2020

PACIFIC NORTHWEST WATER YEAR

IMPACTS ASSESSMENT

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2020 PACIFIC NORTHWEST WATER YEAR IMPACTS ASSESSMENT

ON THE COVER:
Beaver dam at sunrise in the Idaho mountains (Charles Knowles).

Aerial view of the Deschutes River near Bend, Oregon (Casade Drone Photography).

1 PURPOSE

For several years, researchers, practitioners, and boundary spanning organizations in Oregon and Washington have held a joint Water Year Recap and Outlook meeting. A separate but similar meeting in Idaho is also held each year. A water year is defined as the 12 months beginning on October 1 and ending on September 30 of the following year (e.g., water year 2020: October 1, 2019–September 30, 2020). Two main objectives of the water year meetings are to summarize the climate conditions of the previous water year and review climate and weather-related impacts to various sectors, focusing on drought and other extreme events and conditions. In addition to the impact discussions at the water year meetings, a Pacific Northwest (PNW) regional survey to collect water year impacts for multiple sectors was developed in fall 2020. The purpose of this assessment is to summarize the water year conditions and sector impacts as a resource for future management of drought and other climate extremes, using the information from the meeting discussions, the survey, and author expertise.

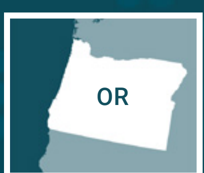
The purpose of this assessment is to summarize the water year conditions and sector impacts as a resource for future management of drought and other climate extremes.

In water year 2020, most of Oregon experienced a significant drought with dominant impacts that included wildfires, agricultural and livestock losses, and limited outdoor recreation. Drought in Washington and Idaho was not as widespread or significant, with localized drought in a few basins in south-central Idaho and east of the Cascade Mountain crest in central Washington. Washington and Oregon also experienced major flood events in February; those impacts and others are highlighted as well.

2

WATER YEAR EVOLUTION

WATER YEAR 2020 AT A GLANCE*

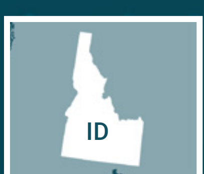


10th **warmest** (tie with 2004 and 1990); +1.0°F

13th **driest**; –7.32 inches (77% of normal)

19th **warmest** (tie with 1941 and 2018); +0.7°F

49th **driest**; ; –2.54 inches (94% of normal)



30th **warmest** (tie with 1900, 1954, 2009); +0.4°F

26th **driest**; –2.83 inches (88% of normal)

*Anomalies relative to 1981–2010; rankings based on entire record beginning in 1895[1]

The 2020 water year was warmer and drier than normal for the PNW. For the region as a whole, the 2020 water year ranked as the 21st driest (86% of normal precipitation) and 22nd warmest on record (since 1895).[1]

The region was relatively drought-free at the beginning of the water year, but drought developed as the water year progressed. Figure 1 (*next page*) shows snapshots of the U.S. Drought Monitor at the start and end of the water year.

1 NOAA National Centers for Environmental information. Climate at a Glance: Statewide Time Series. Published December 2020. Retrieved in December 2020 from *https://www.ncdc.noaa.gov/cag/*

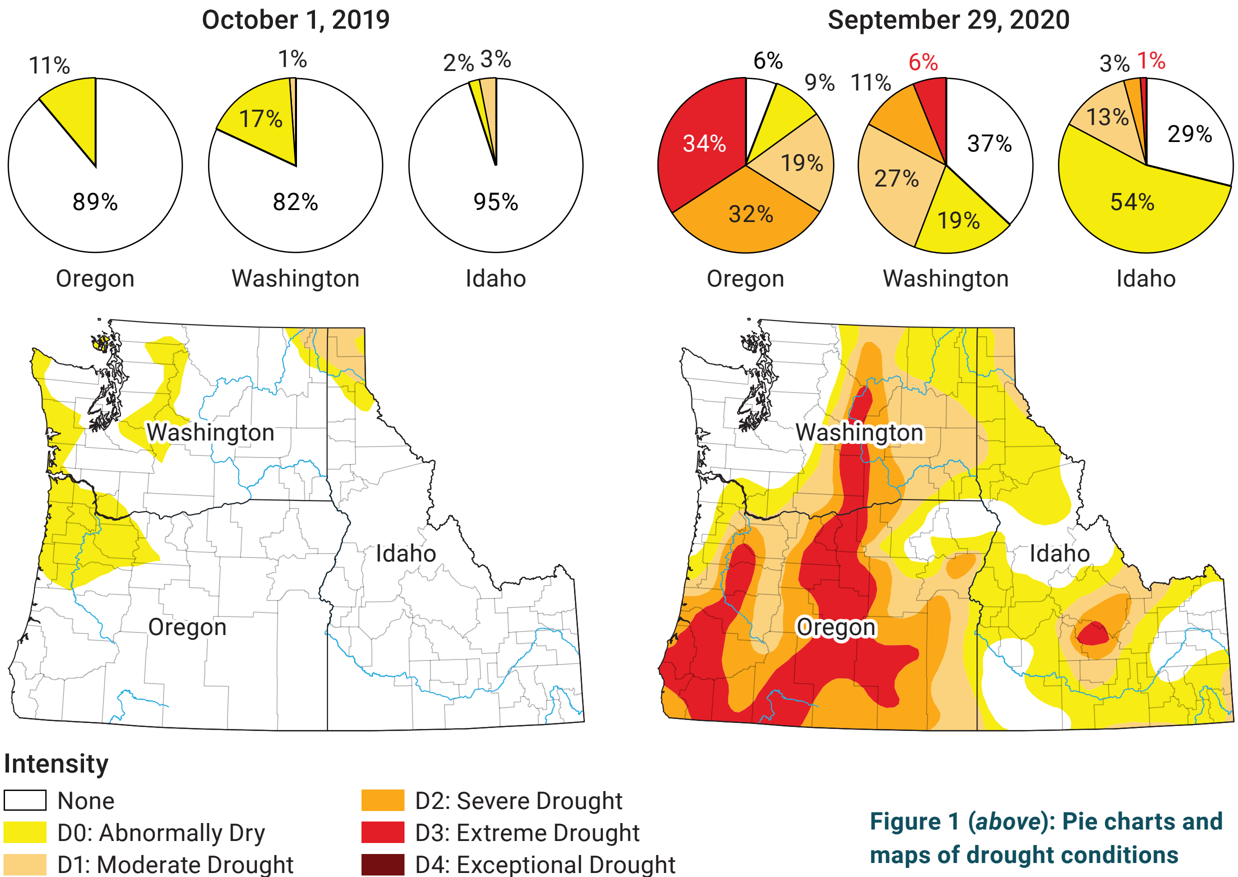
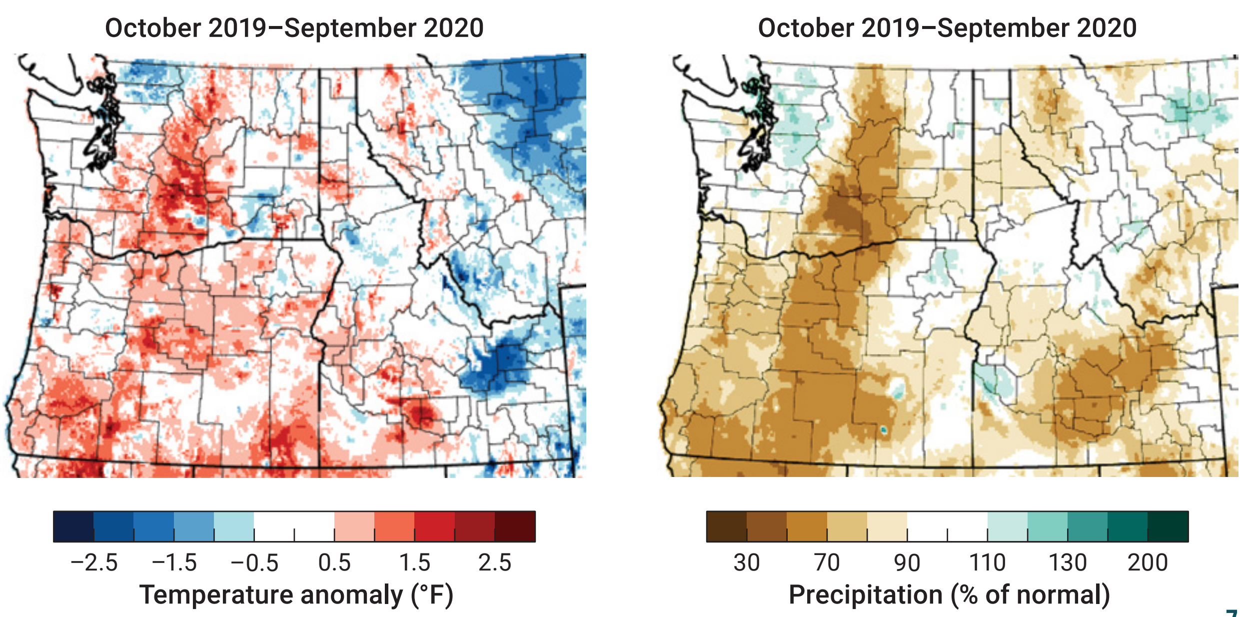


Figure 1 (*above*): Pie charts and maps of drought conditions from the *U.S. Drought Monitor* on October 1, 2019 (*left*) and September 29, 2020 (*right*).

Figure 2 (*below*): October 2019–September 2020 average temperature departures (*left*) and precipitation percent of normal (*right*) (adapted from *WestWide Drought Tracker*). The normal period is 1981–2010.

Drier-than-normal conditions were widespread in Oregon, with the east slopes of the Cascades in Washington and south-central Idaho having comparable deficits (between 50–70% of normal precipitation) for the water year (*Figure 2*). Dry locations tended to be coincident with above-normal temperatures, though the majority of the PNW had near-normal temperatures averaged over the water year. Overall, Oregon was the warmest and driest of the three states.



Seasonal Progression

The seasonal progression of the weather conditions better characterizes the water year, given that the temporal variability in the temperature and precipitation anomalies are averaged out when viewing statistics for the water year as a whole. Figure 3 shows the precipitation percent of normal (compared to the 1981–2010 average) and historical ranking for each month (based on the entire 125-year record) throughout the water year for Idaho, Oregon, and Washington. All three states had either a severely or extremely dry November, an abnormally to exceptionally wet January, and an abnormally to moderately wet June. May was moderately to severely wet for Oregon and Washington. Figure 3 illustrates how extreme the water year was in terms of the precipitation rankings. Oregon, for example, only had two months (December and September) rank as neutral with the other 10 months of the water year in either the driest or wettest tercile.

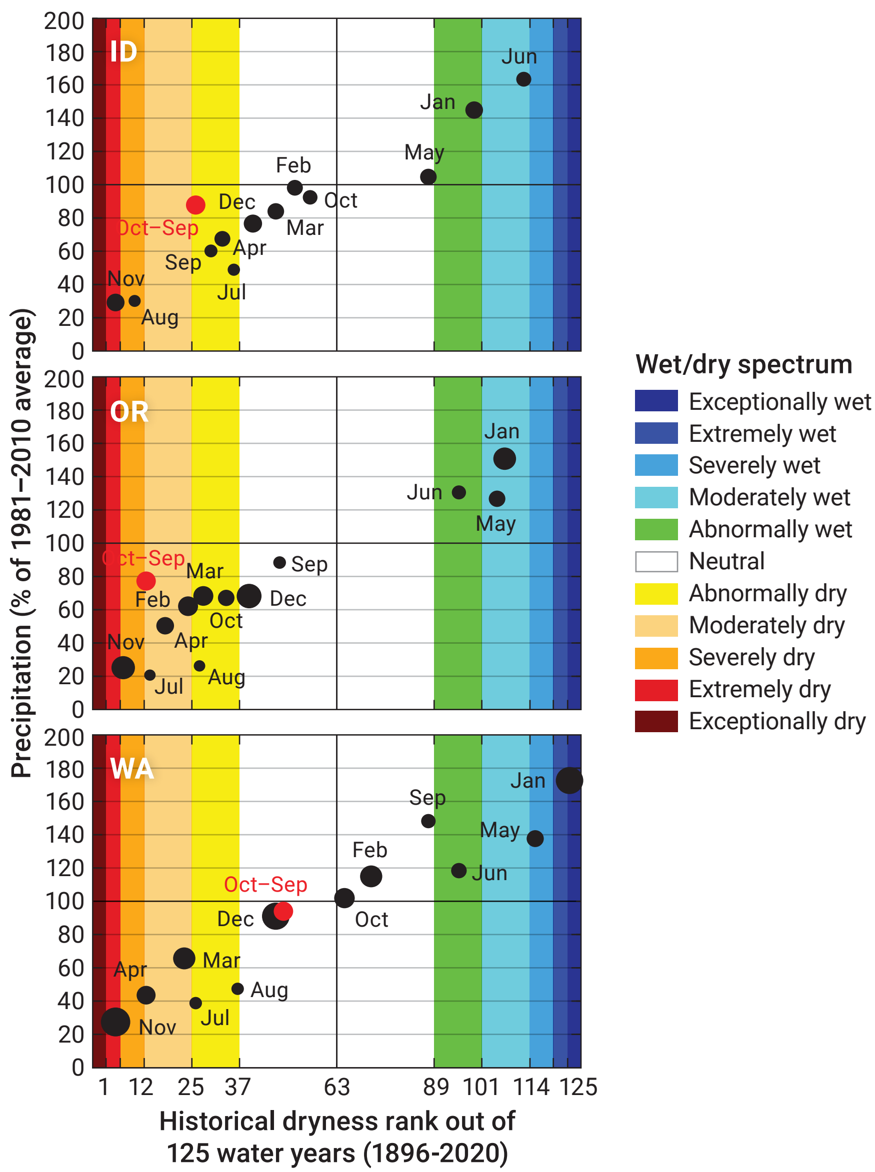


Figure 3: Scatterplots of monthly percent of normal (using 1981–2010 baseline) statewide precipitation (*y*-axis) as a function of the monthly precipitation rank out of the last 125 water years (*x*-axis) for Idaho (ID), Oregon (OR), and Washington (WA). The water year 2020 total is shown by the red data point. The colors show the wet/dry spectrum following the U.S. Drought Monitor drought definitions (for dryness) and extended to the wet spectrum following the Climate Toolbox *U.S. Water Watcher* tool. The sizes of the data points are scaled according to each month's relative average contribution to the water year total precipitation, with historically wetter months in larger circles and drier months in smaller circles (NCEI data accessed on December 21, 2020; figures adapted from L. O'Neill).

The relatively dry and wet periods are also illustrated by the October 2019–September 2020 hydrograph, showing average streamflow for the PNW region (*Figure 4*). Below-normal streamflows are shown in November–December, March–April, and early September, corresponding well with the drier periods of the water year. Above-normal streamflows are shown in late October, January through early February, and the end of September. This is a broad overview of streamflows as there was regional variability throughout the water year.

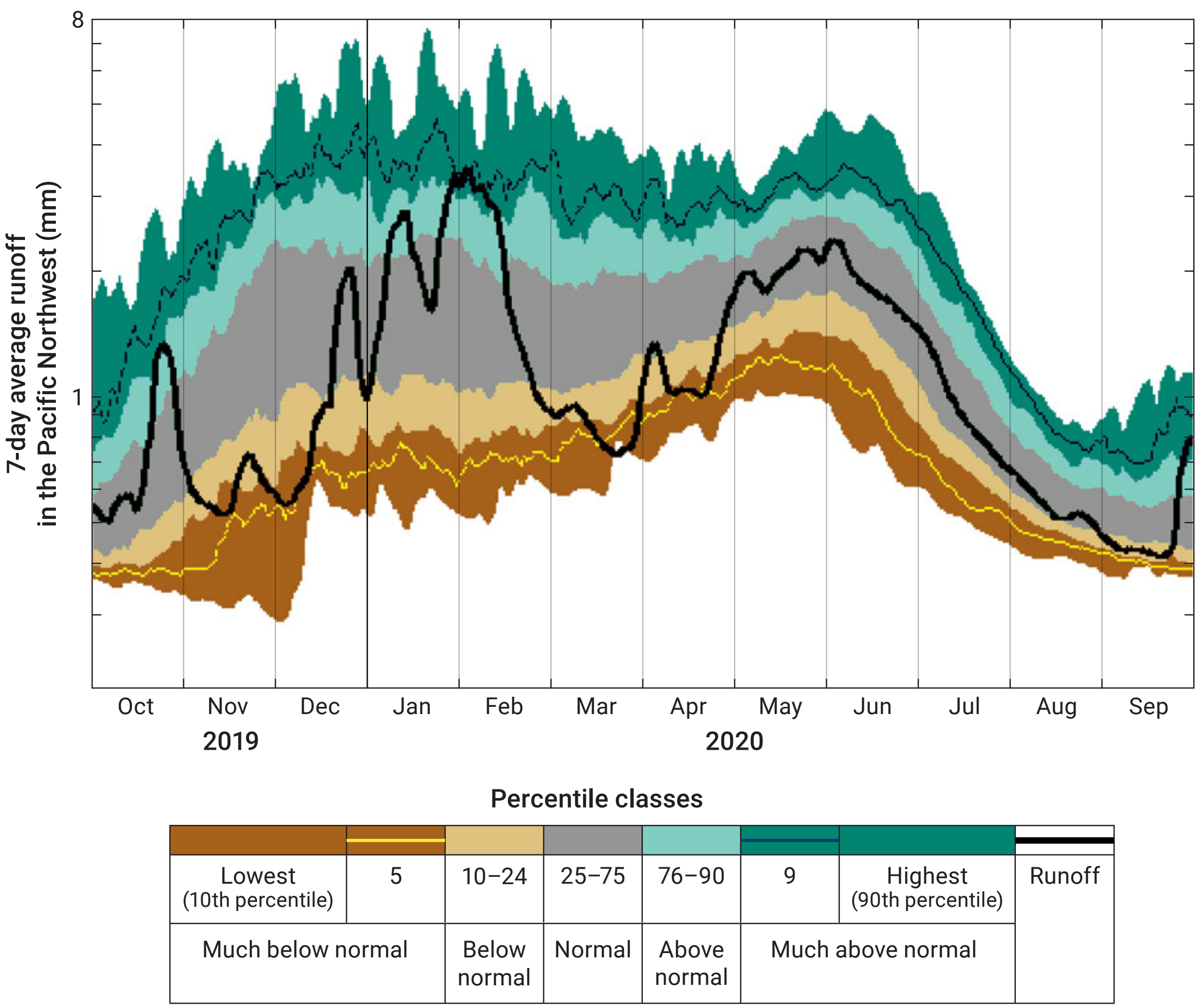
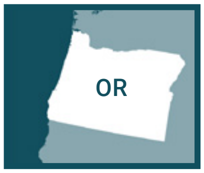


Figure 4: A time series of 7-day average runoff averaged over the sites in the PNW for water year 2020 and the percentiles as the runoff relates to the historical record (adapted from USGS).

OCT 2019 AVG TEMPERATURE STATISTICS*



4th coldest; −5.2°F

2nd coldest; −4.3°F

Record coldest; −7.5°F

*Anomalies relative to 1981–2010 normal; rankings based on entire record beginning in 1895[1]

October–December 2019

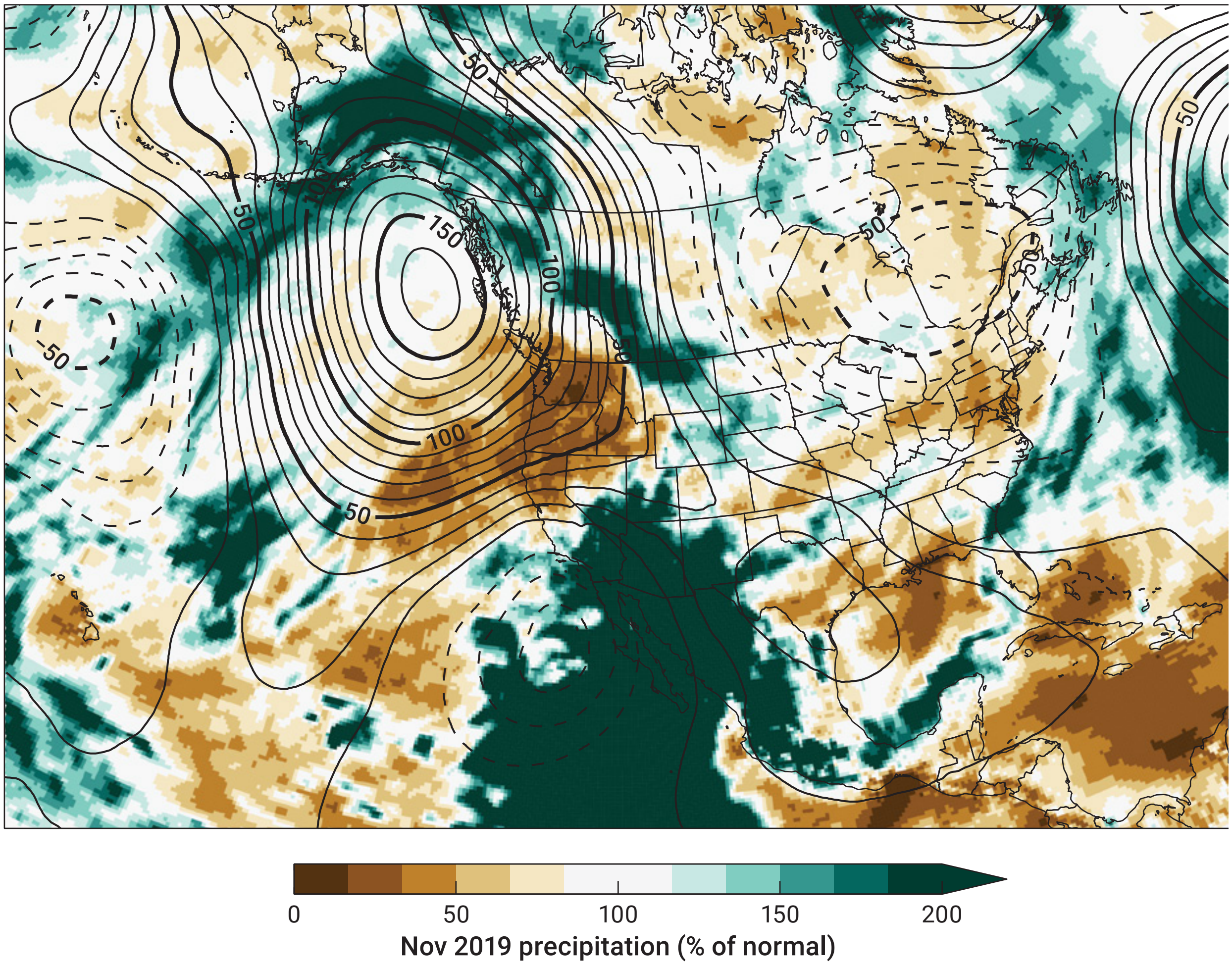
The water year started with exceptionally cold temperatures, particularly in the inland NW. A ridge of high pressure in the north Pacific Ocean and a trough of low pressure in the northern Plains caused unseasonable, anomalous northerly flow that brought cold and snow to Washington and northern Idaho. Southern Idaho and Oregon were also cold, but dry.

Severely-to-extremely dry conditions were region-wide in November (*Figure 3*) as a persistent anomalous ridge of high pressure occupied the North Pacific in the Gulf of Alaska from late October through early December (*Figure 5*). This type of persistent ridging in the North Pacific is sometimes referred to as the Ridiculously Resilient Ridge (R3).[2] The ridge split the storm track so that the PNW remained dry but Alaska and southern California were much wetter than normal, as illustrated by the November precipitation anomalies (*shading*) in Figure 5. November 2019 precipitation percentiles were extremely dry in Idaho and Washington and severely dry in Oregon (*Figure 3*), reducing water year precipitation substantially since it is climatologically the wettest month of the year. All three states received less than 40% of normal precipitation for the month of November (*Figures 3 and 5*).

November and December 2019 was the 8th driest Nov–Dec for the PNW region as whole (records since 1895), with 53% of normal precipitation. As shown in the individual state statistics (*page 11*), Washington and Idaho were not quite as dry relative to normal as Oregon was. The precipitation that did fall during this period ended up being critical for easing drought concerns later in the spring in Washington.

Washington's December precipitation totals were boosted by a heavy precipitation event in the Puget Sound region at the end of month. An atmospheric river with a south-southwest orientation impacted the southern and southeast Olympic Peninsula and central Puget Sound, in particular, with heavy precipitation from Dec 19th through the 21st. The Puget Sound islands and northern Puget Sound were partially in the rain shadow of the Olympic Mountains and received less precipitation. Both moderate river flooding and urban flooding were associated with this event.

2 Swain, D.L., M. Tsiang, M. Haugen, D. Singh, A. Charland, B. Rajaratnam, N.S. Diffenbaugh (2014). The Extraordinary California Drought of 2013/2014: Character, Context, and the Role of Climate Change. *Bull. Am. Meteorol. Soc.* 95: S3–S7.



January–March 2020

A series of January storms and cooler mountain temperatures resulted in substantial recovery of snowpack

Figure 5: Map of percent average precipitation (*shading*) and 500 hPa geopotential height anomaly (*contours*) for November 2019 from the ERA5 reanalysis. Positive (*solid*) and negative (*dashed*) height anomalies are shown with a contour interval of 10 meters. Monthly 500 hPa height anomalies were computed relative to the 1979–2010 ERA5 monthly climatology. Figure adapted from L. O'Neill.

NOV–DEC 2019 PRECIPITATION STATISTICS*

9th **driest**; –5.18", 48% of normal

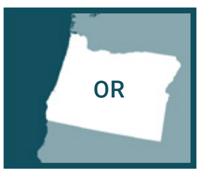
8th **driest**; –5.44", 58% of normal

10th **driest**; –2.68", 53% of normal

*Anomalies relative to 1981–2010 normal; rankings based on entire record beginning in 1895[1]

and improved the water supply outlook at the end of the month regionwide. January precipitation relative to normal was greater in Washington than in Oregon and Idaho, resulting in lesser drought concerns in the spring and summer. January was the 3rd wettest on record in Washington, ranking as exceptionally wet, with 173% of normal precipitation (*Figure 3*). Washington mountain precipitation alone (as measured by the mountain SNOTEL network) was the 4th wettest on record for January, and over half of the Washington SNOTEL sites set or neared a new snow water equivalent record during the first half of the month (most records began in the early 1980s). Precipitation across the entire state of Idaho was classified as abnormally wet compared to the historical record (*Figure 3*), and the precipitation in the Idaho mountains was

JAN 2020 SNOW WATER EQUIVALENT*



45%
of median

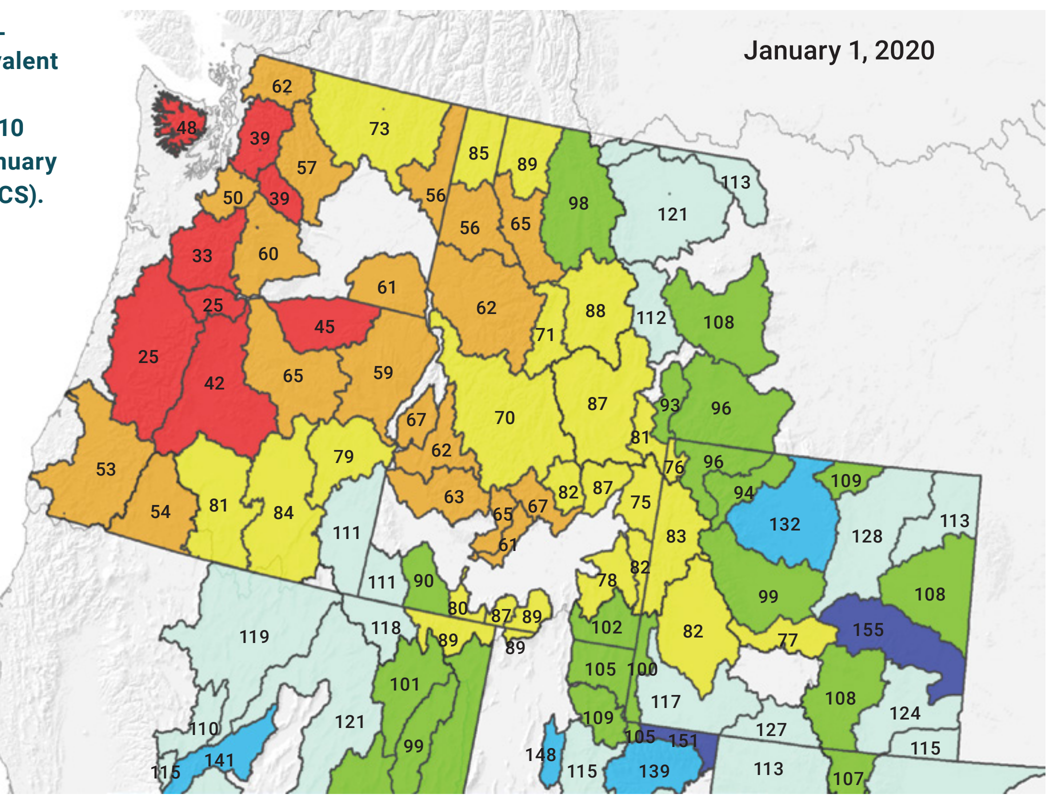
49%
of median

68% **of median** N. of Salmon River

73% **of median** S. of Salmon River

*Statewide on Jan 1, 2020; Source: National Resources Conservation Service

Figure 6: SNOTEL snow water equivalent (SWE) percent of normal (1981–2010 median) as of January 1, 2020 (from NRCS).

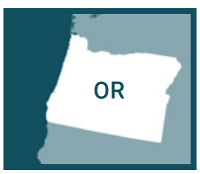


Snow water equivalent (%)
- No data
- <50
- 50–69
- 70–89
- 90–109
- 110–129
- 130–149
- ≥150

also above normal for most river basins. Cooler temperatures followed this weather pattern change in the beginning of January, resulting in snowfall for all elevations in Idaho, including the lower valleys. Statewide January precipitation in Oregon ranked as moderately wet (*Figure 3*). At Oregon mountain locations (measured by the SNOTEL network) water year precipitation totals were still below normal on February 1, despite January's copious precipitation. Still, there was a large improvement in snow water equivalent on February 1 compared to January 1 regionwide (*Figures 6 and 7*).

During the first week of February, an atmospheric river event impacted the entire region. While the Cascade Mountains in Oregon and Washington received heavy precipitation, the unusual west-northwest

FEB 2020 SNOW WATER EQUIVALENT*



93% **of median**

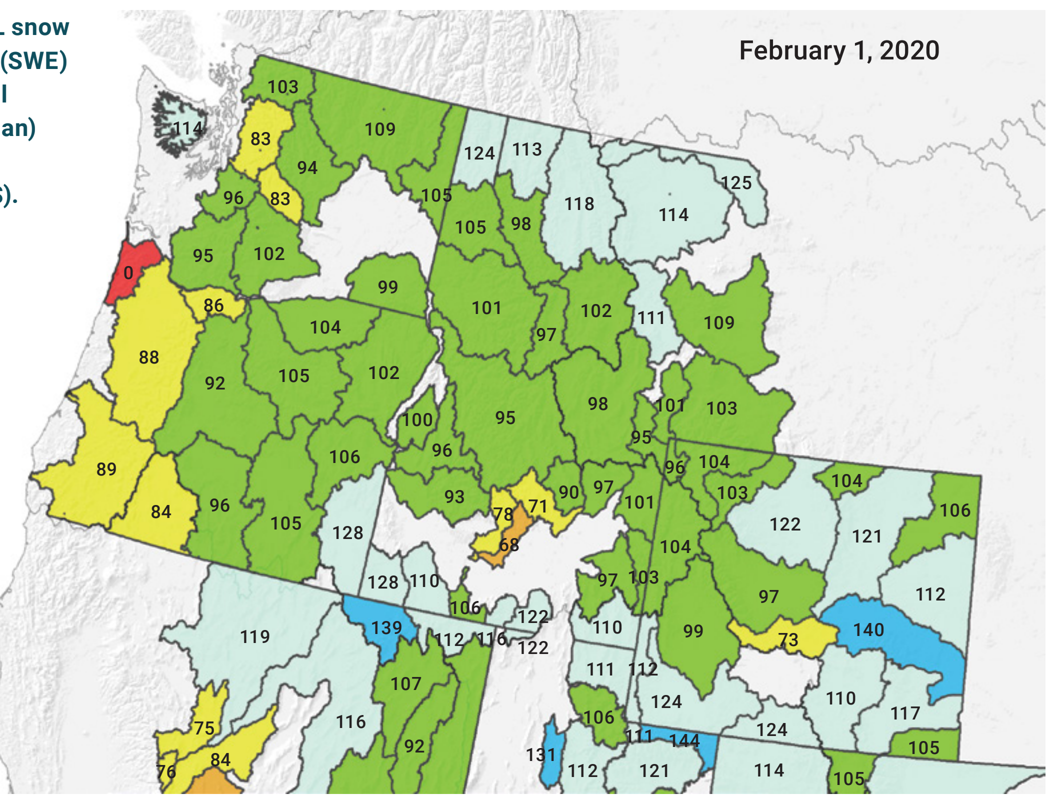
97% **of median**

107% **of median** N. of Salmon River

96% **of median** S. of Salmon River

*Statewide on Feb 1, 2020; Source: National Resources Conservation Service

Figure 7: SNOTEL snow water equivalent (SWE) percent of normal (1981–2010 median) as of February 1, 2020 (from NRCS).



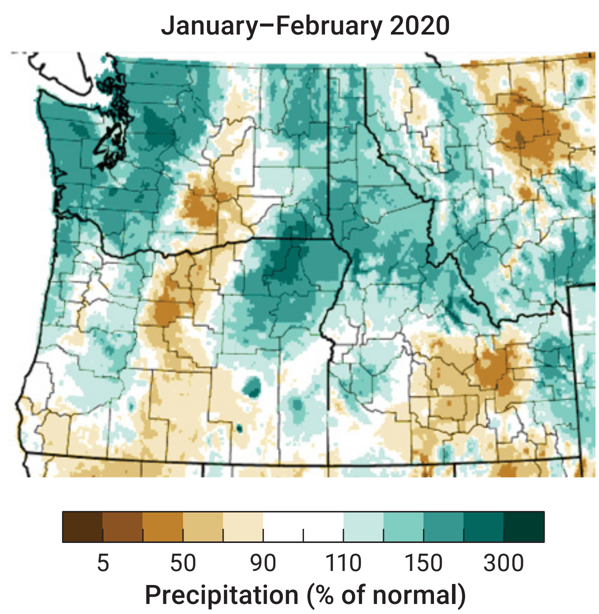
orientation of the event especially impacted the Umatilla and Walla Walla River basins in NE Oregon and SE Washington, respectively, amplifying precipitation over the Blue Mountains. Record-high streamflows were measured on Mill Creek in Walla Walla and Umatilla River near Gibbon, and widespread damage from catastrophic flooding was reported.

The majority of the rest of PNW was drier than normal in February, with substantial variability between individual basins. The southwestern basins in Oregon, in particular, received well below normal snow and precipitation, which led to significantly lower snow water equivalent and cumulative water year precipitation values on March 1st compared to February 1st. The Wood and Lost River basins in south-central Idaho were also very dry and recorded a new record low monthly precipitation based on the mountain SNOTEL stations (most records began in the early 1980s).

Figure 8 shows the precipitation for January and February 2020, which was wetter than normal considering individual statewide averages. Washington, in particular, had its 6th wettest Jan–Feb on record; the totals for Oregon and Idaho relative to normal did not rank as high compared to the historical record.[1] The late winter featured a strong rain shadow on the east side of the Cascade Mountains of Washington and Oregon, which is consistent with the enhanced mid-tropospheric zonal flow that occurred. These precipitation deficits were a major driver of drought conditions that developed later in the water year. The months of January and February as a whole were wet for the northern part of Idaho, and on the dry side for the south-central part of the state.

March was drier than normal for nearly the entire PNW (southeastern Idaho was the exception). Statewide, March

Figure 8: January–February 2020 precipitation percent of normal (relative to 1981–2010) for the PNW (adapted from *WestWide Drought Tracker*).



JAN–FEB 2020 PRECIPITATION STATISTICS*

50th wettest; +0.94", 112% of normal

6th wettest; +5.07", 149% of normal

40th wettest; +1.18", 124% of normal

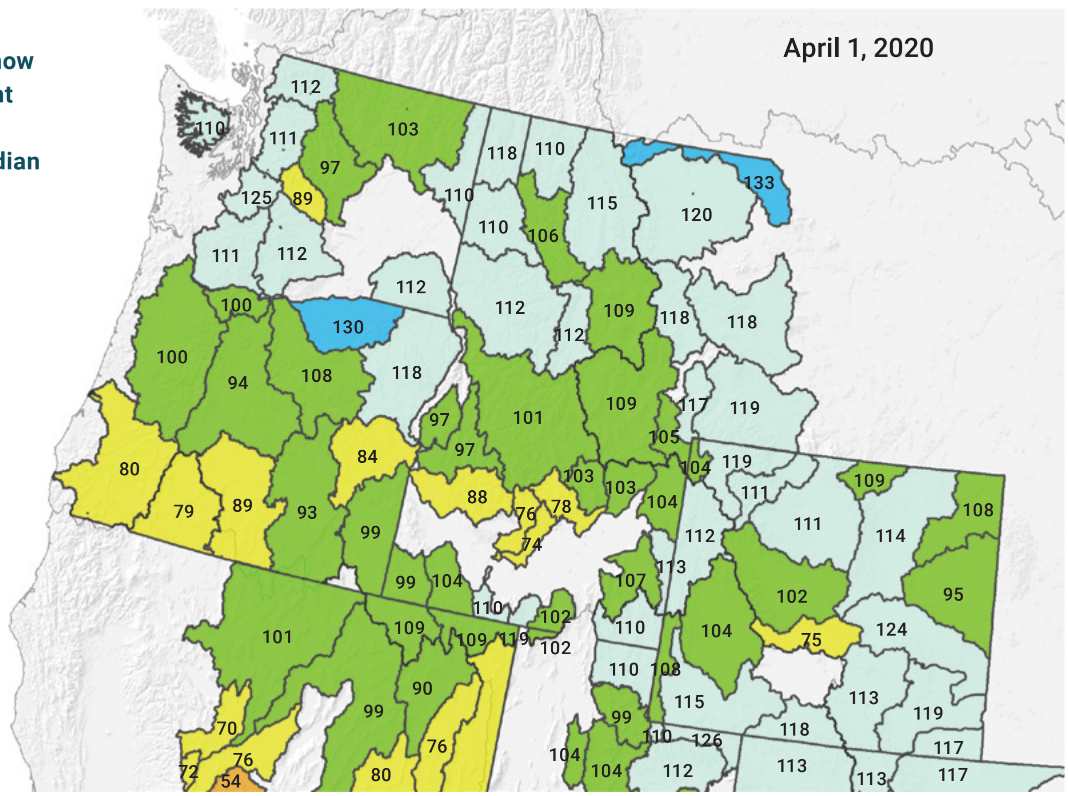
*Anomalies relative to 1981–2010 normal; rankings based on entire record beginning in 1895[1]

ranked as moderately dry for Washington, abnormally dry for Oregon, and neutral for Idaho (*Figure 3*). Temperatures were below normal in Washington and Oregon, however, which helped to preserve the snowpack in the mountains. Another factor preserving the mountain snowpack into early spring was the lack of any significant rain-on-snow events throughout the PNW.

April–June 2020

By April 1, snowpack was above normal for a majority of the basins in the PNW (*Figure 9*). In Oregon, there was well above normal snowpack in the northeast and below normal snowpack in the southwest (between 79 and 89% of normal). April 1 snowpack in Idaho was also mostly normal to above normal, except for Boise, Big Wood, Little Wood, and Big Lost basins (between 74 and 88% of normal). Washington fared better

Figure 9: PNW April 1, 2020 snow water equivalent percent of 1981–2010 median (from NRCS).



Snow water equivalent (%)
- No data
- <50
- 50–69
- 70–89
- 90–109
- 110–129
- 130–149
- ≥150

APR 2020 PRECIPITATION STATISTICS*

18th driest; –1.36”, 50% of normal

6th driest; –1.79”, 44% of normal

33rd driest; –0.69”, 67% of normal

*Anomalies relative to 1981–2010 normal; rankings based on entire record beginning in 1895[1]

on April 1, with only the Upper Yakima basin with below normal SWE (89% of normal). The snowpack was at its maximum for each state shortly after the 1st, peaking on April 5 in Washington (113% of median) and on April 8 in Oregon (109% of median) and Idaho (117% of median North of Salmon River and 102% of median South of Salmon River).

April was drier than normal throughout the PNW (abnormally dry or moderately dry for each of the three states; *Figure 3*) and warmer than normal for most of Oregon. A noteworthy warm spell occurred in late April/early May in western Oregon, which melted much of the snowpack 1–3 weeks early (*Figure 10*). The dry April exacerbated low snowpacks in some parts of southern Idaho. More specifically, on May 1 the Big Wood, Little Wood, and Big Lost Basins in Idaho had basin snowpack levels at 44%, 41%, and 45% of median,

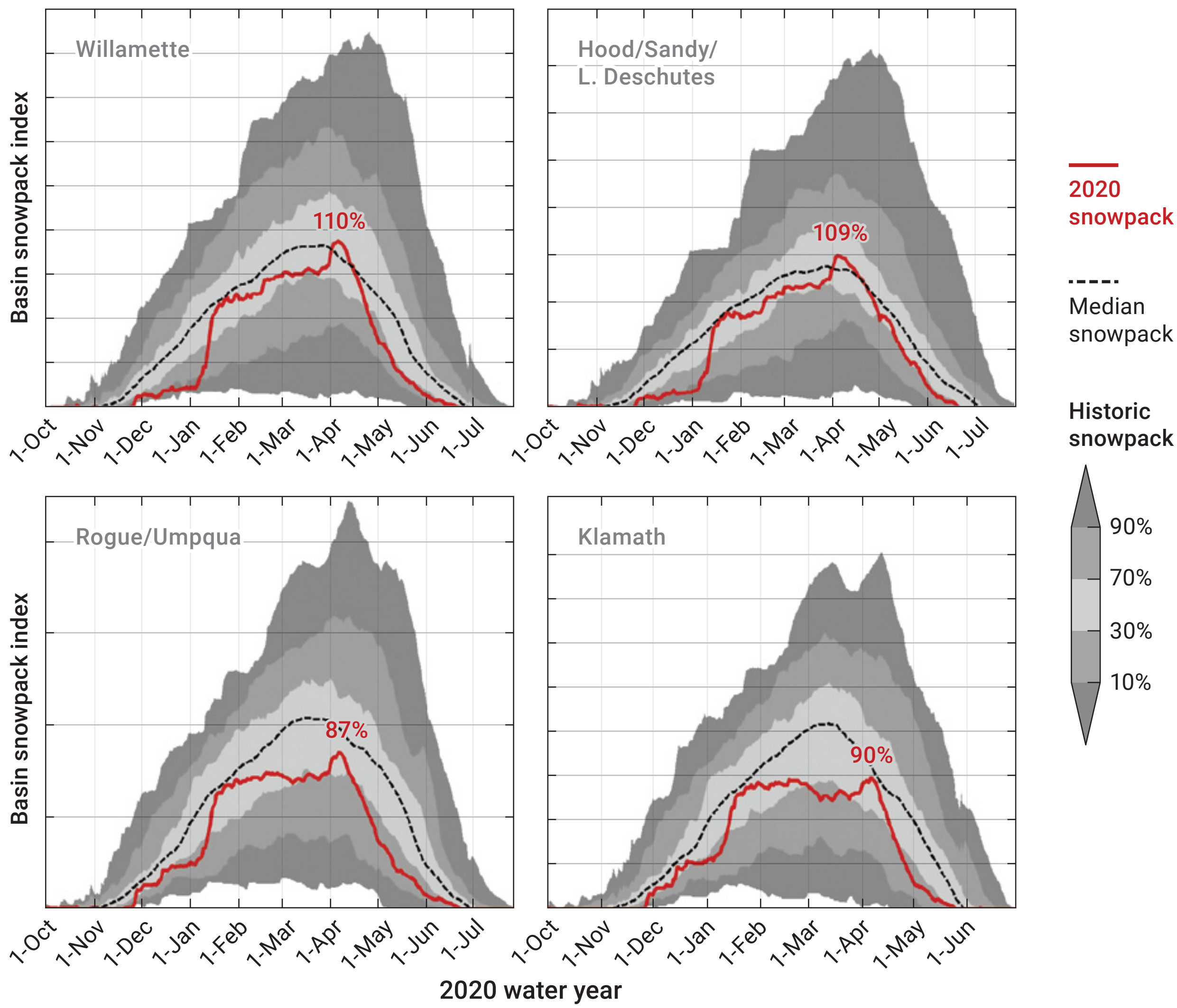
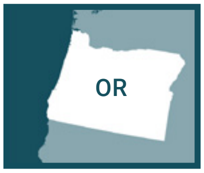


Figure 10: Water year 2020 snowpack traces compared to normal for 4 basins in western Oregon, illustrating an earlier than usual SWE meltout (adapted from NRCS).

MAY-JUN 2020 TEMPERATURE & PRECIPITATION*



17th **wettest;** +1.10", 128% of normal, +0.6°F

13th **wettest;** +1.33", 129% of normal, +0.4°F

24th **wettest;** +1.26", 130% of normal, −0.1°F

*Anomalies relative to 1981–2010 normal; rankings based on entire record beginning in 1895[1]

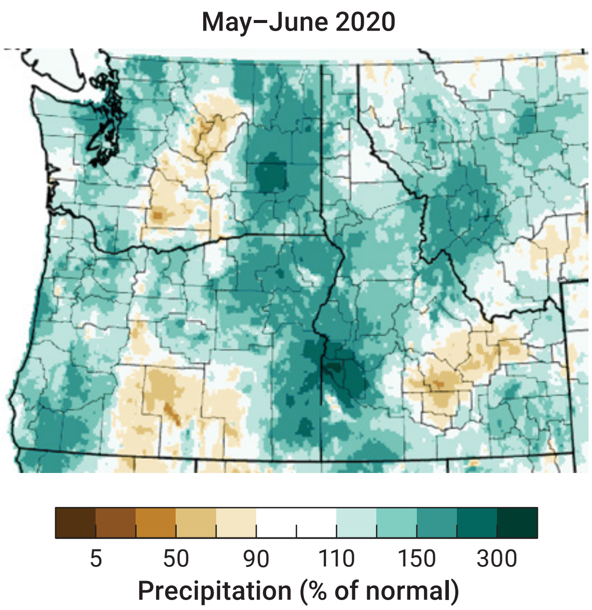


Figure 11: May–June 2020 precipitation percent of normal for the PNW (adapted from *WestWide Drought Tracker*).

respectively. The counties in which drought declarations were made in Idaho in water year 2020 were within these basins.

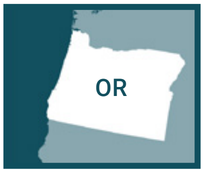
Total precipitation for May and June 2020 was greater than normal for all three states, with some spatial variation (*Figure 11*). The single months of May and June were either abnormally wet or moderately wet for all three states (*Figure 3*), except for May in Washington (severely wet) and Idaho (just barely neutral). May–June temperature was near-normal throughout the PNW, with a tendency for above normal temperature anomalies in May and below normal temperature anomalies in June.

July–September 2020

One of the two climatologically driest months of the year, July was still drier than normal throughout the PNW. The individual state averages ranked as either abnormally dry or moderately dry (*Figure 3*). July temperatures, on the other hand, were near normal for most of Oregon and Washington (+0.3°F and +0.1°F, respectively) and below normal in Idaho (–0.6°F).[1] The unusually cool July conditions in Idaho helped the regions in south-central Idaho that were already experiencing drought by extending water storage supplies longer than anticipated.

In contrast, conditions in August and September were some of the warmest weather on record experienced in the PNW. Oregon recorded its 2nd warmest August–September period (+4.3°F above normal), despite the widespread wildfire smoke during much of September. Not far behind, Idaho and Washington ranked as the 6th warmest during this period.[1] Averaged statewide, August ranked as

JUL 2020 AVG TEMPERATURE ANOMALIES*



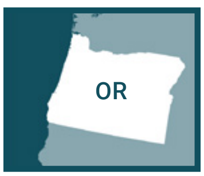
+0.3 °F

+0.1 °F

–0.6 °F

*Anomalies relative to 1981–2010 normal[1]

AUG–SEP 2020 AVG TEMPERATURE STATISTICS*



2nd
warmest;
+4.3°F

6th
warmest;
+3.3°F

6th
warmest;
+3.8°F

*Anomalies relative to 1981–2010 normal; rankings based on entire record beginning in 1895[1]

abnormally dry in Washington and Oregon and severely dry in Idaho (*Figure 3*).

Synoptic-scale wind patterns associated with the North American Monsoon (NAM) generally bring rain and cooler temperatures to Idaho and eastern Oregon and Washington, and is an important source of precipitation during the summer period. Rather than a persistent moisture source, the NAM is generally characterized by episodic bursts of convective activity (i.e., thunderstorms). A resilient ridge of high pressure resided over the western U.S. during much of the summer, as shown by the 500-hPa height contours in *Figure 12*, which diverted most moisture away from the southwestern U.S. and inhibited normal convective thunderstorm activity. The failure of the NAM to materialize further expanded drought severity and extent across the PNW. Nearly the entire U.S. west received less than 50% of its normal precipitation during August 1–September 15 (*shading in Figure 12*). Much of southern Oregon, and particularly in Malheur and Harney counties in southeast Oregon, exhibited exceptionally high levels of evaporative demand (*Figure 13*), which led to exceptionally dry surface soils in early September 2020 (*example shown in Figure 14*). The abnormally warm conditions, lack of precipitation, and dry soils are characteristic of flash drought, which inflicted much of Oregon, despite near-normal snowpack levels in the spring. The summer flash drought can be partially characterized as a low summer precipitation flavor of drought,[3] though the speed in which it occurred was faster than the summer droughts described in Bumbaco

3 Bumbaco, K.A., and P.W. Mote (2010). Three Recent Flavors of Drought in the Pacific Northwest. *Journal of Applied Meteorology and Climatology*, 49: 2,058–2,068.

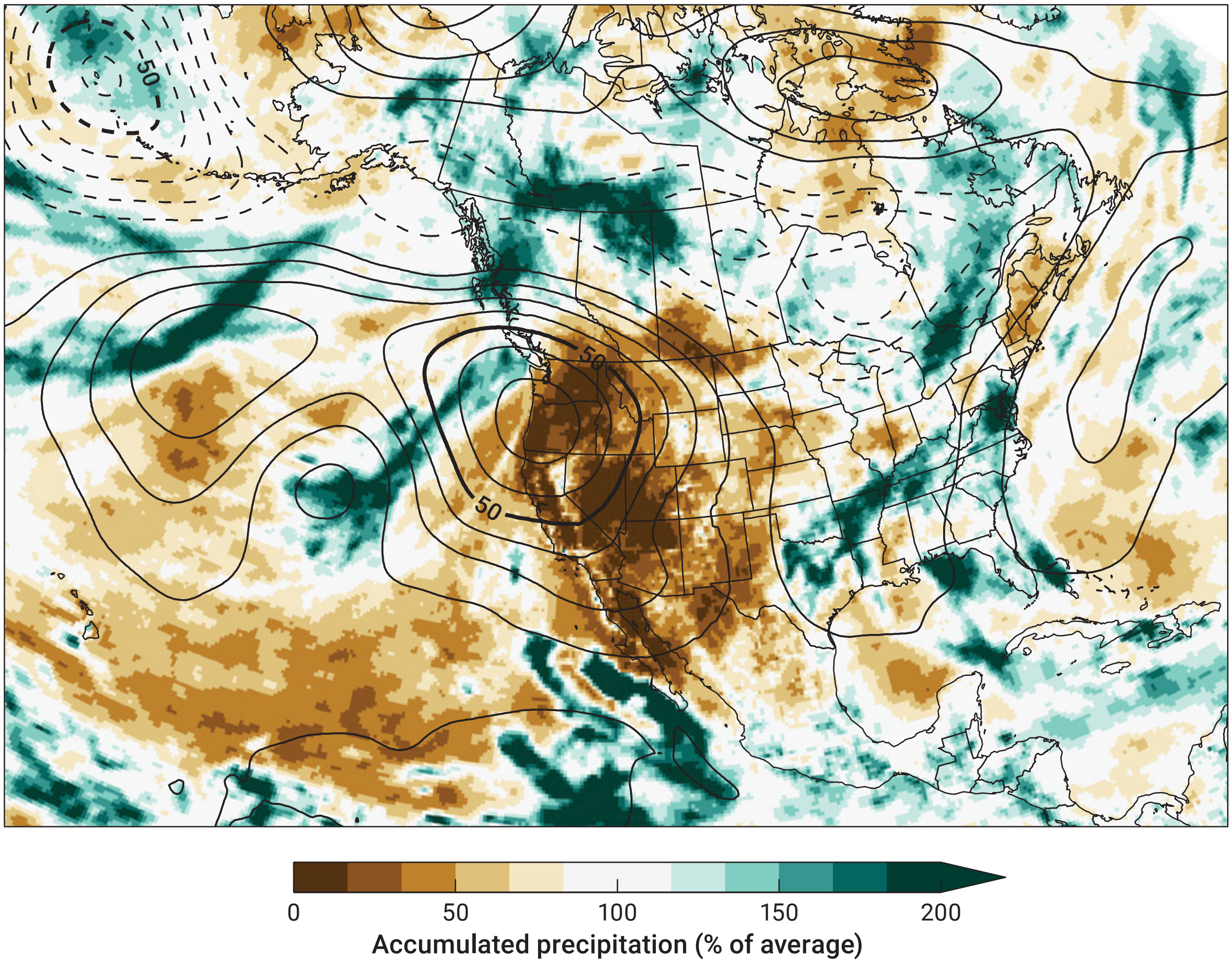


Figure 12: Map of 500 hPa geopotential height anomaly (*contours with an interval of 10 meters; solid contours are positive anomalies and dashed are negative*) and percent of average precipitation (*shading*) for Aug 1–Sep 15, 2020 from the ERA5 reanalysis.

and Mote 2010.[3] These same conditions led to widespread exceptionally dry soils over most of western Oregon as well in early September (*Figure 14*). A fortunate byproduct of the weak NAM during the summer was a relative lack of lightning activity in regions with extreme drought-induced wildfire risk.

The lack of NAM moisture and dry conditions in Idaho deteriorated the drought conditions that were already being experienced in the south-central portion of the state. The Big Wood Canal Company's reservoir ran dry at the beginning of September and the summer releases at other reservoirs in this region were much below normal (Big Wood Reservoir was 21% of average, the Little Wood Reservoir 39% of average, and the Big Lost Reservoir [Mackay Reservoir] was 50% of normal). The drought in Idaho can be characterized as both a low winter precipitation and a low summer precipitation flavor of drought.[3]

Large and intense wildfires in early September were a major event for the

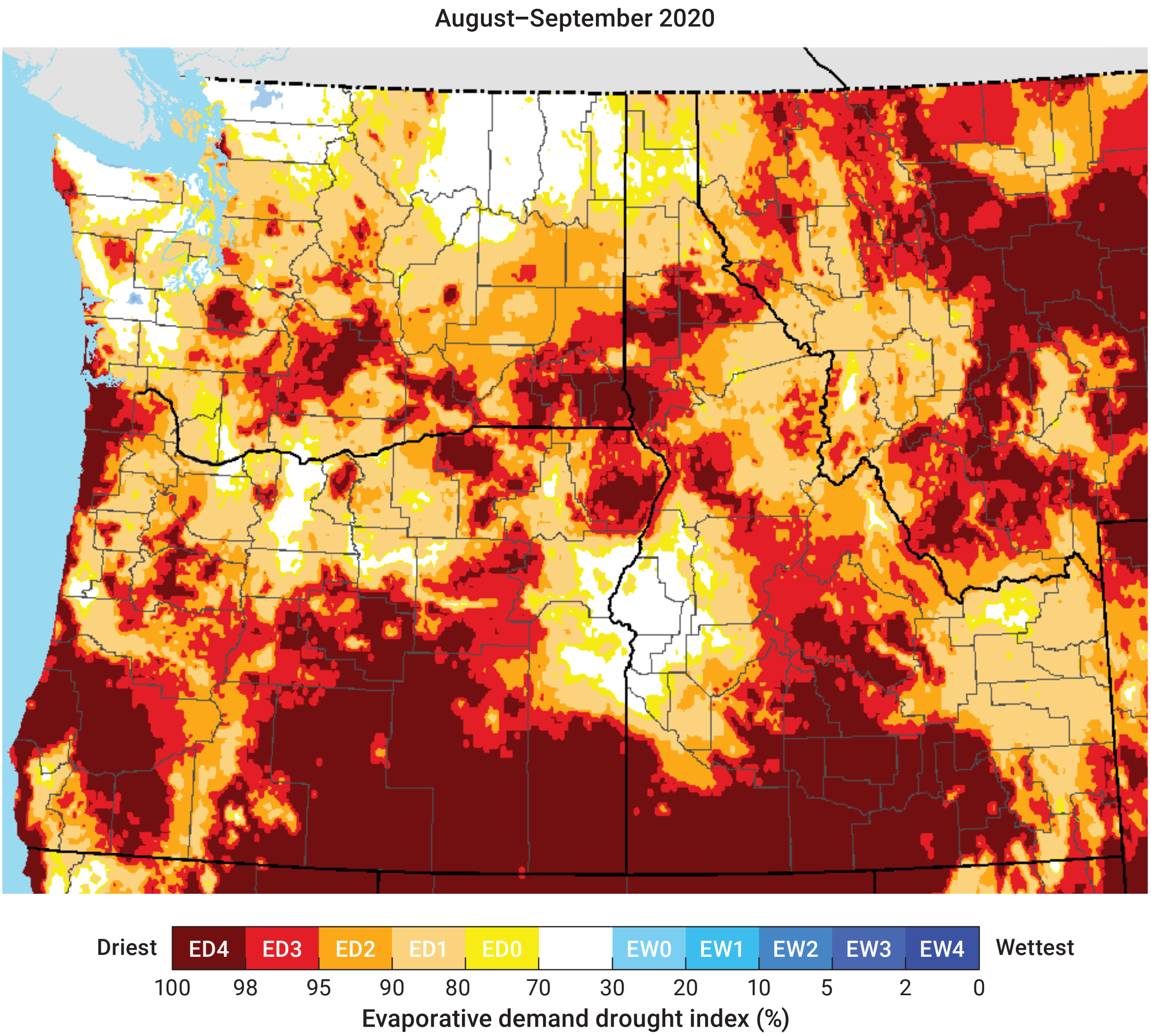


Figure 13: Map of August–September 2020 Evaporative Demand Drought Index (EDDI) from *gridMET data*, a measure of moisture at the land–surface interface. EDDI categories correspond to percentiles for the 1979–2019 period and use the same classification scheme as the U.S. Drought Monitor (Adapted from R. Norheim).

water year, the impacts of which are only briefly summarized in this report. Overall, Oregon had over 30 wildfires that burned over 1 million acres during the 2020 wildfire season. Information on the wildfires is available in this *storymap* developed by the OSU Extension Fire Program. The events were anticipated by forecasters. On September 7, NOAA Storm Prediction Center issued an "extremely critical fire weather warning" for NW Oregon, and Clark and Skamania counties in SW Washington due to forecasts showing extremely low relative humidity and strong east winds. On September 8, SW Oregon (Jackson, Josephine, and Douglas counties) was added to the "extreme category". This was only the 2nd time that an "extremely critical" fire weather warning

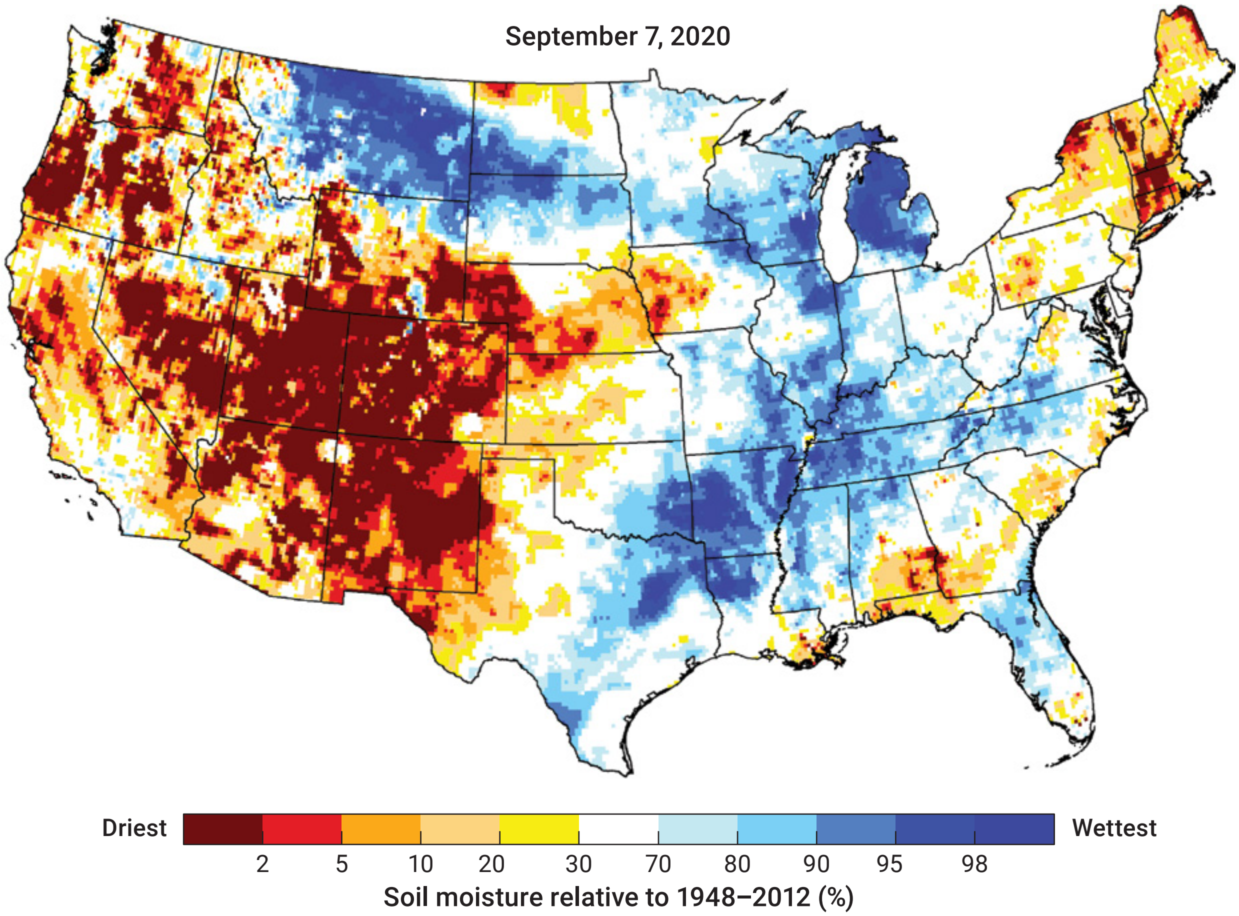


Figure 14: Map of surface soil moisture drought index from NASA GRACE on Sept. 7, 2020. The drought index categories correspond to the same classification scheme as the U.S. Drought Monitor (hosted by the *National Drought Mitigation Center*).

was issued in Washington or Oregon since the maps began to be archived in 2002. This extreme fire weather came at a time when moisture conditions were anomalously low across the PNW, especially in southern and SW Oregon. The Evaporative Demand Drought Index (EDDI) is a measure of moisture conditions at the atmosphere–surface interface that indicates sustained and rapidly evolving drought conditions and is well correlated with wildfire hazard potential. The August–September EDDI was above the 70th percentile for much of the PNW, but for large areas in W and SW Oregon, EDDI was in the 95th to 98th (1.5–2.0) and 98th to 100th percentile (2.0–2.5) categories, corresponding to the extreme and exceptional drought categories of the U.S. Drought Monitor.

Finally, it is worth noting that there was a pattern shift during the second half of September that brought precipitation into the PNW. Western Washington and western Oregon had above normal September precipitation totals. Averaged statewide, total September precipitation was above normal for Washington (ranked neutral; *Figure 3*), near-normal for Oregon (ranked neutral), and below normal for Idaho (abnormally dry).

3

WATER YEAR IMPACTS

Information on drought impacts and other conditions of the water year is critical to connecting climate conditions to consequences for local resources, people, and economies. Here we summarize impacts to multiple sectors in Oregon, Idaho, and Washington from three sources:

- The national ***Condition Monitoring Observer Reports (CMOR)***
- A northwest regional water year impacts survey
- Presentations and discussions from the 2020 water year meeting

The impacts presented in this report are not comprehensive, as only what was reported in these three sources of information are included.

Condition Monitoring Observer Reports (CMOR)

The CMOR on drought (National Drought Mitigation Center and the National Integrated Drought Information System) collects local observations of drought impacts from landowners to inform drought monitoring and research. Impacts provide input into the U.S. Drought Monitor process and inform agencies that make drought-related decisions based on dry or wet conditions.

Water Year 2020 Northwest Regional Impacts Survey

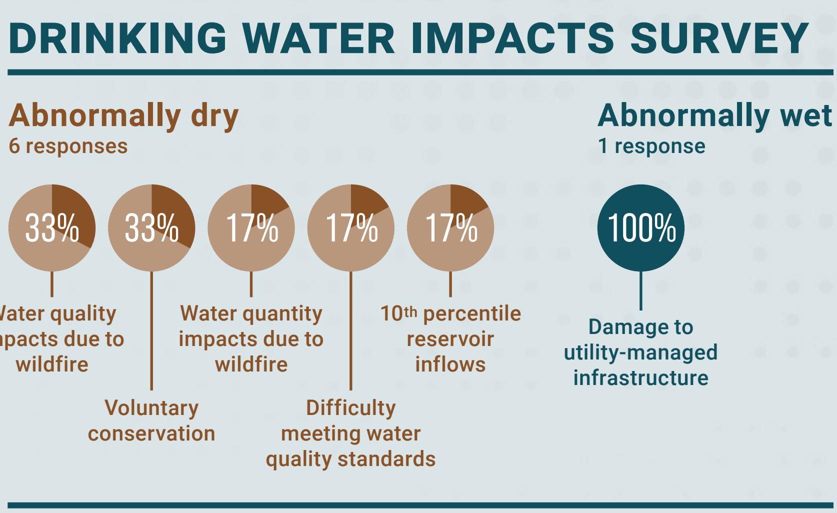
To augment CMOR, we administered a PNW regional survey to collect water year impacts for multiple sectors (drinking water, agriculture, forestry, fisheries, hydropower, recreation, and stormwater) due to abnormally wet and abnormally dry conditions. Determination of abnormally dry or wet conditions was left to the survey respondents. Respondents had the option to select impacts from a list or specify their own impacts.

We distributed the survey in October 2020 via listservs of the National Integrated Drought Information System, the Office of the Washington State Climatologist, and the Climate Impacts Group, as well as some regional water associations. Forty people responded; most respondents (51%) were employees of state and federal agencies, with additional respondents representing Tribes, nonprofit organizations, universities, and power/water utilities. We include responses from agencies, as well as those managing resources directly, and in some cases responses may describe the same impacts.

SECTOR-SPECIFIC WATER YEAR IMPACTS

Drinking water

Six (6) survey respondents reported impacts to drinking water. Of these, 6 (100%) reported impacts due to abnormally dry conditions and 1 (17%) reported impacts due to abnormally wet conditions. Most drinking water sector impacts reported via the survey were for watersheds in Oregon, including the Bull Run and Clackamas. The primary cause of impacts was wildfire, which affected drinking water quality, quantity, and infrastructure.



Bend, Oregon

A major thunderstorm on August 5, 2020 greatly affected water quality in the Deschutes National Forest in the designated municipal watershed of Bend, Oregon (*Figure 15*). Lightning also causes power outages and has damaged equipment in similar high intensity storms. This storm caused extremely high instantaneous streamflows in the Tumalo Creek watershed. High flows, in combination with lingering soil instability from previous wildfires that occurred decades ago, caused a major turbidity event that affected drinking water production, quality, and filtration.

Figure 15: The image on the left shows typical turbidity levels and the image on the right shows the high turbidity on August 5, 2020 associated with a major thunderstorm in the Tumalo Creek Watershed municipal water supply for Bend, Oregon (City of Bend).

Sep. 2020 wildfire damage to a pump station at the City of Detroit, Oregon (*top*) and a water treatment plant facility at Panther Creek Water District, Oregon (*bottom*). Photo credit: Heath Cokeley, Oregon Association of Water Utilities Circuit Rider.

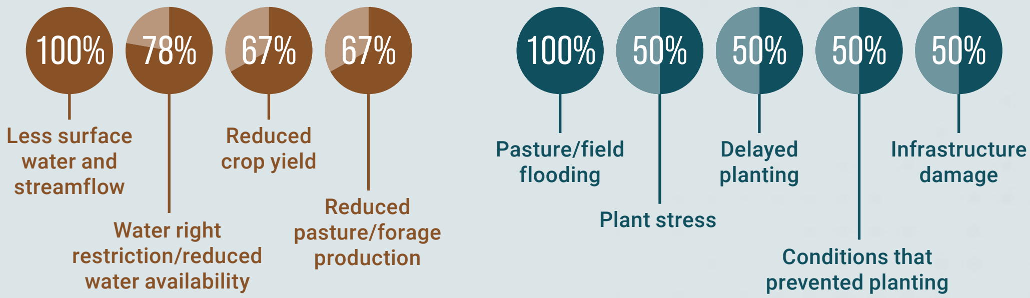
The Oregon Association of Water Utilities described several impacts to drinking water systems due to the 2020 wildfires. Wildfires jeopardized over 60 drinking water systems and 20 systems were compromised. Water systems experienced loss of pressure due to infrastructure damage and power outages. Some communities had notices to not use or boil water. Several systems incurred major infrastructure loss including treatment plants, pump stations, and generators. Severely affected communities included Lyons/Mehama, Gates, Detroit, Blue River, Talent, Phoenix, Panther Creek, Echo, Salmon River and River Bend. Impacts to individual wells, including damaged equipment, reduced water quality, and groundwater contamination were also suspected but not well known.

Wildfires also affected drinking water systems in Pierce, Douglas, and Okanogan counties in Washington. Systems experienced power outages that affected system pressure, chlorination, and other aspects of system operations. Some customers experienced service interruptions and were under boil water health advisories until systems could be restored and water quality tested.

AGRICULTURE IMPACTS SURVEY

Abnormally dry
9 responses

Abnormally wet
2 responses

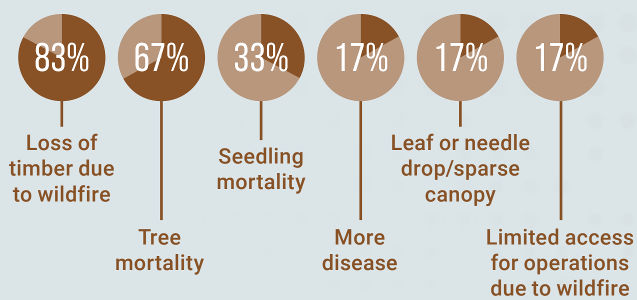


Agriculture

Ten (10) survey respondents reported impacts to agriculture. Of these, 9 (90%) reported impacts due to abnormally dry conditions and 2 (20%) reported impacts due to abnormally wet conditions. Deschutes, Crooked, and Rogue River basins in Oregon had numerous impacts due to abnormally dry conditions, as did Okanogan and Ferry Counties in Washington. Impacts from dry conditions in Oregon affected dryland and irrigated agriculture, rangeland production, and the beef cattle industry. In Okanogan County Washington, production of dryland crops and forage was reduced. Wine crops in both Oregon and Washington were damaged by wildfires and smoke. The abnormally wet conditions were reported in Umatilla county due to a major flood event in February, and impacted pasture fields and agricultural infrastructure.

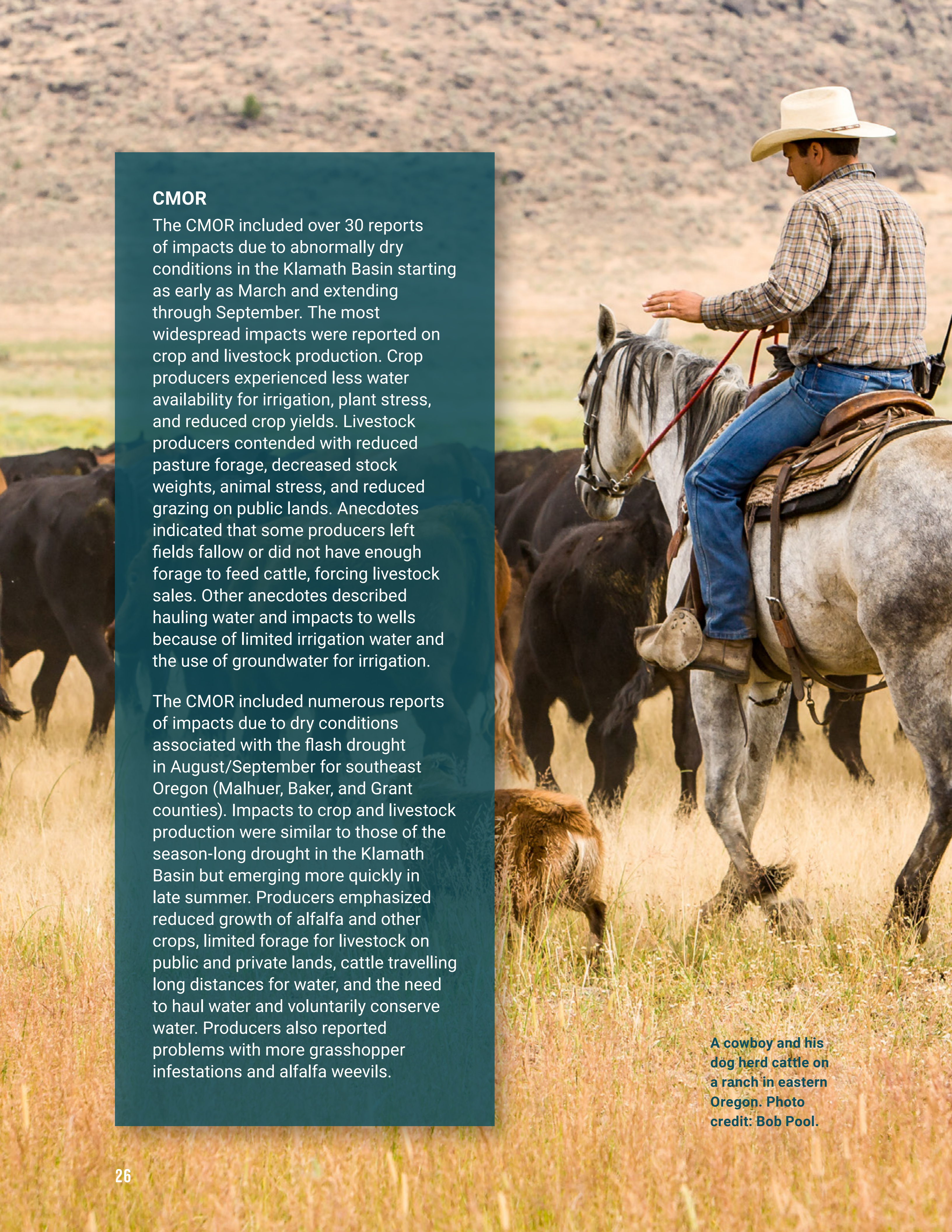
FORESTRY IMPACTS SURVEY

Abnormally dry
6 responses



Forestry

Six (6) survey respondents reported impacts to forestry and all impacts were due to abnormally dry conditions. Impacts to forestry were reported for areas throughout Oregon and Washington with specific impacts in Okanogan and Ferry counties and the Nooksack river basin in Washington.



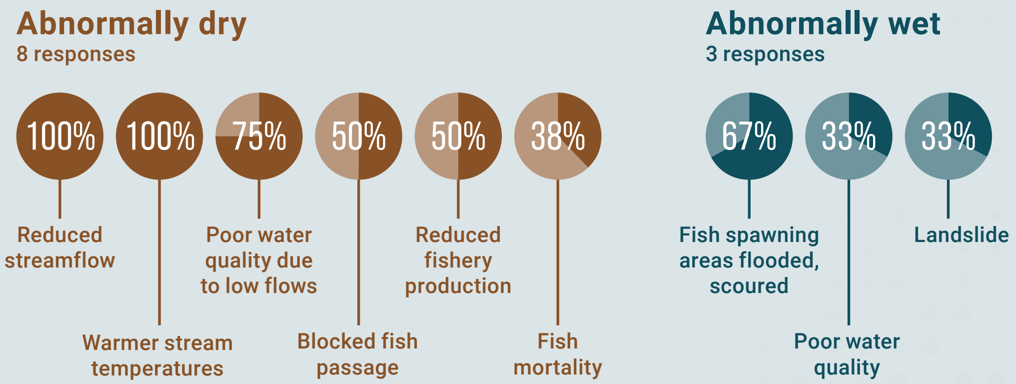
CMOR

The CMOR included over 30 reports of impacts due to abnormally dry conditions in the Klamath Basin starting as early as March and extending through September. The most widespread impacts were reported on crop and livestock production. Crop producers experienced less water availability for irrigation, plant stress, and reduced crop yields. Livestock producers contended with reduced pasture forage, decreased stock weights, animal stress, and reduced grazing on public lands. Anecdotes indicated that some producers left fields fallow or did not have enough forage to feed cattle, forcing livestock sales. Other anecdotes described hauling water and impacts to wells because of limited irrigation water and the use of groundwater for irrigation.

The CMOR included numerous reports of impacts due to dry conditions associated with the flash drought in August/September for southeast Oregon (Malhuer, Baker, and Grant counties). Impacts to crop and livestock production were similar to those of the season-long drought in the Klamath Basin but emerging more quickly in late summer. Producers emphasized reduced growth of alfalfa and other crops, limited forage for livestock on public and private lands, cattle travelling long distances for water, and the need to haul water and voluntarily conserve water. Producers also reported problems with more grasshopper infestations and alfalfa weevils.

A cowboy and his dog herd cattle on a ranch in eastern Oregon. Photo credit: Bob Pool.

FISHERIES IMPACTS SURVEY



Fisheries

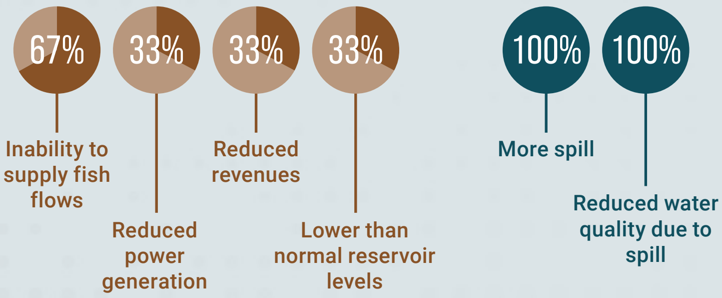
Nine (9) survey respondents reported impacts to fisheries. Of these, 8 (89%) reported impacts due to abnormally dry conditions and 3 (33%) reported impacts due to abnormally wet conditions. Impacts to fisheries due to abnormally dry conditions were reported for Oregon, Washington, and Idaho. In Washington, impacts were reported for several counties (Okanogan, Ferry, Thurston, Kittitas, and Chelan), as well as the Yakima and Nooksack river basins. In Oregon, impacts were reported for the Upper Deschutes Basin. In Washington, impacts to fisheries due to abnormally wet conditions were reported for Okanogan and Pierce counties and Water Resource Inventory Areas (WRIAs) 19 and 20 on the Olympic Peninsula.

A fisherman holds a rainbow trout from the Lower Deschutes River in Oregon (Joshua Rainey).

HYDROPOWER IMPACTS SURVEY

Abnormally dry
3 responses

Abnormally wet
1 response



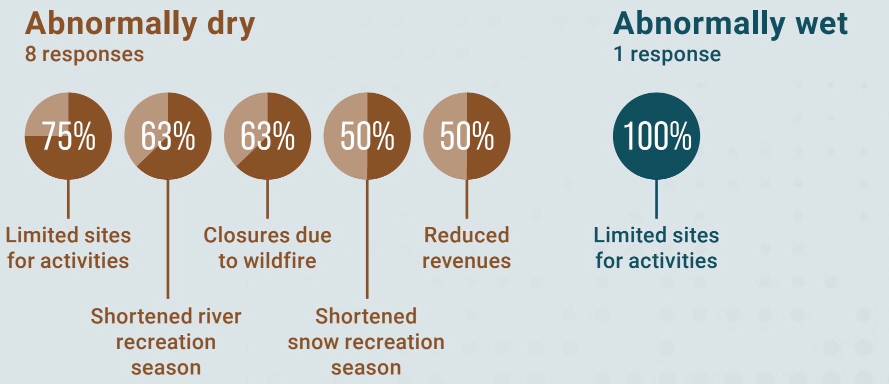
Hydropower

Three (3) respondents reported impacts to hydropower. Of these, 3 (100%) reported impacts associated with abnormally dry conditions and 1 (33%) reported impacts associated with abnormally wet conditions. Abnormally wet conditions due to high spring flows caused more spilling at dams that impaired water quality by increasing total dissolved gasses. Impacts to hydropower associated with abnormally dry conditions were reported for the Snake and Columbia River Basins, as well as smaller rivers in Oregon. Loss of hydropower generation due to wildfires was also reported for Oregon.

The dry start to the water year caused concern among hydropower utilities in the PNW and increased fall energy market purchases, as well as market uncertainty, but a wet winter subsequently increased power generation and eased concerns. Later in the summer, low streamflows on the Deschutes and Clackamas rivers in Oregon reduced hydropower generation.

Aerial view of Alder Lake Dam in Washington (Cascade Creatives).

RECREATION IMPACTS SURVEY

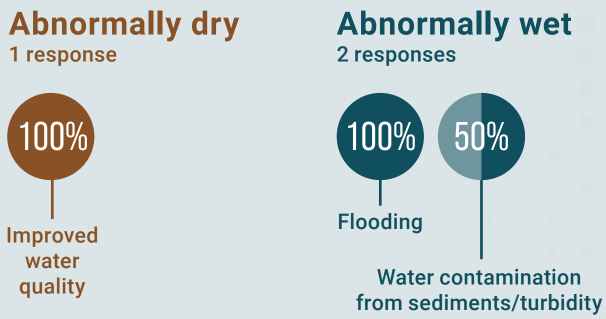


Recreation

Eight (8) survey respondents reported impacts to recreation. Of these, 8 (100%) reported impacts associated with abnormally dry conditions and 1 (13%) reported impacts associated with abnormally wet conditions. Impacts to recreation were reported for areas throughout Oregon with the Upper Deschutes River Basin highlighted. Impacts were also reported for Okanogan and Ferry counties in Washington.

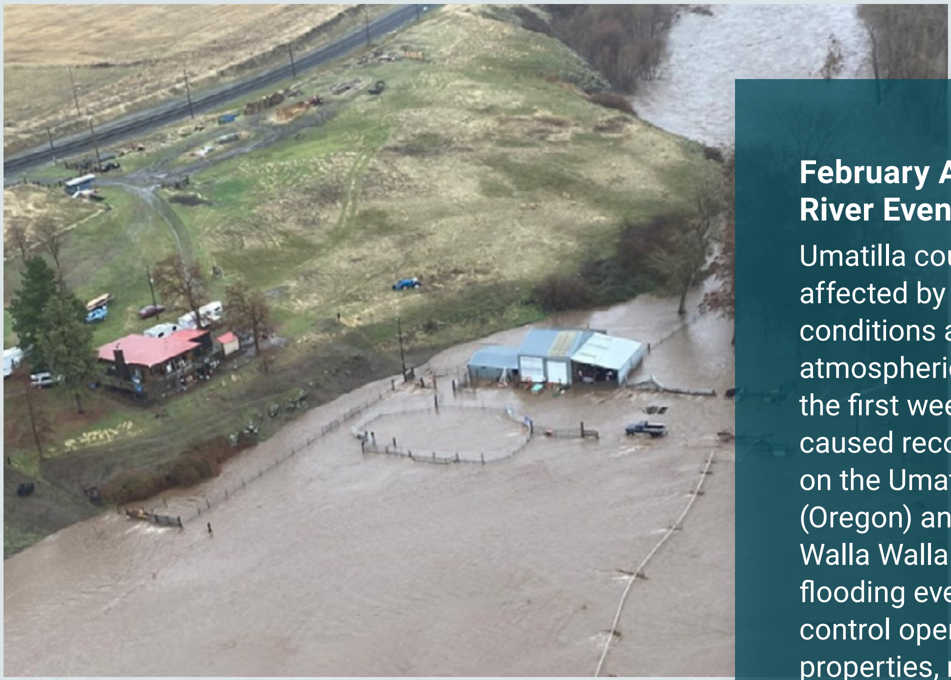
Limited sites for recreation activities was the most commonly reported impact for both dry and wet conditions. Specific examples of limited recreation were unreliable access for skiing due to variable snow accumulation, low reservoir levels or reservoirs completely drained, limited river rafting, closures of recreation sites due to smoke and poor air quality. Unusually low flows on the Umpqua river (Oregon) reduced access for fishing and floating.

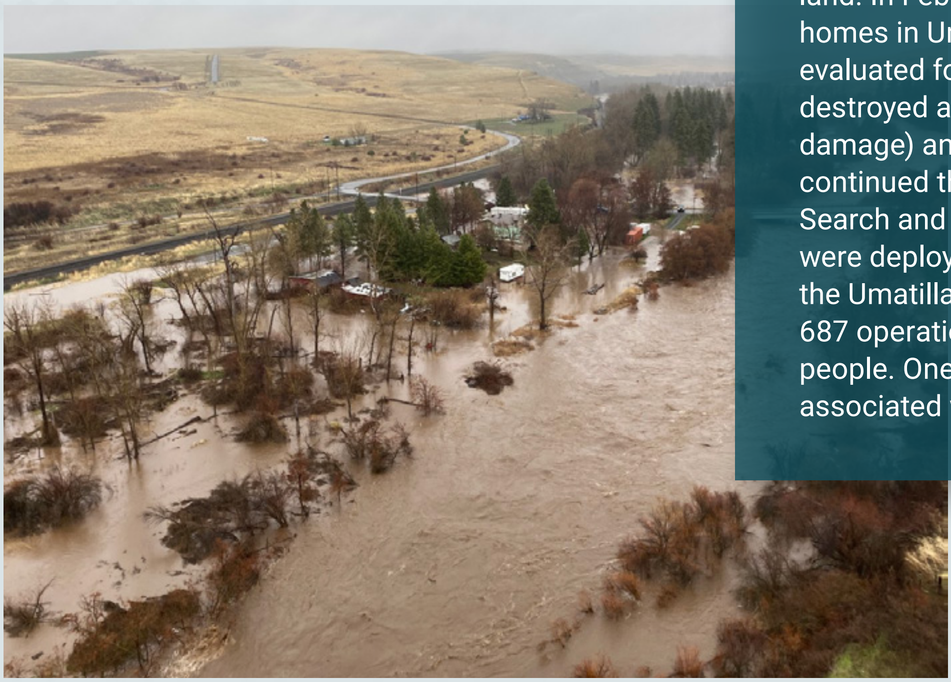
STORMWATER IMPACTS SURVEY



Stormwater

Three (3) survey respondents reported impacts to stormwater management. Of these, 1 (33%) reported impacts associated with abnormally dry conditions and 2 (66%) reported impacts associated with abnormally wet conditions. Impacts due to abnormally dry conditions were reported for Portland, Oregon. Abnormally dry conditions in Portland resulted in no combined sewer overflows (CSOs). Impacts due to abnormally wet conditions were reported for the Deschutes basin in Oregon and Thurston County in Washington. Abnormally wet conditions in Thurston county led to road closures and stormwater runoff from roads.





February Atmospheric River Event

Umatilla county was greatly affected by abnormally wet conditions associated with the atmospheric river event during the first week of February, which caused record high streamflow on the Umatilla River near Gibbon (Oregon) and Mill Creek in Walla Walla (Washington). The flooding events required flood control operations and flooded properties, roads, and pasture land. In February alone, 283 homes in Umatilla county were evaluated for damages (6 were destroyed and 147 had major damage) and assessments continued through the year. Search and rescue operations were deployed on Mill Creek and the Umatilla River, for a total of 687 operation hours, rescuing 57 people. One fatality was tragically associated with this event.

February 2020 flooding of infrastructure and agricultural land in Umatilla County, Oregon.

4 INDIVIDUAL, ORGANIZATION, & STATE-LEVEL RESPONSES

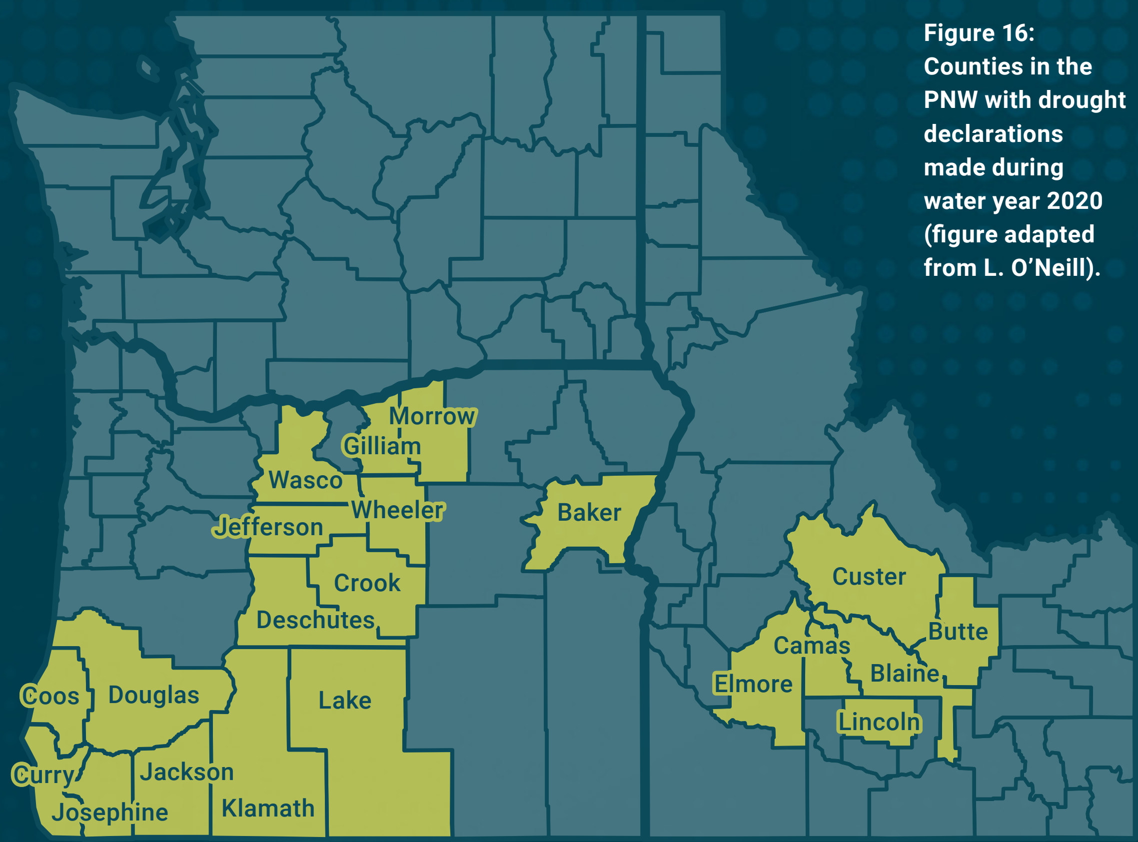


Figure 16: Counties in the PNW with drought declarations made during water year 2020 (figure adapted from L. O'Neill).

A large glowing cloud from wildfires near Walterville, Oregon on Sept 9, 2020. Credit: J. Robert Williams

State Response

Drought declarations (*Figure 16*) for the water year in Oregon began with Klamath county on March 2 and ended with Baker county on September 15. In total, Governor Brown declared 15 Oregon counties in drought. In Idaho, Governor Little approved early drought declarations in Butte and Custer counties on April 29, Lincoln County on May 26, and Blaine County on June 5. Governor Little also issued drought declarations for Camas County (within the Big Wood basin) and Elmore County in September. Washington did not have any official drought declarations.

There were several emergency proclamations made for weather and climate conditions that aided in the state response. Both Governor Inslee and Governor Brown declared emergencies for the February heavy rain and flooding in SE Washington and NE Oregon on February 5 and February 6, respectively. On August 19, Washington and Oregon issued a state of emergency for the threat of wildfires. Oregon issued over 10 emergencies for individual fires in the late summer, and also another statewide proclamation on the extreme fire danger on September 9.

Organizational or Individual Response

The 2020 water year impacts survey asked respondents if they modified operations in anticipation of or in response to abnormally dry or abnormally wet conditions experienced during the water year. Respondents in all sectors indicated some change in operations in response to conditions.

Sector	Condition (total responses)	Percent modified operations	Modified operations
Drinking Water	Dry (6)	33%	• Used more chemicals to manage water quality due to ash.
	Wet (1)	0%	None reported
Agriculture	Dry (9)	66%	• Beef cattle industry: supplemented forage, moved cattle to new forage supplies, fed hay earlier, and reduced livestock herds. • Managed reservoirs more closely and set minimum flows at lowest levels. • Greater coordination with partner and stake-holder agencies to manage low flows. • Reduced irrigation district supplies. • Voluntary curtailment by districts with senior water rights to assist districts with junior water rights. • Drained reservoirs, shut operations until natural water returned.
	Wet (2)	0%	None reported
Forestry	Dry (6)	50%	• Closed forestry operations earlier in the season. • Greater fire suppression efforts in western Oregon and Washington.
	Wet (0)		None reported
Fisheries	Dry (8)	33%	• Captured and relocated fish • Fish barrier removal • Water wheeling
	Wet (3)	100%	• Released fish from net pens early to the river to increase survival. • Actions to mitigate effects of landslides.
Hydropower	Dry (3)	66%	• Stopped power generation. • Increased power generation. • Reduced spill.
	Wet (1)	100%	• Released fish from net pens to the river early to increase survival.

Sector	Condition (total responses)	Percent modified operations	Modified operations
Recreation	Dry (8)	63%	• Closed sites • Refunded recreation fees • Modified recreation activities due to wildfires and smoke
	Wet (1)	0%	None reported
Stormwater	Dry (1)	0%	None reported
	Wet (3)	66%	• Proactively closed roads • Increased revegetation projects to mitigate effects of stormwater runoff

Changes in Operations Based on Forecasted Conditions

Water providers and natural resource managers overwhelmingly indicated on the impacts survey that they use seasonal forecast information throughout the year (90% of survey respondents) and take anticipatory action based on the forecasts. The most commonly used forecast is the *NOAA Climate Prediction Center Seasonal Outlook*. In addition to monitoring forecasts more closely as drought developed and increasing efforts to provide forecast information to users, some specific actions were taken in anticipation of the forecast of abnormally dry conditions.

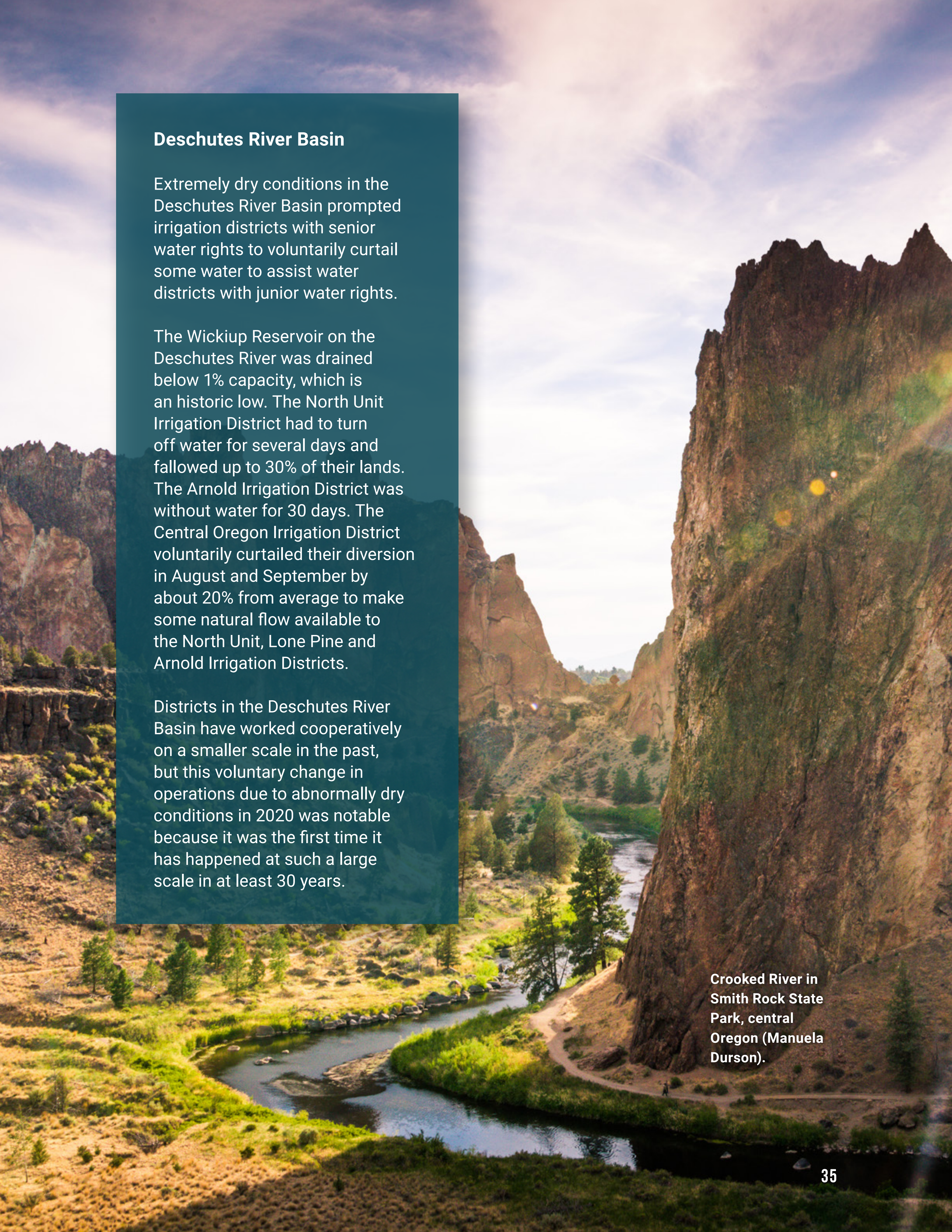
- Proactive engagement with the media and stakeholders to respond to questions relating to the onset of drought and dry conditions.
- Summer voluntary water conservation campaigns.
- Ending the forest work season earlier and adding more helicopter surveillance for wildfires.
- Proactive coordination to mitigate aquatic habitat impacts associated with low dissolved oxygen conditions due to lack of precipitation and low snowpack runoff.
- Collaboration with conservation districts to increase funding and technical assistance for land managers anticipating drought conditions.

Deschutes River Basin

Extremely dry conditions in the Deschutes River Basin prompted irrigation districts with senior water rights to voluntarily curtail some water to assist water districts with junior water rights.

The Wickiup Reservoir on the Deschutes River was drained below 1% capacity, which is an historic low. The North Unit Irrigation District had to turn off water for several days and fallowed up to 30% of their lands. The Arnold Irrigation District was without water for 30 days. The Central Oregon Irrigation District voluntarily curtailed their diversion in August and September by about 20% from average to make some natural flow available to the North Unit, Lone Pine and Arnold Irrigation Districts.

Districts in the Deschutes River Basin have worked cooperatively on a smaller scale in the past, but this voluntary change in operations due to abnormally dry conditions in 2020 was notable because it was the first time it has happened at such a large scale in at least 30 years.



Crooked River in Smith Rock State Park, central Oregon (Manuela Durson).

Wood River and Big Lost Basins

Fall colors on the Big Wood River in Sun Valley, Idaho (CSNafzger).

Water managers in the Wood River Basin and the Big Lost Basin, in the heart of Idaho's drought, indicated that adverse agricultural impacts were less than expected. Seeing snowpack was less than 50% of normal at the typical peak (May 1), farmers adjusted crop mixes to include more early season crops such as spring wheat and barley to minimize late season water demand. These adjustments to crop mix in combination with near-normal May–June temperatures and below normal July temperatures also helped to reduce demand for stored water. The Big Wood Canal Company ran out of stored water later than expected and the irrigation districts on the Little Wood and Big Wood were able to stretch storage supplies to the end of the season.

Deschutes, Crooked, and Rogue River Basins

The Deschutes River heads toward Benham Falls near Bend, Oregon (Wirestock Creators).

The Bureau of Reclamation changed reservoir operations on the Deschutes, Crooked, and Rogue River Basins based on the forecast of dry conditions. Reservoir releases were reduced, minimum flows were set at the absolute lowest levels, and the agency increased coordination with partner and stakeholder agencies to communicate operation plans. Reservoirs were allowed to fill above flood control rule curves (reducing flood storage capacity) based on the forecast dry conditions. This anticipatory action prevented further degradation of the water supply conditions for irrigators and other water users.

5 FORECAST VERIFICATION

Over 90% of the survey respondents indicated their reliance on the Climate Prediction Center's seasonal forecasts.

Forecast skill is higher in some years compared to others. On the following pages, two example seasonal forecasts, one made for November 2019–January 2020 (NDJ) and one made for April–June 2020 (AMJ), are examined qualitatively for accuracy.

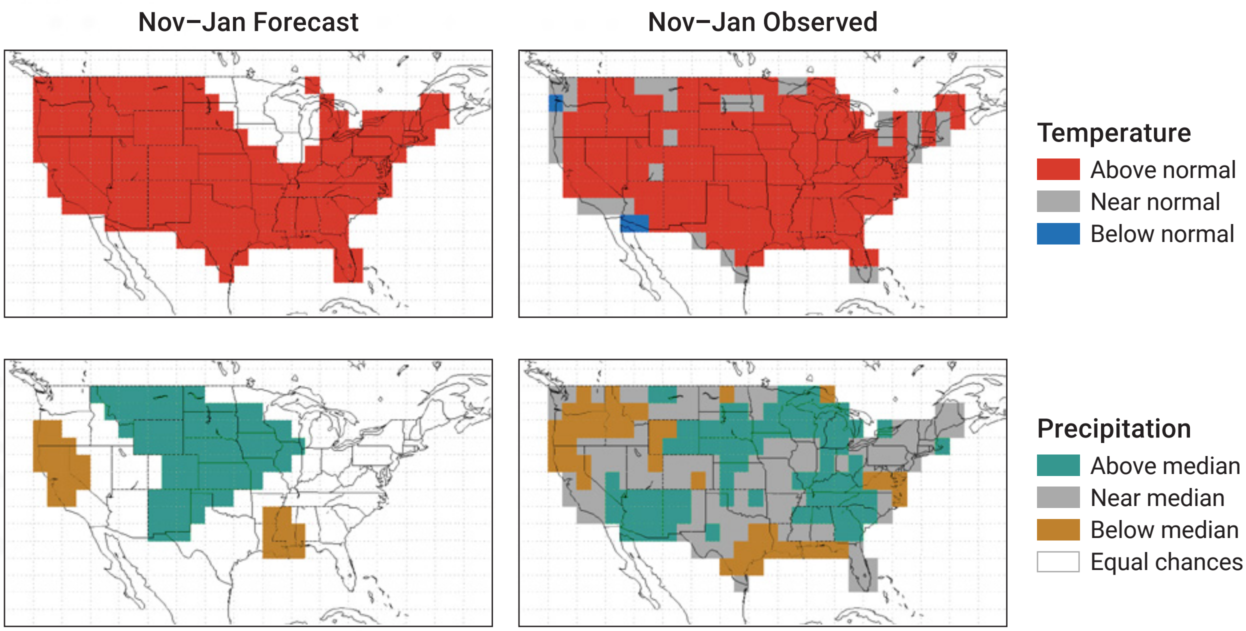


Figure 17: Categorical temperature and precipitation forecasts for November 2019–January 2020 (NDJ) issued October 2019 compared to NDJ observations (*Climate Prediction Center*).

November 2019–January 2020 Forecast and Verification

The Climate Prediction Center (CPC) temperature forecast issued in October 2019 favored higher odds of above normal temperatures for the entire PNW for NDJ (*Figure 17*). That forecast verified for all of Idaho, eastern Washington, and central and eastern Oregon. Most of western Washington through the Cascade Mountains and western Oregon had near-normal temperatures for NDJ, resulting in a Category 1 type error for the CPC seasonal forecast. A small area encompassing SW Washington and NW Oregon had below normal NDJ temperatures, a Category 2 error and not anticipated from the forecast. The CPC NDJ precipitation forecast indicated below median precipitation for southwestern Oregon and above median precipitation for northern Idaho. The remaining areas were expected to receive near median precipitation. The forecast verified for SW Oregon as most of the PNW received below median precipitation. Western Washington, NE Washington, southern Oregon, and southern Idaho received near-median precipitation, also verifying the CPC forecast. Northern Idaho received below median precipitation, resulting in a Category 2 error.

NOV–JAN FORECAST

Above normal temperatures mostly verified throughout the PNW, but the period was drier than forecast.

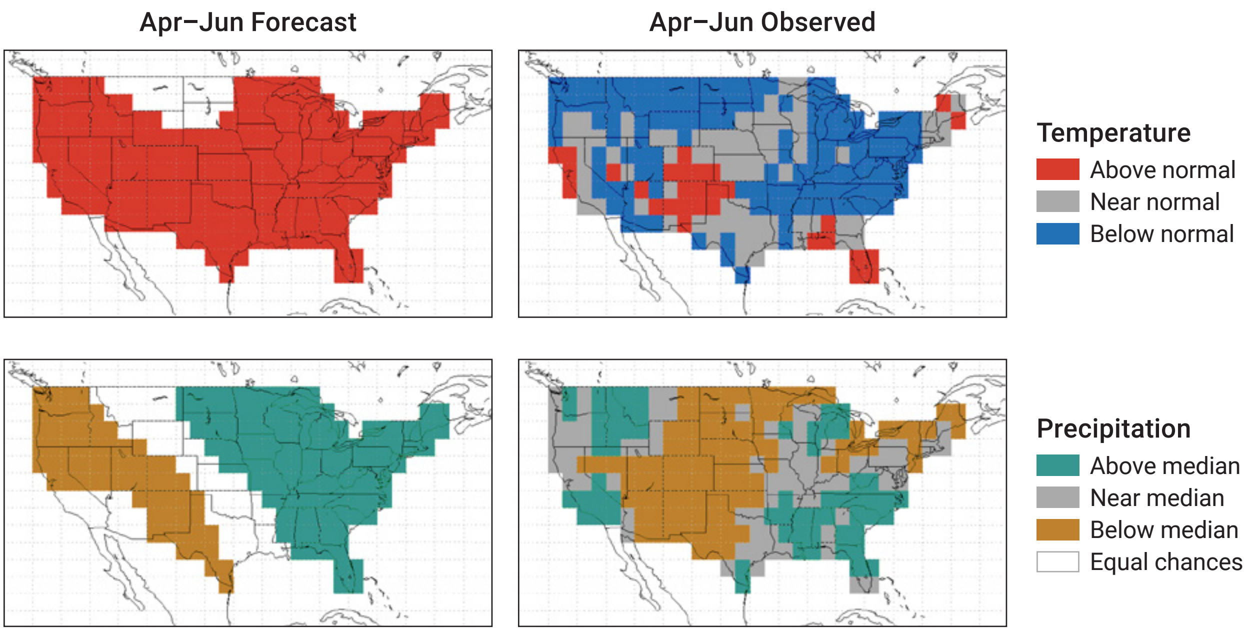


Figure 18: Categorical temperature and precipitation forecasts for April–June 2020 (AMJ) issued March 2020 compared to AMJ observations (*Climate Prediction Center*).

April–June 2020 Forecast and Verification

The CPC temperature forecast issued in March 2020 favored higher odds of above normal temperatures for the entire PNW for AMJ (*Figure 18*). That forecast was largely a Category 2 error as all of Washington, northern Idaho, coastal Oregon, and parts of NE Oregon and southern Idaho had below normal temperatures for the period. The remaining areas of the PNW had near-normal temperatures. The CPC AMJ precipitation forecast, calling for below median precipitation region-wide, was also a miss as precipitation was either above median or near the median throughout the PNW.

APR–JUN FORECAST

Average conditions were cooler and wetter than forecast.

It bears emphasizing that these forecast verifications are merely recent examples, and should not be generalized. They do illustrate that actual seasonal temperature and precipitation anomalies tend to be patchier than the broad-scale distributions that are forecast. In general, the skill of seasonal predictions of temperature is greater than that for precipitation, and for the winter season, with major ENSO events providing much of that predictability for the PNW.

6 LESSONS LEARNED

Water and natural resource managers shared lessons learned from managing for the climate events of water year 2020 at the regional meetings.

For example, the extreme drought in the Deschutes Basin, which can be characterized as a low winter and summer precipitation flavor of drought,[3] prompted some water managers to consider developing better communication tools to help with water conservation efforts during these types of droughts in the future. In addition, the devastating wildfires in Oregon had some major drinking water suppliers reconsidering emergency plans to better address contingency plans should a wildfire move into the watershed directly. Ultimately, given the extent of the impacts from wildfires during a global pandemic, the water year demonstrated that seemingly unlikely events can occur at the same time, demonstrating the need to think about risk more broadly as we plan for future climate and drought resilience.

For climate and drought information providers (such as many of the authors of this assessment) and those that manage drought at the federal, state, and local level, water year 2020 provided lessons as well. Systematic collection of water year impacts to multiple sectors is desired and would provide key information for responding to climate-related events in the future, using past impacts of climate events to show clarity around specific trigger points for action. Drought monitoring would also benefit from increased

Low water levels in the Breitenbush River near Detroit City, Oregon. Credit: Victoria Ditkovsky.

regularity and timeliness of drought impact reports during all times of year and from a broader range of sectors. As for the regional water year impacts survey that was developed in fall 2020, wider distribution of the survey is needed to capture more regional impacts, with more specifics on the location of impacts described.

Continued collaboration among states in the PNW throughout the water year is beneficial for gathering impacts as the year progresses. The late summer 2020 flash drought in SE Oregon was not necessarily well represented in established drought metrics, and was slower to be shown in the U.S. Drought Monitor than droughts that have developed more gradually, indicating a potential area of research. Finally, attribution analyses that determine to what extent anthropogenic climate change contributed to key climate events is critical for communication on building future resilience.

Given the extent of the impacts from wildfires during a global pandemic, the water year demonstrated that seemingly unlikely events can occur at the same time.

2020

PACIFIC NORTHWEST WATER YEAR

IMPACTS ASSESSMENT

Supported by the
NOAA National Drought
Information System

NIDIS