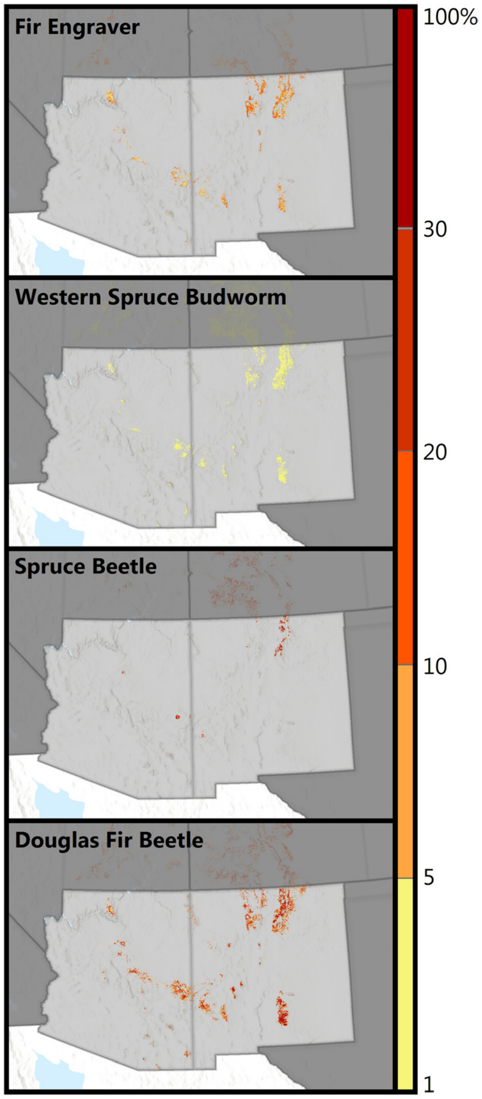


Figure 3 - Cascading ecological effects of drought (source: Don Falk)

Interactions between increased temperature and increased frequency, severity, and extent of disturbances have far reaching consequences (McKenzie et al. 2004). For example, large scale fires have accelerated vegetation change in some Southwestern pinyon-juniper woodlands, where trees are being replaced with shrub species and invasive species (Floyd et al. 2004).

Figure 4 - Insect and disease impacts in the Southwestern Region, 2000-2016.



Additional effects of drought include post-disturbance factors such as flooding and debris flows, or a transition from one biotic community to another. Increased wildfire in Southwestern forests can lead to altered water supply, seasonal stream flows, and flooding (Cannon et al. 2001). Post-fire debris flows and flooding can damage areas outside fire perimeters, with most of the economic damage and fatalities occurring post-wildfire (D. Falk, n.d.).

Forest Ecosystems—Management Response Options

- Use commercial and non-commercial thinning to reduce tree densities and maximize species diversity. Promote firewood cutting as a recreational experience to augment silvicultural thinning.
- Use prescribed fire to reduce surface fuels, small trees, and vulnerability to drought.
- Create a regional rapid response burn/strike/ vegetation management team by formalizing multi-agency cooperation and sharing resources and responsibilities.

Rangeland Ecosystems

Drought plays an important role in rangeland productivity in the Southwest, with economic implications for livestock grazing on rangeland vegetation. The Tonto National Forest experiences a drought year 16 percent of the time. During the 2003 to 2004 drought, the effects were so dire that the entire forest was unavailable for grazing, essentially putting the ranchers out of business.

Duration and intensity of water stress are key instigators of drought effects on rangeland ecosystems in the Southwest. As droughts increase in duration and severity, soil moisture reserves decrease (Kozlowski et al. 1997). Vegetative growth and reproduction are directly linked to soil moisture, with aboveground net primary productivity directly correlated to mean annual precipitation (Briggs and Knapp 1995).

Drought affects quantity and quality of wildlife habitat and livestock grazing because of the reduction of herbaceous vegetation during drought periods (Laurenroth and Sala 1992). Some species populations expand as vegetation cover and biomass decrease (e.g., black-tailed prairie dog), while other populations decline as tree and shrub regeneration decreases (Cincotta et al. 1988; Rumble and Gobeille 2001).

Rangeland Ecosystems—Management Response Options

» Maintain collaboration with private landowners and use conservation easements to avoid loss of open space if forage production on federal lands cannot support livestock grazing.

» Develop ***Coordinated Resource Management Plans*** with the USDA Natural Resources Conservation Service across all federal, state, and private lands.

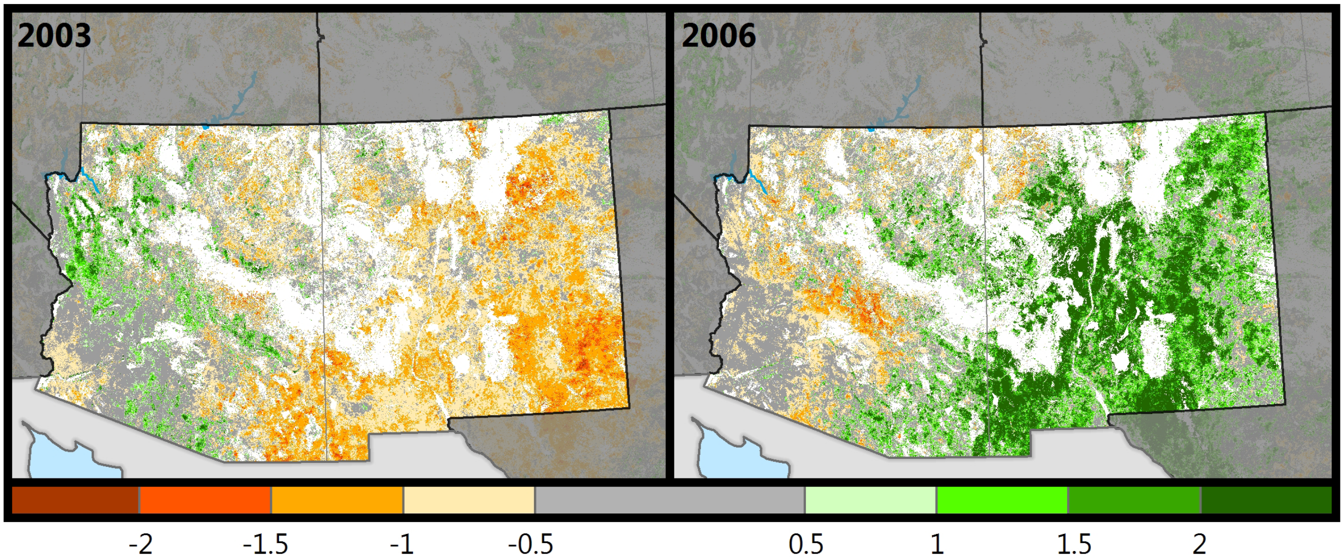
» Increase efforts to control invasive species through ***Integrated Pest Management***, and early detection and rapid response strategies.

» Educate the public and agency personnel about invasive weeds. Co-monitor and manage with permittees to encourage collaborative learning.

» Increase or maintain vegetative cover to be more resilient to drought by managing the amount, timing, and distribution of ungulate herbivory. Implement woody plant management to promote herbaceous groundcover.

» Plant drought resistant native plants and monitor precipitation to improve management of vegetative cover.

Figure 5 - Examples of low and high productivity years, expressed in standard deviations from the mean, based on 2000–2016 data. Total forage for Region 3 ranged from 38 to 55 million tons for 2003 and 2006, respectively. [Click here for more information and interactive maps]().



Aquatic Ecosystems

Increased drought frequency and warmer temperatures affect aquatic ecosystems, especially native fish species in Arizona and New Mexico. Increased groundwater and air temperatures, reduced stream flows, and slower water velocities result in increased stream temperatures (Vose et al. 2016). Native desert fish have lower thermal tolerance than nonnative fish, with the exception of the desert pupfish *(Cyprinodon macularius)* (Carveth et al. 2006).

For much of Arizona and New Mexico, fragmentation of fish habitat is expected to increase with drought because of water diversions and groundwater pumping. By mid-century, severe droughts in the Southwest are predicted to alter hydrologic connectivity and reduce stream connectivity for native fish by 6 to 9 percent each year, and up to 12 to 8 percent during spring spawning months (Jaeger et al. 2014).

Increased probability of wildfire and higher suspended sediments in streams can create indirect drought effects on aquatic species (Rinne 1996). Suspended sediments in streams following fires can be greater than 500,000 mg/L, a potentially lethal concentration for the Yaqui chub fry *(Gila purpurea)* which are susceptible to mortality at levels as low as 8,000 mg/L (Clark-Barkalow and Bonar 2015).

Aquatic Ecosystems—Management Response Options

» Monitor the effects of trees planted for shade on lowering stream temperature.

» Create refugia habitats (e.g., hatcheries and ponds) during fire or drought evacuations to hold high value species. Develop ***Fire-Drought Evacuation Plans*** for threatened and endangered species as needed, including quarantine areas to hold species.

» Prioritize native species restoration in habits that will persist through drought periods.

» Increase fish habitat connectivity by modifying infrastructure (e.g., aquatic organism passages).

» Reconnect floodplains and side channels, and maintain and restore functioning riparian corridors (e.g., by re-establishing riparian vegetation).

» Recharge groundwater by using restoration techniques for rewetting floodplains. Reintroduce American beavers to increase water storage.

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Recreation

Drought influences the behavioral response of the recreational user and their preferences. In Southwestern forests, higher temperatures may shift recreational visitation patterns because people's thermal tolerances affect their recreation decisions (Fisichelli et al. 2015).

There is a significant relationship between monthly temperatures and visitation numbers; when temperatures are above 88 to 90 degrees Fahrenheit, recreation visits decline (Fisichelli et al. 2015). Visitation will likely increase in managed forest areas with higher elevation recreation sites because these sites will warm less rapidly than lower elevation areas (J. Smith, n.d.).

Drought in the Southwest indirectly affects recreation behavior (e.g., fishing) by affecting the characteristics of recreation settings. For example, specific fish species that have evolved to adapt to seasonal drought in the Southwest, but cannot recover from supra-seasonal droughts, could be extirpated from some streams (Lake 2003). Despite changing fisheries conditions, most recreationists will alter the location and timing of angling before substituting another type of recreation activity (Daugherty et al. 2011).

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Recreation—Management Response Options

» Include Forest Service decision makers in a social dialogue on planning for drought. Train decision makers to embrace creative opportunities and to have more conversations with citizen groups.

» Develop an awareness and educational campaign to encourage young people to recreate in water and further value it as a resource.

» Grow an understanding of the cultural uniqueness, heritage, and traditions of unique place-based recreation among decision makers.

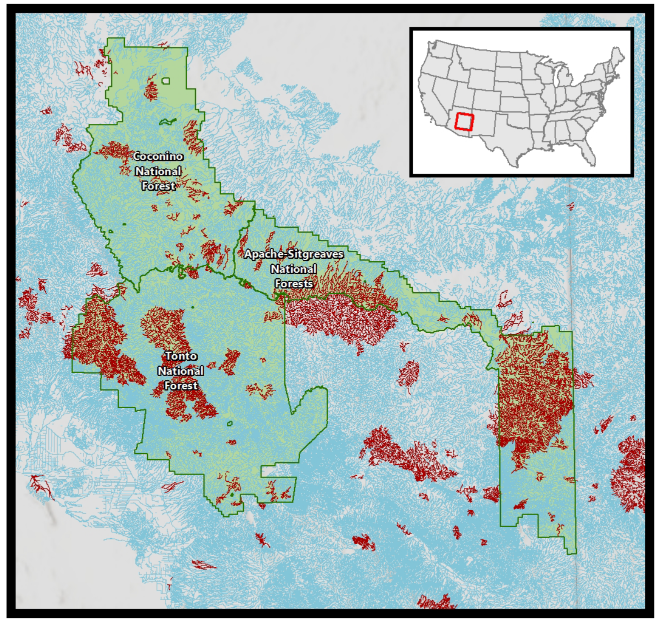
» Hire people who see their job as building community in order to manage for cultural diversity and collaboration.

External Infrastructure

In the Southwestern Region, wildfire and post-fire flooding and debris flows alter water chemistry and transport sediment downstream (Goode et al. 2012), thus degrading water quality and reducing dam storage capacity. Erosion of dams in Arizona has accelerated recently due to more acidic water chemistry.

Many organizations in the Southwest are working together to reduce the threat of severe wildfire in and around watersheds that drain into dams and reservoirs through forest restoration activities.

Figure 6 - Streams impacted by wildfire near Mogollon Rim, 2000-2015.

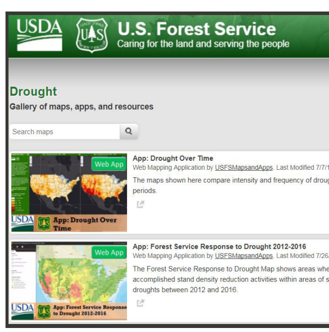


External Infrastructure—Management Response Options

» Accelerate forest restoration and fuel reduction to minimize high severity wildfires, thus protecting water delivery to dams and reservoirs.

» Work with acequia associations to identify strategies to maximize infiltration and storage capacities. Develop ***Acequia Ambassadors*** to communicate common issues and goals.

Figure 7 - Visit the [OSC Drought Gallery] for maps, apps, and other climate-related resources.



http://arcg.is/2uTALWW

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This fact sheet was written by Aurora Cutler and Dave Peterson. Any errors or omissions remain the responsibility of the authors.

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