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Potential Drought Impacts
in the
Pacific Northwest

A synopsis of presentations and work group sessions from the

Region 6 Drought Resilience Workshop

April 2017 *Portland, OR*

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USDA Northwest Climate Hub
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Background

Over the next several decades, the Pacific Northwest (Oregon and Washington) could be facing drier and hotter summers when demand for water is greatest for people, vegetation, and wildlife. Less precipitation in the summer may be exacerbated by diminishing snowpack because of warmer winters. For example, in 2015 the Pacific Northwest had an exceptionally warm winter and spring that resulted in record low snowpack. This “snowpack drought,” combined with high temperatures and low precipitation levels in the spring and summer, led to extremely low flows in streams and rivers, injury to crops, and degraded habitat. The drought resulted in widespread fish mortality and agricultural impacts estimated at $336 million in the state of Washington (Anderson et al. 2016).

As drought becomes more prevalent in the future, the conditions of natural resources may change rapidly.

The National Drought Resilience Partnership builds on the 2016 Drought Science Synthesis (Vose et al. 2016), promoting drought resilience nationwide. As a part of this effort, the Forest Service conducted a series of workshops across the country to build organizational capacity to address the effects of short and long term drought on forest and rangeland resources, thus informing land management, restoration, and climate change adaptation.

In April 2017, a drought resilience workshop was conducted in Portland, Oregon as a contribution to the National Drought Resilience Partnership. The workshop included nearly 60 participants from the ***US Forest Service, USDA Climate Hub, USDA Natural Resources Conservation Service, US Environmental Protection Agency, Bureau of Land Management, Bureau of Indian Affairs, Washington Department of Ecology, Washington Department of Natural Resources, Northwest Climate Science Center, Oregon Water Resources Department, Tribal Federal Caucus, and University of Washington.***

Detroit Lake, OR (© Dee Browning)

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).

Topics covered in the workshop included drought and climate trends; the primary effects of drought on forests, rangelands, and human communities; and the secondary effects of drought, such as wildfire and insect outbreaks. Key messages from presentations and small workgroups are described below.

Future Drought in the Pacific Northwest Region

Average temperatures in the Pacific Northwest are expected to increase 4 to 6 degrees Fahrenheit by the 2050s (relative to the late 20th century), and warming is expected across all seasons (Snover et al. 2013). Overall, warming will increase evaporation of available soil and surface water. However, on the east side of the Cascade Range where conditions are already dry, many drought-adapted species are near their tolerance limit for soil moisture, and further reductions in soil water will have more prominent effects than on the west side of the Cascades.

Annual precipitation in Washington and Oregon is projected to increase slightly, but summers are expected to be drier. The average spring snowpack in the Columbia River Basin is projected to decline by 52 percent by the 2080s (Hamlet et al. 2013), which may affect the timing and quantity of water available in basins that rely on snowmelt.

In general, changes in seasonal and annual precipitation will be small compared to historical year-to-year variability.

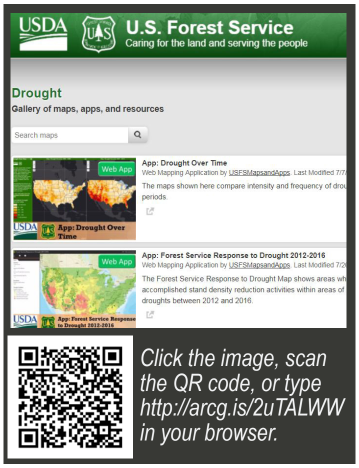

Figure 1 - Visit the U.S. Forest Service Drought Gallery for maps, apps, and other resources.

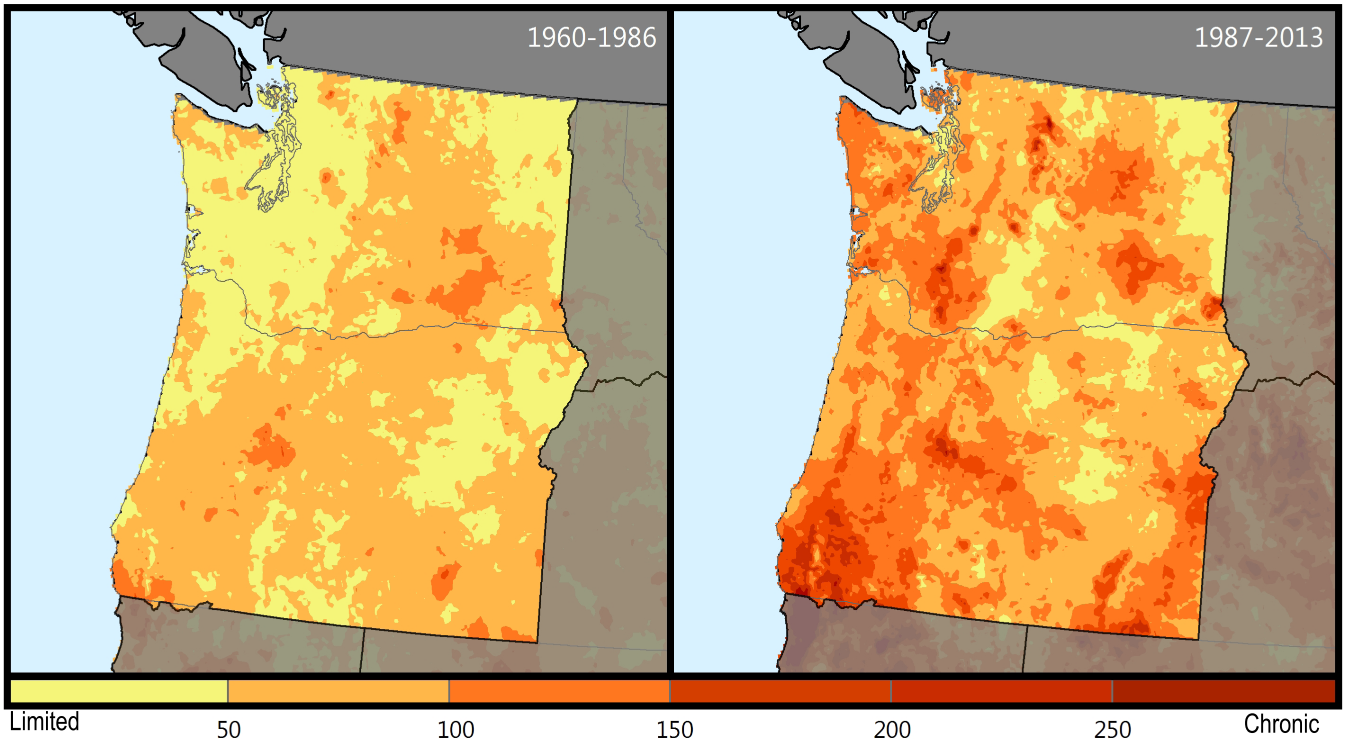

Figure 2 - Cumulative drought severity index, calculated using weighted monthly frequencies of Palmer Drought Severity Index values, reported for the periods 1960–1986 and 1987–2013. This indicates the duration and intensity of the long term drought effects based on historical precipitation and temperature, and shows that droughts in the region became more frequent and severe between these time periods. [Click here for more information and interactive maps.]

Drought Effects on Water Availability

Surface geology and soils determine drainage properties and the severity of drought effects across mountainous landscapes in the Pacific Northwest. For example, in areas with highly permeable volcanic rock and ash soils, water rapidly infiltrates down hundreds of meters, supporting neither water storage for human uses nor water availability for vegetation during drought (Konrad 2006).

Melting snow during the growing season has historically provided water for vegetation (Elsner 2010). However, reduced snowpack in warm winters decreases late season snowmelt, resulting in earlier peak flows and lower, warmer base flows (Mote et al. 2005, Stewart et al. 2005, Kormos et al. 2016). Some areas are likely to experience a decline in summer streamflow as water drains into deep groundwater storage in basalt aquifers (Drost et al. 1990).

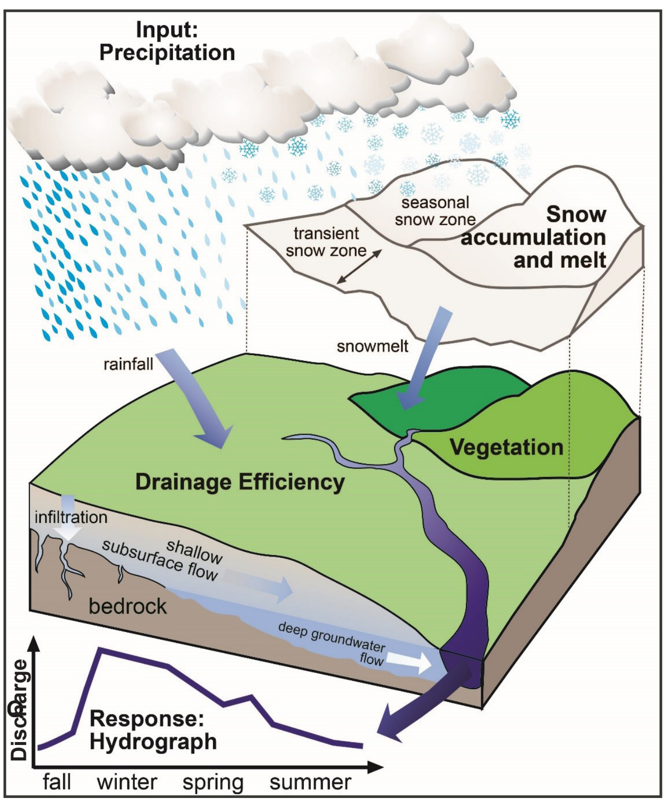

Figure 3 - Precipitation inputs and drainage discharge process (Tague and Grant, 2009).

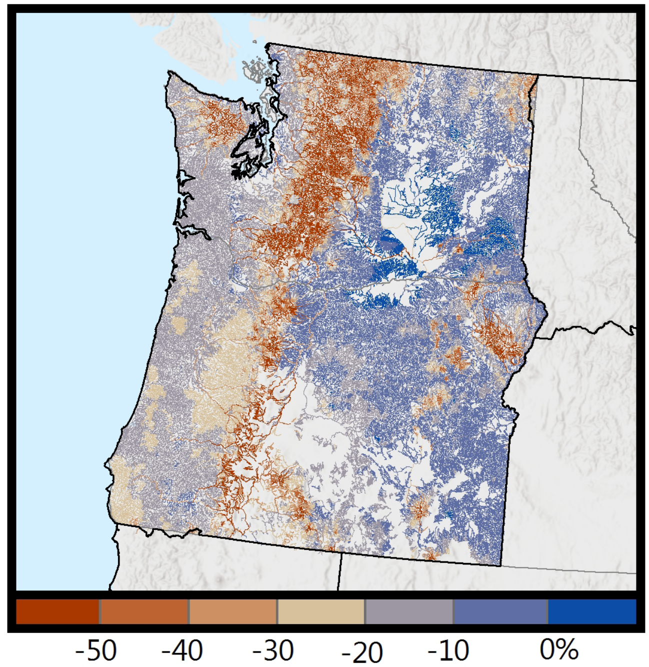

Figure 4 - Projected change in mean summer stream flow from historical mean (1977–2006) and future (2080s) time periods. Values represent changes from current flows. Largest reductions are shown in the mountainous areas, likely influenced by reduced snowpack at higher elevations. The least amount of reduction in mean summer stream flow is expected on the east side of the Cascade Range, although a small reduction in an already dry landscape is likely to have significant effects (data source: Luce et al. in press). Click here for an interactive map.

Figure 5 - The Blue Mountains, OR and WA (© Miles Hemstrom)

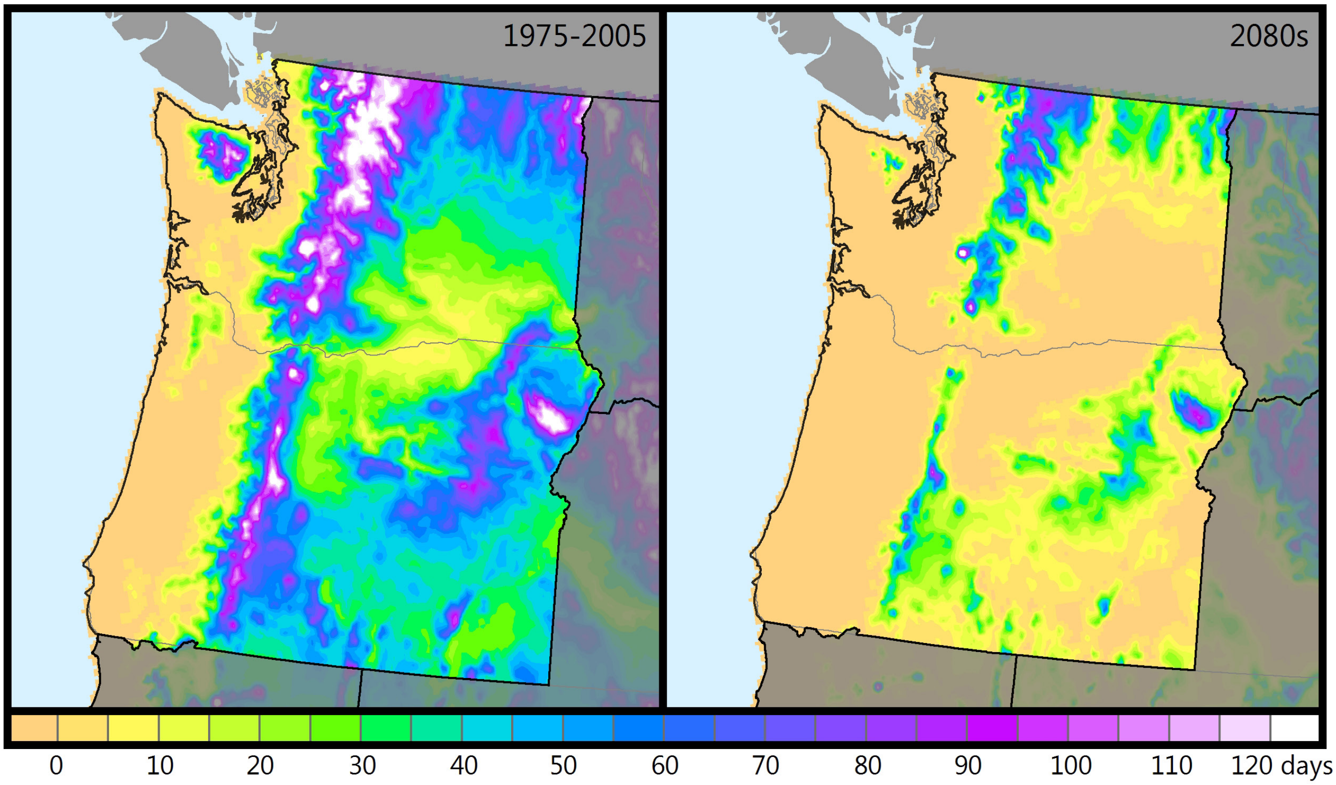

Figure 6 - Snow residence time will decrease in the future, particularly on the east side of the Cascade Range. Modeled change in snow residence time for 1975–2005 and the 2080s in days, using a high greenhouse gas emission scenario (RCP8.5; no climate policy and high population). Click here for more details and interactive maps.

Management Response Options—Water Availability

» Manage for healthy drought-resilient forest ecosystems by favoring drought-tolerant tree species and genotypes, and maintaining more open forest structures in drier forests.

» Redesign roads to reduce the velocity of downstream drainage.

» Improve soil properties and soil water infiltration and retention by producing biochar onsite where feasible (Pacific Northwest Biochar Atlas, n.d.).

» Restore wet meadows and riparian areas through activities such as placing logs into streams, re-introducing American beavers, and constructing structures mimicking beaver dams, to reduce streamflow velocity (Erwin 2009, Mitch et al. 2013).

» Retain water on the landscape with activities that promote healthy soils. Increase water conservation with better technology and less wasteful practices, including stream restoration, making water systems more resilient to drought (e.g., deeper wells), and preparing for future storage needs.

» Construct low-rise dams in arid landscapes where streams are already eroded, especially on non-fish-bearing streams.

» Quantify water budgets in order to manage watersheds more effectively.

» Increase water conservation within U.S. Forest Service operations and modernize infrastructure (e.g., roads, trails, and facilities).

Forests and Disturbances

Forest growth is likely to decrease in most areas in the Pacific Northwest because of drought-related water limitations, especially in low to mid elevation coniferous forests. Douglas fir, an important ecological and economic species, is expected to have lower growth on both the east and west sides of the Cascade Range (Littell 2006, Restaino et al. 2016). High elevation coniferous forests are likely to increase in growth because less snowpack will create a longer growing season (Mote et al. 2005, Littell et al. 2010).

More tree mortality can be expected, especially in dense stands, at the lower treeline, and in whitebark pine that are already stressed from white pine blister rust (Bega 1978, Sturrock et al. 2011). Trees of many species and sizes can be affected simultaneously.

Rising temperatures may extend the length of the growing season, creating a greater demand for water by vegetation (Littell et al. 2010). Dry soils and topographic positions that do not retain soil moisture are vulnerable, especially where they affect seedling establishment (Joslin et al. 2000). Western hemlock, which have shallow roots, are sensitive to prolonged dry weather (Burns et al. 1990). Carbon storage may be reduced as vegetative growth decreases, forest disturbances increase, and early seral forest structure becomes more prevalent across the landscape (Kashian et al. 2006).

Drought frequency and duration affect the frequency and extent of wildfires and other disturbances. Drought increases fuel flammability by reducing fuel moisture and increasing the concentrations of volatile chemicals in leaves and needles (Simard 1968). In forests, highly combustible fine fuels will dry earlier in the growing season and remain dry longer (Westerling et al. 2006).

Dense forests are particularly susceptible to bark beetle attack, and although beetles typically focus on weak trees, they can also spread to nearby drought-stressed but otherwise vigorous trees (Cates and Alexander 1982, Fettig et al. 2007, Lieutier 2004).

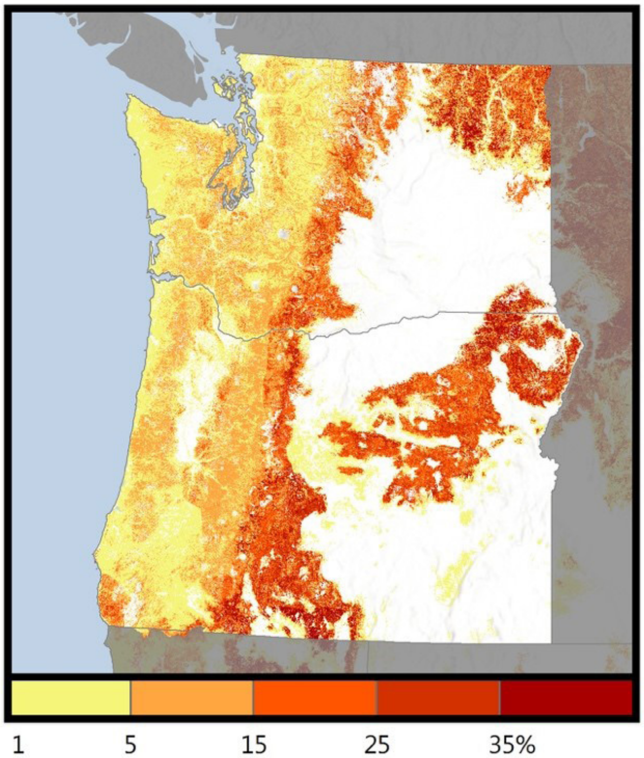

Figure 7 - Projected percent of basal area lost due to insects and diseases, including all damage agents, across all hosts, between 2013 and 2027. Click here for more information and interactive maps about forest disturbances and drought.

Management Response Options—Forests and Disturbances

- Increase vigor of trees by reducing forest density with mechanical thinning and prescribed fire.
- Favor drought-tolerant species in mixed conifer forests.
- Monitor for drought using ground-, aerial-, and satellite-based systems.
- Leverage existing early drought warning systems such as the Evaporative Demand Drought Index (EDDI) and develop additional early warning indicators for drought. Develop drought risk maps

as has been done for insects and disease (e.g., Kerns et al. 2016).

» Increase use of managed wildfire where appropriate, reduce fuels and conserve on water on the land.

» Identify and protect drought refugia where soil moisture is expected to remain high enough that vegetation and habitat will not change significantly.

» Use natural landscape features and management techniques to slow snowmelt.

» Use partnerships to increase capacity for mitigating and responding to drought (e.g., create a regional coordinating group of the National Drought Resilience Partnership).

» Consider the effects of drought in forest plan revisions and NEPA documents for projects where appropriate.

Rangelands

Drought reduces growth in rangelands during the growing season, especially if large numbers of non-native annual grasses are present (Fehmi and Kong 2012, Runyon et al. 2012), and can favor the spread of those grasses (Tisdale et al. 1965, Kindschy 1994, Tausch et al. 1994). Excessive reductions in aboveground plant material through grazing by livestock or wild horses and burros during drought reduces belowground roots, creating growing space for invasive plant species (Biondini et al. 1998, Fuhlendorf et al. 2001).

Although grazing typically occurs on perennial grasses, shrubs are also prone to browsing when grasses are unproductive or dormant. Livestock are more likely to graze riparian areas during the summer when conditions are hottest, and when grasses in the adjoining uplands are dormant.

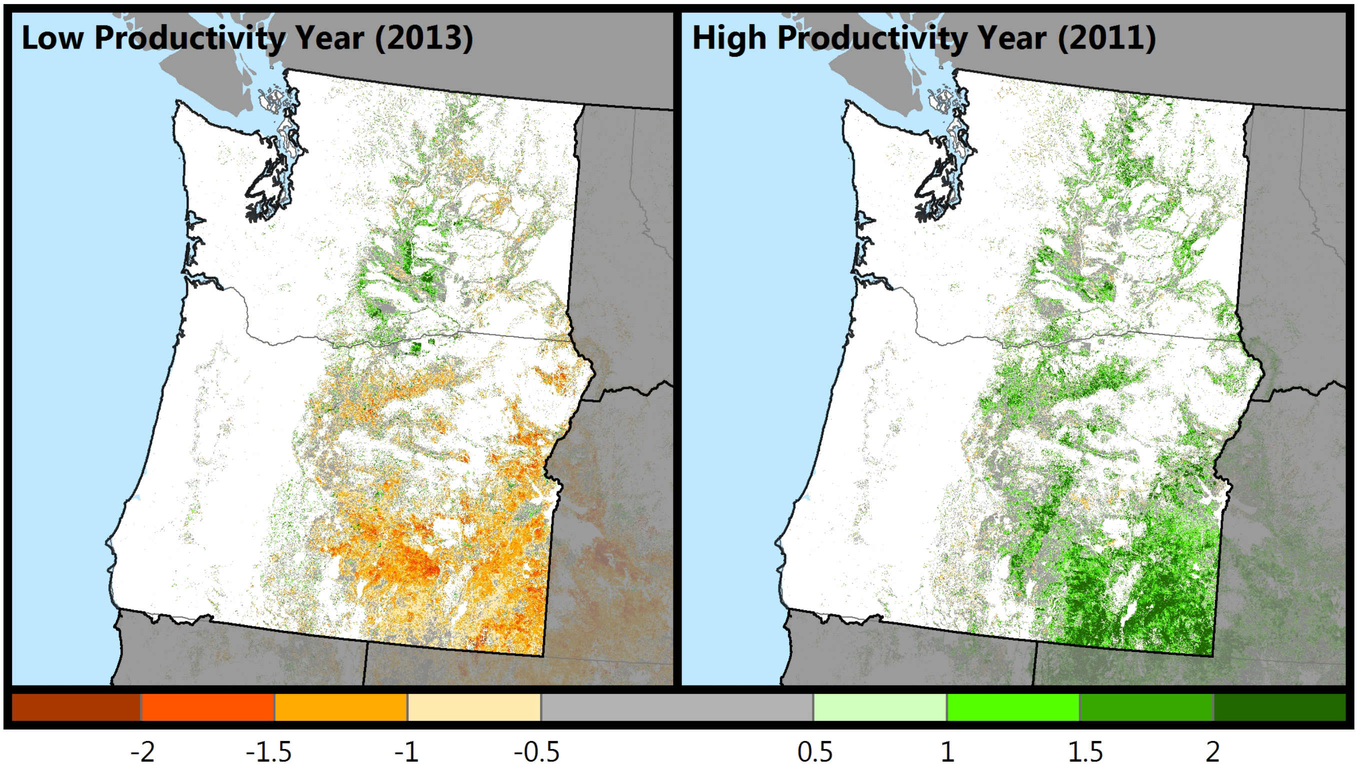

Figure 8 - Relative rangeland productivity in 2011 was above average for most of OR/WA as indicated by green colors (positive numbers) in the map. In 2013, much of southwest Oregon was below average as indicated by orange colors (negative numbers) which was likely caused by a combination of the preceding year's average soil moisture and current year's moisture deficit. (Data source: Reeves 2017). Click here for more information and interactive maps.

As drought intensity increases, rangeland productivity decreases, although the amount of decrease depends on the type of site (e.g., sagebrush-steppe versus mountain meadows). In semiarid sites, non-native annual grasses (e.g., cheatgrass) tend to increase fire frequency and fire spread (Balch et al. 2013).

Typically, large rangeland fires occur when a high-productivity year that produces abundant fine fuels is followed by a drought that reduces fuel moisture. In some cases, drought induces more intense fire behavior, increasing the difficulty of suppression. Although fuel quantity typically controls energy released during a fire, drought can extend the duration of conditions under which fuels will readily burn (Brown et al. 2005).

Figure 9 - Hash Rock Fire, Ochoco National Forest, 2016

Management Response Options—Rangelands

» Reduce non-native species, especially cheatgrass and other annual species that increase fire frequency.

» During drought and the post-drought recovery periods, consider altering grazing practices such as shortening the grazing season, reducing the number of grazing animals, or altering the timing of grazing activities to mitigate for reduced vegetation productivity.These actions may also improve soil health by increasing ground cover and soil organic matter, and reducing degradation of biological soil crust.

» Increase round-ups of wild horses and burros.

» Provide supplemental water away from riparian areas.

» Work collaboratively with ranchers to develop grazing plans that promote drought resilience.

Water and Ecosystem Services

Water is the most widely valued resource provided by public lands. During times of drought, decisions about allocation of limited water often involve trade-offs among fish habitat, agricultural use, municipal use, recreational use, and livestock grazing.

Water quality may also be affected by drought. Warmer temperatures, in addition to limited water availability, may increase the likelihood of algal blooms that degrade aquatic habitat and can be harmful to people.

Figure 10 - Algal blooms in Haystack Reservoir (Crooked River National Grassland) are stimulated by extended periods of warm weather and limited water, resulting in undesirable conditions for recreation (Forest Service photo).

During non-drought years, forests generally have sufficiently high water quality. However, water bodies are impaired mostly during periods of high temperatures, exacerbated by drought, thus affecting aquatic species. There are nearly 1000 special-use permits in the Pacific Northwest Region for various water uses including ditches, pipelines, wells, reservoirs, and dams—all of which are assets that may be negatively affected by drought conditions.

Management Response Options—Water and Ecosystem Services

» Assess and map risks to critical fish habitat, and infrastructure such as roads and recreational sites.

» Assess and map areas serving as cold water refugia where water bodies will remain cool enough to support native aquatic biota.

» Increase floodplain connectivity with vegetation restoration and instream improvements.

» Remove infrastructure that was designed to drain water in order to promote stream channel complexity.

» Protect critical fish habitat from livestock impacts using tactics such as fencing off riparian areas or providing alternative water supplies for livestock.

» Communicate with stakeholders about resources and values at risk, such as the effects of non-native fish species on native fish populations. Collaborate with federal and state agencies to prioritize non-native fish management activities.

» Improve water efficiencies, particularly in irrigation.

» Remove dikes and levees to restore connectivity of streams and floodplains where feasible.

» Reduce road density to reduce sedimentation and improve water quality.

Figure 11 - Emergency drawdown for irrigation of Eightmile Lake in Alpine Lakes Wilderness, Okanogan-Wenatchee National Forest, Sept. 2015 (Forest Service photo).

Next Steps

The information developed in the regional drought workshops will be used to develop a Forest Service General Technical Report that synthesizes the most important issues related to drought effects on natural resources and adaptation actions. Building on information generated from a previously-published drought science synthesis (Vose et al. 2016) and drought workshops, this publication will describe planning and management options in each Forest Service region, providing the necessary documentation for on-the-ground actions.

The Forest Service and Bureau of Land Management in Oregon and Washington are working with partners to coordinate management responses to drought, extreme weather, and other disturbances to forest and rangeland ecosystems. This will be an ongoing effort to ensure long term sustainability of natural resources and ecosystem services on public lands.

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