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April 27, 2015

MEMORANDUM

TO: Council members

FROM: Jim Ruff – Manager, Mainstem Passage and River Operations

SUBJECT: Hydrologic conditions, water supply forecasts and drought declarations for the Columbia River Basin

Presenter: I will present this agenda item.

Summary: The April 20 water supply reports issued by the Natural Resources Conservation Service (NRCS) and NOAA's Northwest River Forecast Center show widely varying precipitation across the Columbia River Basin which, when combined with higher than normal temperatures, combine to result in an early spring runoff from a meager mountain snowpack across the basin. The end result is that April water supply forecasts have continued to deteriorate. While British Columbia, western Montana, north-central Washington and the headwaters of the Snake have near to slightly below normal runoff forecasts, the forecasts for the lower Snake River, southern Idaho, and eastern and western Oregon and Washington are mostly well below average. Water supply forecasts are low enough that drought declarations have been declared in numerous counties and watersheds in Idaho, Oregon and Washington.

Relevance: The relevance and purpose of this agenda item is fourfold: 1) provide the Council with the latest NOAA weather and Natural Resources Conservation Service's precipitation and snowpack summary through March 2015; 2) provide the NOAA-Northwest River Forecast Center's latest April water supply forecasts for selected sites in the Columbia River Basin; 3) highlight the current drought declarations in the Northwest states; and 4) present NOAA's long-range temperature and precipitation forecasts for the region over the next three months.

Work plan: Although this briefing information is not part of the Council's work plan, the poor water supply conditions will most likely affect fish and wildlife, hydropower production, irrigated agriculture, and other water uses in the Columbia Basin this spring and summer.

Background information: To summarize March weather conditions, precipitation across the Columbia Basin was quite variable, with average to well above average rainfall in the north-central part of the basin and below, to much below, normal precipitation in the southern half of the basin. March precipitation in the upper Snake Basin was less than 50 percent of normal.

Seasonal precipitation for the water year (October 1, 2014 through April 21, 2015) was also quite variable and shows a similar trend, with normal to above normal rainfall in the north-central portions of the Columbia Basin into British Columbia and much below normal (60-70 percent) in the upper Snake Basin and in the Yakima Basin (Figure 1). Seasonal precipitation for the Columbia River above Grand Coulee Dam is 106 percent of average; water year precipitation for the Snake River Basin above Ice Harbor Dam is only 78 percent of normal; and seasonal rainfall for the Columbia River above The Dalles is 89 percent of average.

The most notable weather trend during the 2015 water year has been the higher than normal temperatures since last October. With the exception of November, which was cooler than normal, during every other month the Columbia Basin experienced 3 to 6 degree F temperature deviations above historic averages (Figure 2 shows the temperature deviation across the basin during March 2015).

This warmer than normal trend has resulted in lower than normal snowpack levels across the basin, with the exception of the high elevation areas along the Rocky Mountains. The warming trend has continued into the early spring months, when the region could still be building up snowpack into the middle of April.

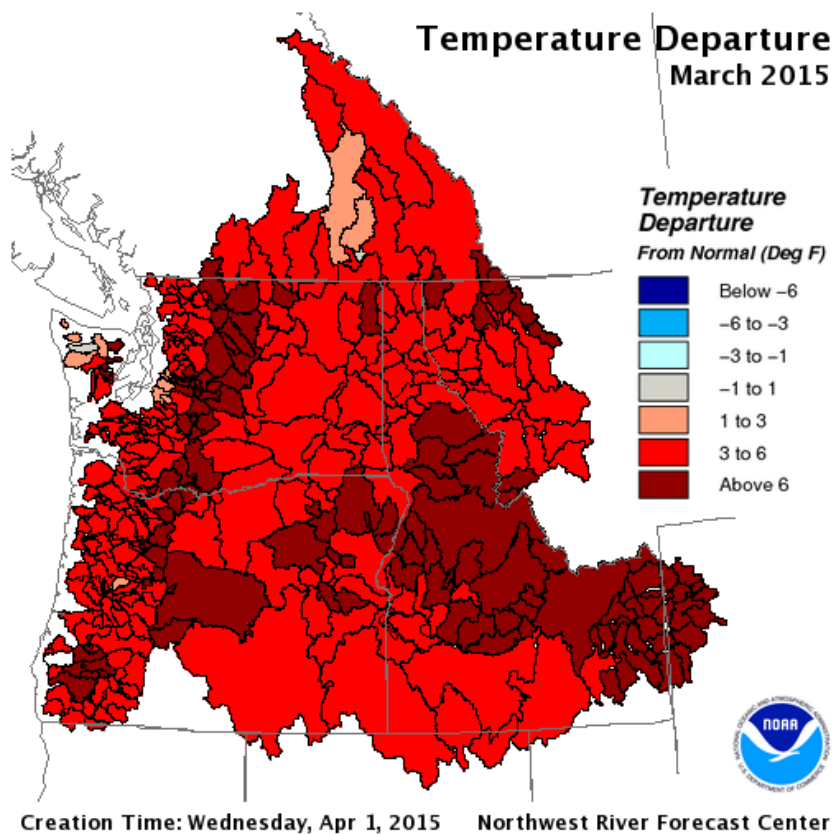
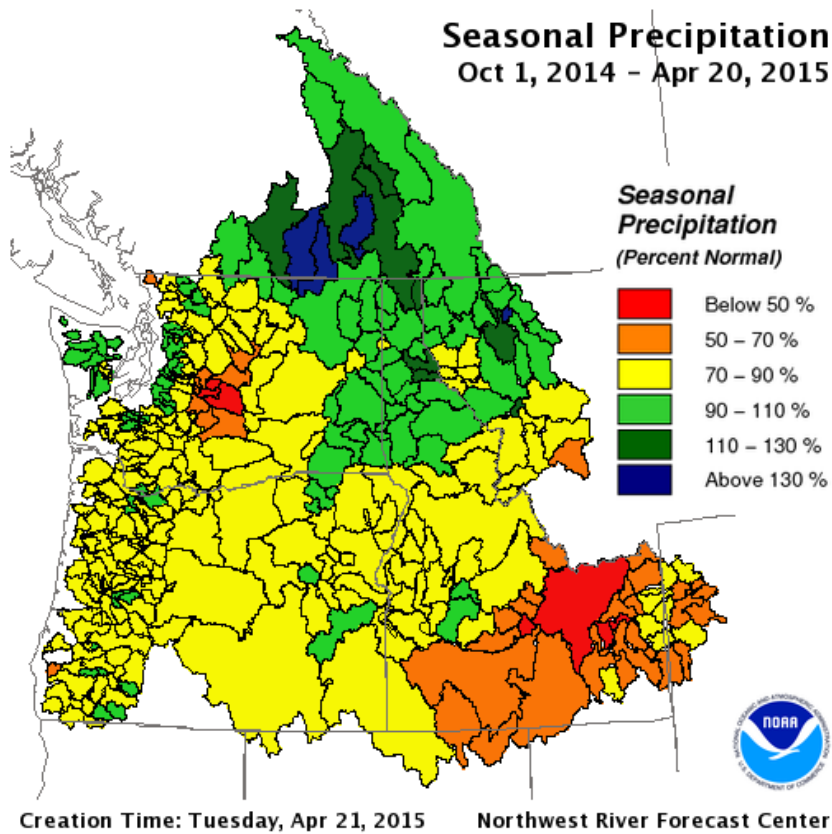


Figure 1. Seasonal Precipitation in CRB

Figure 2. Temperature Departure during March

Snowpack Summary

Snowpack levels in the region have been steadily declining during 2015 due to the continuing warm and generally drier than normal conditions, particularly in the U.S. portion of the Columbia Basin. In some cases in the U.S. areas of the basin, the low elevation snow monitoring sites have already melted out for the season. The largest drops in snowpack levels since mid-March have occurred in the Snake Basin above Palisades Reservoir (down 15 percent from 92 to 77 percent), the upper Snake Basin tributaries (down 21 percent to 46 percent), and the Umatilla River basin, which lost 20 percent from last month and is now measuring just 5 percent of average.

As of April 21, the lowest snowpack levels in the Columbia Basin can be found in the Owyhee, the Deschutes, the John Day, the Willamette, the Umatilla and Walla Walla basins, and the Hood River and lower Columbia sub-basins, all of which are currently below 12 percent of median snow water equivalent (SWE)¹. Many of the snow courses in these sub-basins have no snow remaining, particularly at the lower elevations.

Figure 3 is a map of the automated snow gauge sites in the Columbia River Basin which illustrates the paucity of snowpack levels depicted by the large number of sites showing red dots, with only a few locations showing green or blue dots in the high elevation Rocky Mountains.

State Snowpack Reports

Idaho: Warm, dry conditions again dominated March weather, which greatly increased the probability of water shortages or marginally adequate water supplies this summer. As of April 1, about half of Idaho's basins were reporting less than 50% of median snowpack levels.

Montana: This is the third straight month of declining basin snowpack percentages due to well above average temperatures and below normal snowfall. As a result, spring and summer streamflow forecasts continue to drop.

Oregon: As of April 1, 76 percent of Oregon's long-term snow monitoring sites were at the lowest snowpack levels on record. In a typical year at this time, most sites would be near their peak snowpack. This year, more than half of all snowpack measurements across the state reported bare ground on April 1, which will lead to reduced water supplies this summer.

Washington: Extremely low snowpack conditions continue across the state. Combined with an early snowmelt during a warm March, streamflows for the spring and summer are expected to be correspondingly low.

In summary, the winter conditions of 2015 did not provide enough cold weather fronts necessary to build and sustain basin snowpacks to normal or beyond. The overall

¹ Snow Water Equivalent (SWE): The liquid water equivalent of the snowpack, expressed in terms of depth.

snowpack conditions in the Columbia Basin are dismal, except in the high elevation northern and eastern portions of the basin, e.g., the Rocky Mountains. With much below average snowpacks as of April 1st, chances are good that summer runoff will be much below normal in many tributaries of the Columbia River Basin.

Columbia River and Pacific Coastal Basins Mountain Snowpack as of April 1, 2015

Percent of
1981-2010 Median (US)
1981-2010 Average (Canada)

- > 180
- 150 - 180
- 130 - 149
- 110 - 129
- 90 - 109
- 70 - 89
- 50 - 69
- 25 - 49
- < 25

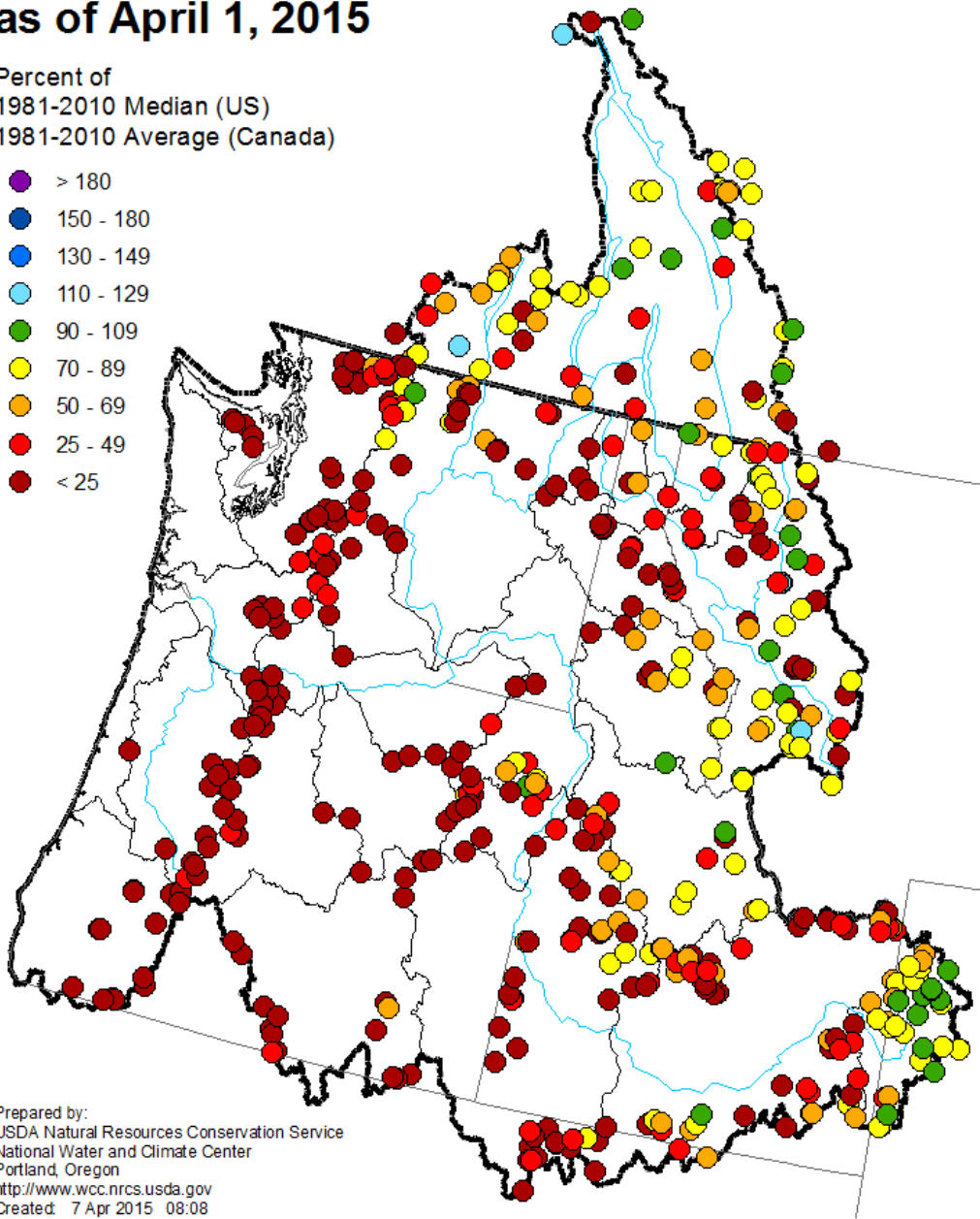


Figure 3. Columbia River Basin Mountain Snow Water Equivalent on April 1, 2015.

Current Streamflow Conditions

From January 1st through April 21, observed flows in most rivers across the Columbia Basin have been well above average, indicative of early snowmelt and runoff. The Columbia River at Grand Coulee and at The Dalles, for instance, have been flowing at 121 and 124 percent of normal, respectively, while the Salmon River at Whitebird has been flowing at 140 percent. Some notable exceptions to the recent above average streamflow conditions include the Snake River at Hells Canyon Dam which, since the start of the year, has been flowing at only 63 percent of normal, and the John Day River at Service Creek, flowing at 76 percent of average – both due to a lack of precipitation.

The combined meteorological and hydrologic conditions have set the stage for below average streamflow forecasts for the Columbia River system from now until late summer or early fall, with implications for salmon, hydropower production, irrigated agriculture, and other water uses.

April 2015 Water Supply Forecasts

The forecast information in this memo is based on the NOAA Northwest River Forecast Center's water supply forecasts for the Columbia River Basin. Included in these April water supply forecasts are updated snowpack, precipitation and observed runoff values from all available sites in Oregon, Washington, Idaho, western Montana, western Wyoming, northern Nevada and British Columbia, Canada. The River Forecast Center's runoff forecasts assume that future precipitation for the remainder of the forecast period will be normal. If future rainfall across the basin is greater or less than average, then the actual runoff may differ from the forecasted volumes.

The NOAA water supply forecasts for the upcoming spring-summer period, shown in Table 1 below, were taken directly from the River Forecast Center's April 21 runoff forecasts for various sites in the Columbia River Basin, and are compared to last year's observed runoff at each location. The below average snow accumulations, ranging from much below average in southern parts of the Columbia Basin to slightly below to average in northern portions of the basin, have resulted in forecasts for well below average runoff this year. In general, runoff forecasts have continued a gradual decline from the January 1st levels.

As indicated in Table 1, the most likely April-August water supply forecast for the Columbia River at The Dalles is about 67 million acre-feet, which is only 77 percent of normal. This represents a 24 percent reduction in runoff volume from the early January runoff forecast, which was near normal, and 31 percent less than the observed runoff in 2014. The 30-year average runoff volume for the April-August period at The Dalles is 87.5 million acre-feet. This below average runoff volume would rank the 2015 water supply as the 66th lowest in the 80-year record (1929-2008), i.e., only 14 years had a lower runoff volume.

In 2015, the lowest runoff volumes shown in Table 1 are expected to occur in several of the tributary watersheds, including the John Day, Grande Ronde, Umatilla and Yakima rivers, which are forecasted to have only 27, 33, 35 and 36 percent of normal runoff, respectively. The current runoff forecast for the Yakima River at Parker shows the largest change -- 73 percent lower -- compared to last year's observed runoff. Other 2015 runoff forecasts showing large drops from last year's runoff include the Grande Ronde River at Troy (59% lower), the Wenatchee River at Peshastin (58% lower), and inflows to Dworshak Reservoir on the North Fork of Clearwater River (55% lower).

The April-August runoff for the Columbia River at Grand Coulee is forecasted to be 86 percent of average, while the runoff for the Snake River at Lower Granite Dam is forecast to be only 61% of normal. However, the April-August runoff for the Willamette River at Salem is expected to be only 55 percent of normal, which is less than half of last year's observed runoff. With the exception of the Brownlee Reservoir inflow forecast, it is noteworthy that most of the 2015 runoff forecasts shown in Table 1 are significantly less (e.g., lower by 24-59 percent) than last year's observed runoff volumes.

Bottom line: expect much below average stream flows in the Snake River basin, eastern Oregon sub-basins, and lower Columbia River tributaries; below average flows in the mainstem Columbia River; and slightly below average flows in the upper Columbia tributaries this spring and summer.

Table 1

NOAA-NRFC Runoff Volume Forecasts on April 21, 2015

<u>River and/or Station</u>	<u>Forecast Period</u>	<u>Runoff Forecast, in Maf</u>	<u>Percent of 30-year Average</u>	<u>Percent Change from 2014 Observed Runoff</u>
Columbia R. at Grand Coulee	April-Aug.	48.6	86%	-24%
Libby Reservoir inflow-Kootenai River	April-Aug.	5.25 ²	89%	-24%
Hungry Horse Reservoir inflow-South Fk Flathead R.	April-Aug.	1.68	87%	-51%
Wenatchee R. at Peshastin	April-Aug.	0.72	50%	-58%
Brownlee Reservoir inflow-Snake River	April-Aug.	3.28	54%	-11%
Salmon R. at Whitebird, ID	April-Aug.	4.01	70%	-46%
Grande Ronde R. at Troy, OR	April-Aug.	0.41	33%	-59%
Dworshak Reservoir inflow-North Fk. Clearwater River	April-July	1.62 ³	67%	-55%
Snake R. at Lower Granite	April-Aug.	13.0	61%	-38%
Yakima R. near Parker, WA	April-Aug.	0.64	36%	-73%
Umatilla R. near Pendleton	April-Aug.	0.053	35%	-49%
John Day R. at Service Creek, OR	April-Aug.	0.22	27%	-49%
Willamette R. at Salem, OR	April-Aug.	2.47	55%	-48%
Columbia R. at The Dalles	April-Aug.	67.4	77%	-31%

The following link shows a map of the 2015 runoff forecasts for all sites in the Columbia River Basin: <http://www.nwrfc.noaa.gov/ws/> Most of the watershed areas with the lowest runoff forecasts in the Columbia River Basin are in eastern Oregon and the upper Snake Basin. For example, the lowest runoff conditions in the basin are expected in the Burnt, Owyhee, Bruneau and Little Wood, Malheur and Powder rivers, with forecasts ranging from only 9-18 percent of normal. Also, runoff is expected to be only in the 20-30 percent range for several sites in the Upper Snake River and various sites in the Yakima Basin.

² The Corps' April runoff forecast for April-August Libby Reservoir inflow is 5.81 million acre-feet (Maf) (99% of average), which is 0.56 Maf more than the NOAA-RFC forecast shown above.

³ The Corps' April runoff forecast for April-July Dworshak Reservoir inflow is 1.79 Maf (70% of average), which is 0.092 Maf more than the NOAA-RFC forecast above.

The highest runoff forecasts this year can be found in the upper Columbia Basin in British Columbia, Canada. For instance, runoff forecasts for the four major Canadian storage projects⁴ range from 93-98 percent of average, or slightly below average. Spring storms and snowfall accumulation in the mountains in the next month or so could help improve these low runoff forecasts somewhat, but a significant improvement in runoff conditions is not likely this late in the spring season.

State Drought Declarations

Idaho: The Idaho Department of Water Resources (IDWR) has stated the central and eastern portions of the state are experiencing significant drought conditions due to below normal precipitation and snowpack levels. Accordingly, drought emergency declarations in the following counties have been issued by IDWR and been approved by the Idaho governor.⁵

<u>County</u>	<u>Watersheds</u>	<u>Date Approved by Governor</u>
Butte	Big and Little Lost Rivers	April 10, 2015
Custer	Big and Little Lost Rivers and Salmon River	April 10, 2015
Blaine	Big and Little Wood Rivers	April 10, 2015
Lincoln	Big and Little Wood Rivers and Upper Snake	April 10, 2015
Fremont	Henrys Fork and Falls River	April 20, 2015

Oregon: The Oregon Water Resources Department (OWRD) has found that continuing dry conditions, low snowpack and lack of precipitation have caused natural drought and economic disaster conditions in several counties in eastern and southern Oregon. Projected forecasts are not expected to alleviate the severe drought conditions in various counties, and the drought is having significant economic impacts on agricultural, livestock and natural resources in these areas. Accordingly, drought emergency declarations in the following counties have been issued by OWRD and been approved by the Oregon governor.

<u>County</u>	<u>Watersheds??</u>	<u>Date Approved by Governor</u>
Lake		March 16, 2015
Malheur	Malheur River	March 16, 2015
Crook		April 6, 2015
Harney		April 6, 2015
Klamath	Klamath River (outside the CRB)	April 6, 2015
Baker	Powder River	April 20, 2015
Wheeler		April 20, 2015

⁴ Four major Canadian storage projects are Mica, Revelstoke, Keenleyside (Arrow Lakes) and Duncan.

⁵ IDWR drought declarations apply only to the administrative processing of applications for temporary changes of water rights. They do not apply to issues such as financial or disaster support.

Washington:

Washington is also experiencing drought conditions. Snowpack conditions across the state have continued to decline this year. The statewide average snowpack is now at 19 percent, far below the 40 percent of average that occurred in 2005 when Washington State last experienced a statewide drought. Currently more than 70 percent of Washington snow monitoring stations are at record low levels. Many of the state's major rivers are forecasted to have April through September runoff volumes that will be the lowest in the past 64 years. This water supply shortfall is a serious threat to municipal and domestic water supplies, irrigated agriculture, and fisheries.

Thus, with the concurrence of Governor Inslee and following consultation with affected Indian tribes, Department of Ecology Director Maia Bellon expanded the geographic coverage of Washington State's drought emergency to the following Water Resource Inventory Areas, each of which are at risk of experiencing less than 75 percent of normal water supply and associated drought hardship.

<u>Area</u>	<u>Water Resource Inventory Areas</u>	<u>Date Approved</u>
Olympic Peninsula	Lyre/Hoko, Sol Duc/Hoh, and Queets/Quinault Basins (not in CRB)	March 13, 2015
	Walla Walla Basin	March 13, 2015
	Yakima Basin	March 13, 2015
	Walla Walla Basin	March 13, 2015
	Wenatchee Basin	March 13, 2015
	Entiat Basin	March 13, 2015
	Nooksak Basin (not in CRB)	April 22, 2015
	Lower Skagit-Samish Basin (not in CRB)	April 22, 2015
	Upper Skagit Basin (not in CRB)	April 22, 2015
	Stillaguamish Basin (not in CRB)	April 22, 2015
	Puyallup-White basins (not in CRB)	April 22, 2015
	Skokomish-Dosewallips basins (not CRB)	April 22, 2015
	Cowlitz Basin	April 22, 2015
	Lewis Basin	April 22, 2015
	Salmon-Washougal basins	April 22, 2015
	Wind-White Salmon basins	April 22, 2015
	Alkali-Squilchuck (not in CRB)	April 22, 2015
	Okanogan Basin	April 22, 2015

Three-Month Temperature and Precipitation Outlook for the Pacific Northwest

On April 16, NOAA's Climate Prediction Center (CPC) issued its long-range outlook for both temperature and precipitation for the May-June-July period for North America. These three-month predictions are based in part on atmospheric and oceanic observations during the first part of 2015 which indicate an increased trend toward higher predicted values of El Niño⁶-Southern Oscillation ([ENSO](#)) conditions. Predictions of sea surface temperatures ([SST](#)) in the Niño 3.4 region of the Pacific Ocean from models indicate that [SST](#) anomalies will continue to rise from just above +0.5 degrees C in late spring to a peak of just of +1.0 degree C by the fourth quarter of 2015. Some dynamical model forecasts show an even greater SST anomaly over this same period. Thus, by evaluating the combined oceanic and atmospheric conditions, NOAA's outlook is for [ENSO](#) conditions to remain in place and likely strengthen by the end of 2015.

The NOAA-CPC's temperature outlook for the May-June-July period depicts enhanced probabilities for above normal temperatures for most areas west of the Rocky Mountains, including the Pacific Northwest (Figure 4). The greatest probability of warmer than normal temperatures remains along the Pacific west coast and for southern Alaska where a pattern of a large-scale SST anomaly, e.g., a huge pool of warm sea surface temperature⁷, or so-called "blob," established itself in early 2014 and has remained in place in the eastern Pacific Ocean. This SST anomaly has exerted a strong climate influence on weather patterns in the Pacific Northwest this winter and spring, resulting in much warmer than normal temperatures.

Based on the NOAA-CPC climate models, the outlook for May-June-July precipitation shows elevated odds for above median seasonal rainfall for the southeastern portions of the Columbia Basin, and particularly in the upper Snake Basin in Idaho where drought conditions currently exist. However, the western and northern areas of the Pacific Northwest are not expected to trend toward either below average or above average precipitation over the next three months (Figure 5), where equal chances (EC) of normal precipitation are indicated on the map. This includes most of Oregon, all of Washington, the northern panhandle of Idaho and northern Montana. However, coupled with warmer than normal predicted temperatures, this may further erode spring runoff volumes and reduce water supplies in these areas of the Columbia River Basin.

⁶ An El Niño condition typically creates a split-flow in the jet stream, which results in most storm tracks being diverted away from the Pacific Northwest and into northern Canada and the U.S. Southwest areas. The impact of El Niño on the climate over North America is usually greatest during the late winter season.

⁷ This big, circular mass of warm water, about 1 to 4 degrees Celsius (2 to 7 degrees Fahrenheit) above normal, was nicknamed "the blob" by a University of Washington climate scientist, was 1,000 miles long, 1,000 miles wide and 100 yards deep in 2014. This year, "the blob" is still off the West Coast, but it is now squished up against the coast and extending about 1,000 miles offshore from Mexico all the way up through Alaska, with water about 2 degrees Celsius (3.6 degrees Fahrenheit) warmer than normal.

Read more at:

http://www.science20.com/news_articles/warm_blob_in_pacific_ocean_linked_to_weird_weather-154712#ixzz3YXcSnb8I

Figure 4. NOAA-CPC three-month (May-June-July) 2015 temperature outlook.

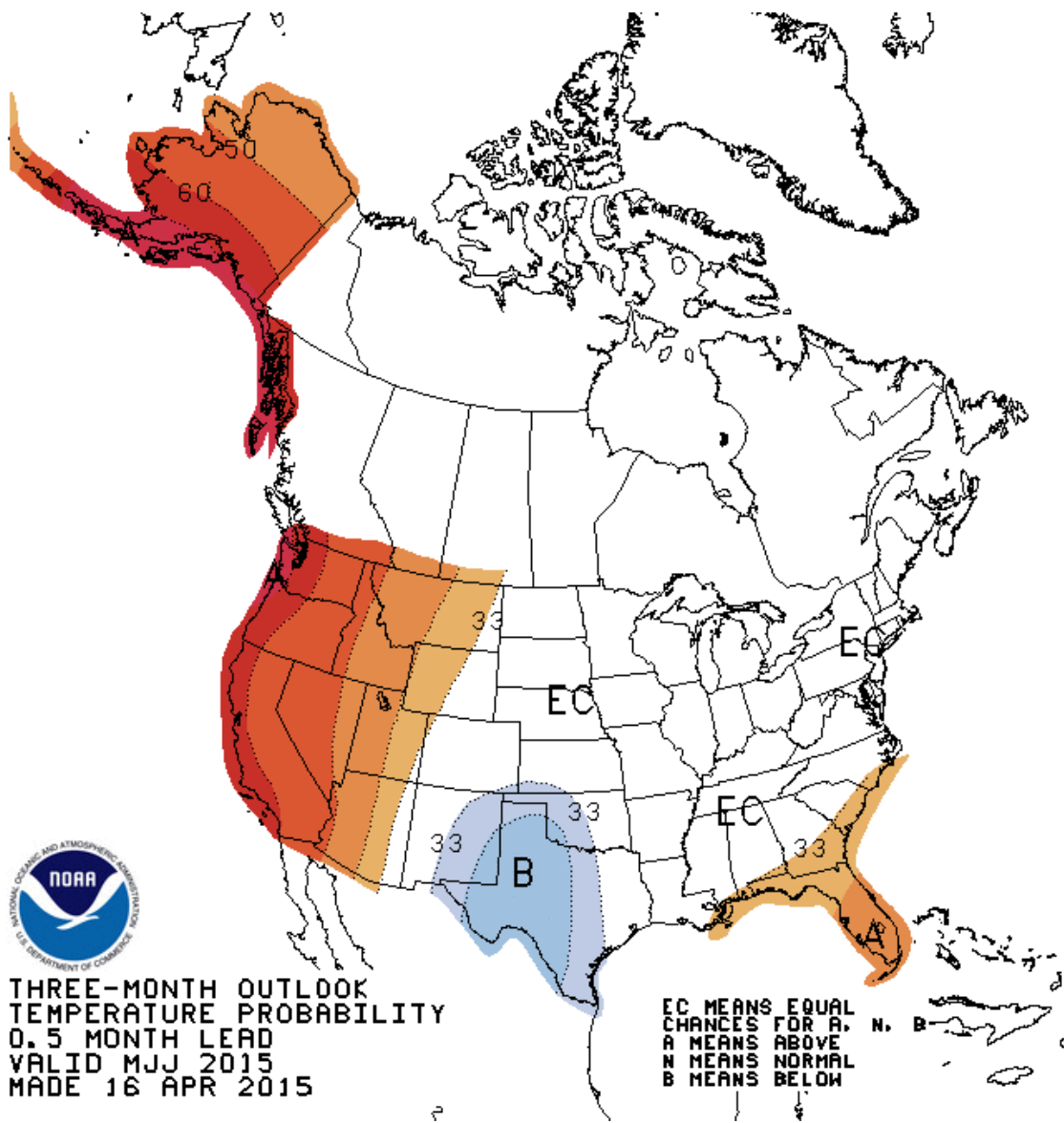
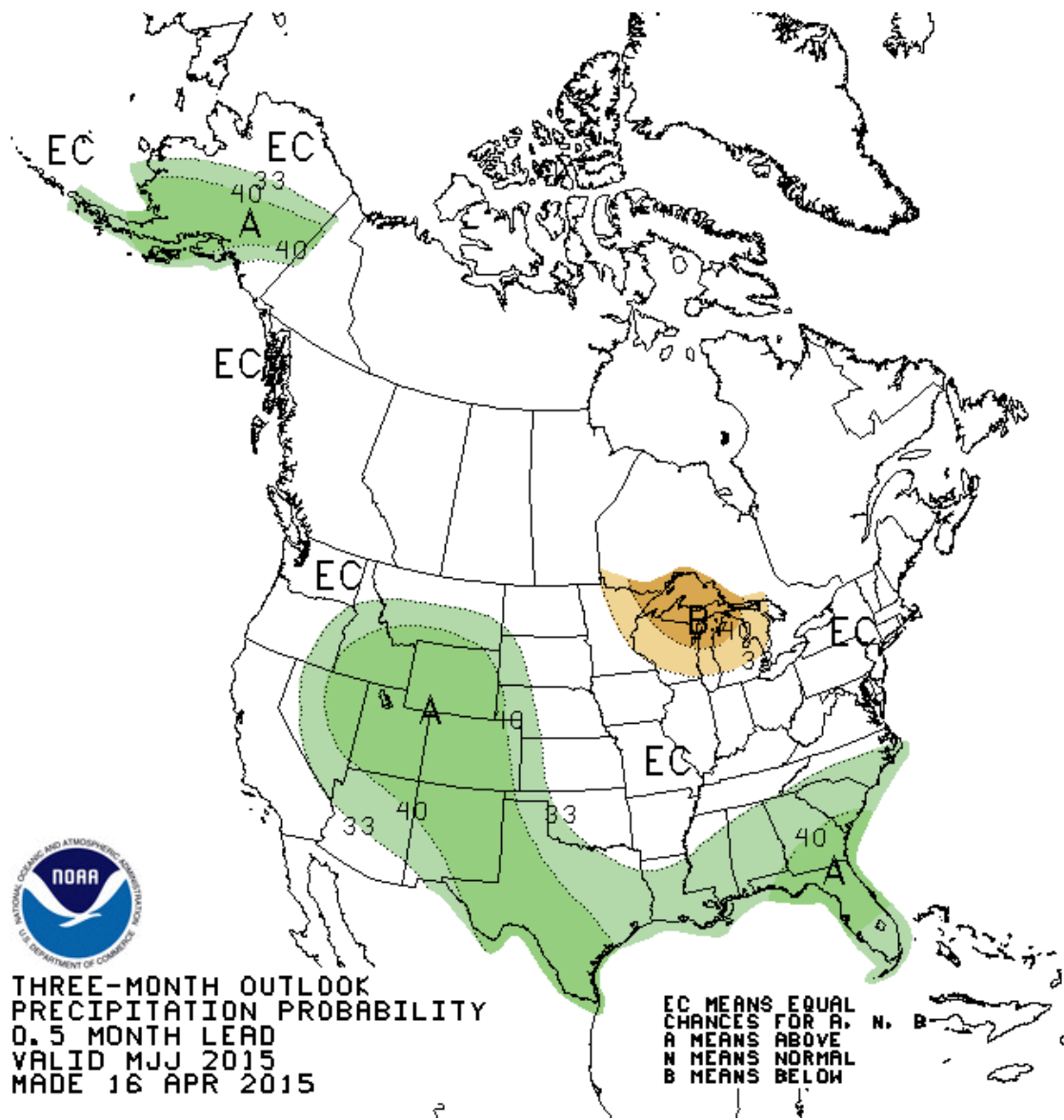


Figure 5. NOAA-CPC three-month (May-June-July) 2015 precipitation outlook.



Hydrologic Conditions, Water Supply Forecasts and Drought Declarations in the Columbia Basin

James D. Ruff

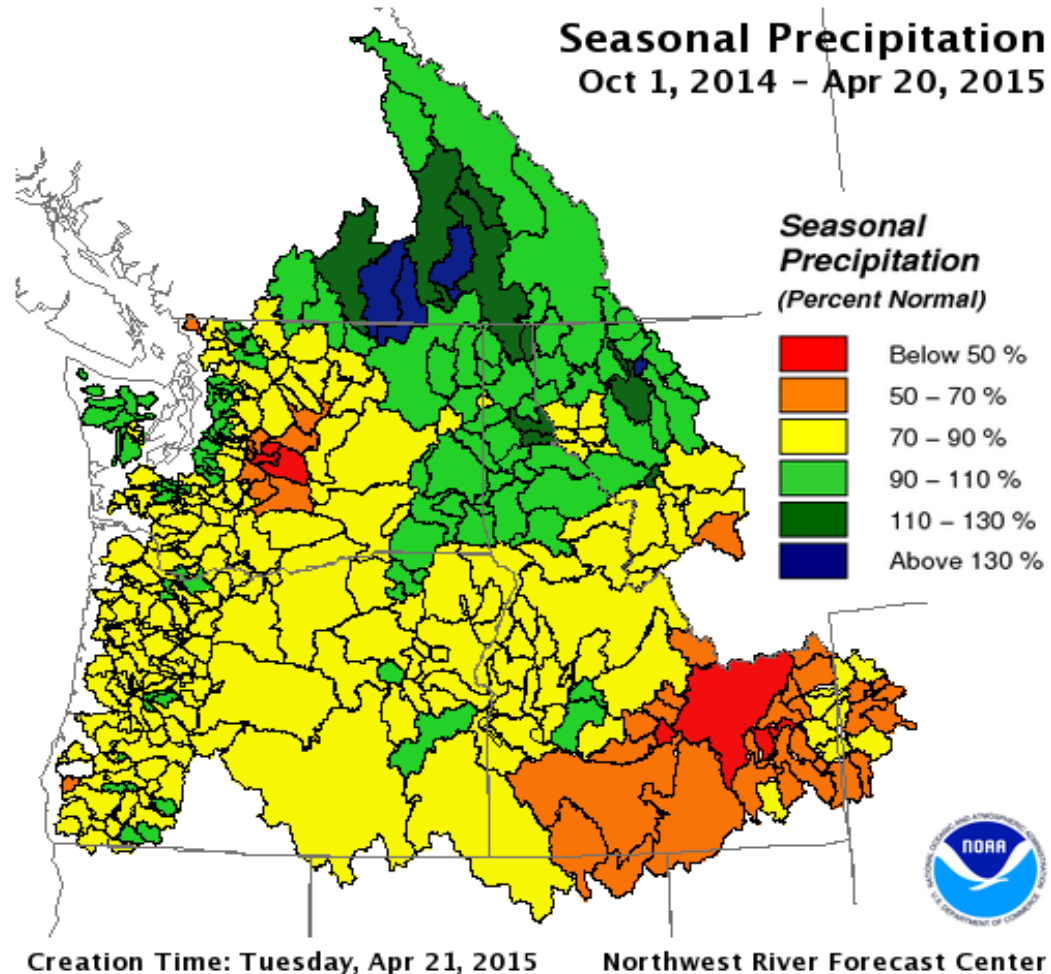
May 6, 2015

**NW Power and Conservation Council meeting
Portland, OR**

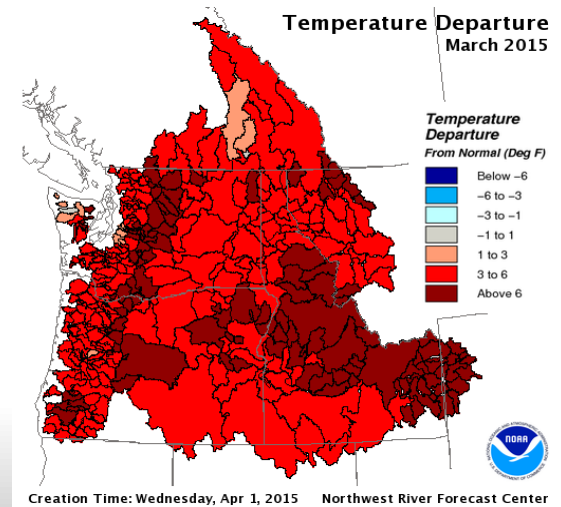
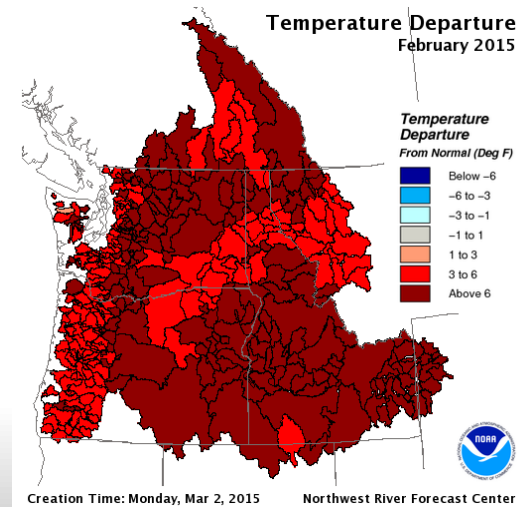
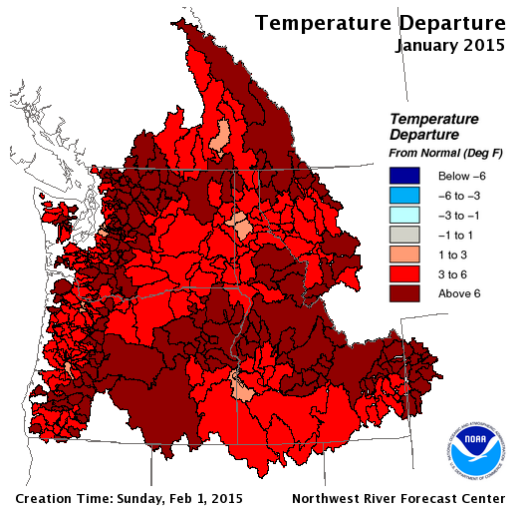
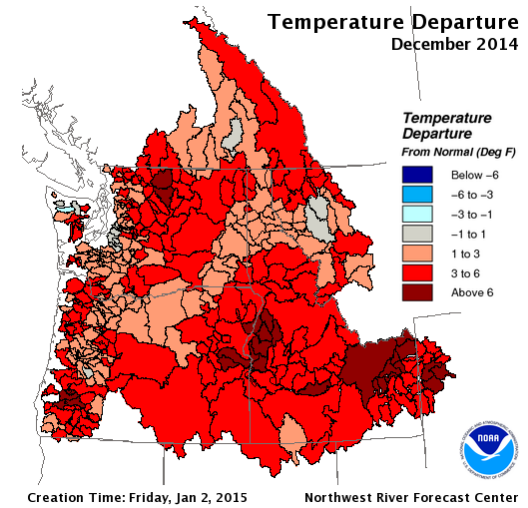
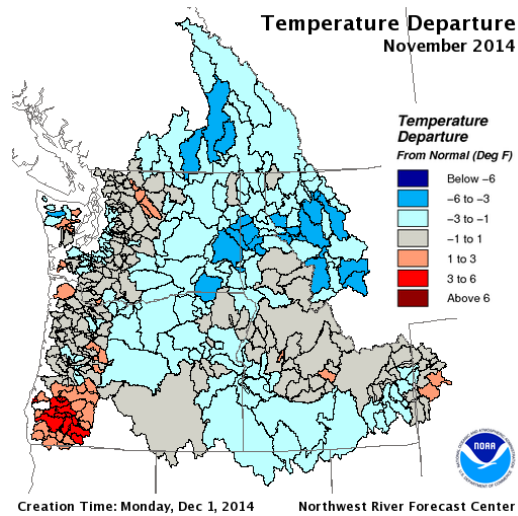
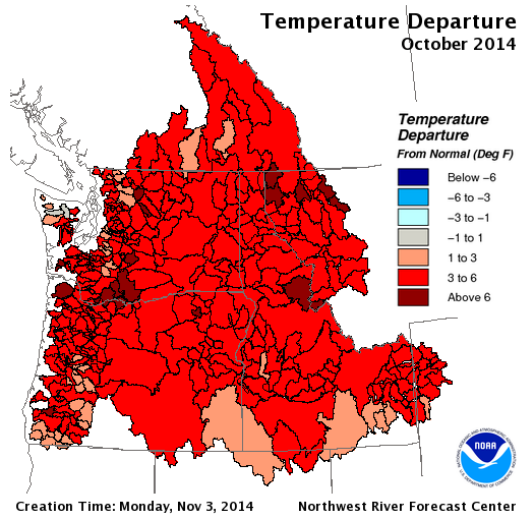
Purposes

- 1. Discuss hydrologic conditions through March 2015**
- 2. Provide latest water supply forecasts for key sites in Columbia Basin**
- 3. Discuss current drought declarations in the Northwest states**
- 4. Present NOAA's long-range temperature and precipitation forecasts**

Hydrologic Conditions – Seasonal Precipitation



Hydrologic Conditions – Monthly Temperature Departures



Hydrologic Conditions – The Northwest's Wet Drought

Drought double whammy:

Even where precipitation was normal this water year (Oct. 1-April 1) snow levels were low.



As of April 14, seven Oregon counties have declared a drought emergency; five of them are receiving additional state support. A total of 17 could receive federal aid. 85 percent of the state is facing some degree of water shortage.

13% normal snowpack

Warm temperatures and rain decimated Montana's snowpack, precipitating the end to a rainy winter. Ski lifts closed early, as did entire ski areas.

68% normal snowpack

"This year is a dress rehearsal for climate change."
-Amy Snover, director, Climate Impacts Group, University of Washington

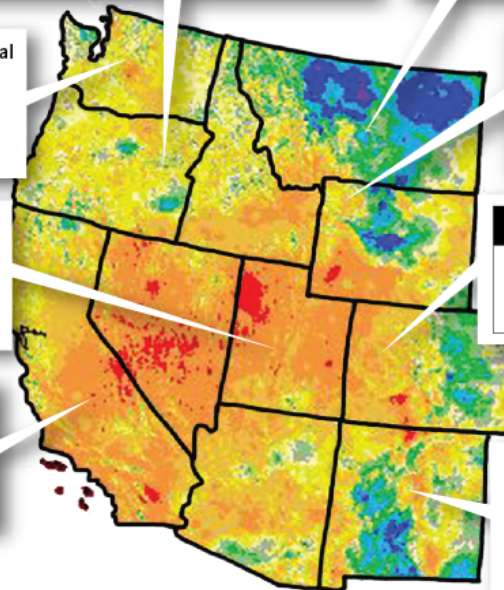
22% normal snowpack

"Suffice it to say – 2015 is a dead skunk."
-Utah Water Supply Outlook Report, Natural Resources Conservation Service

41% normal snowpack

"This is the new normal."
-Gov. Jerry Brown

5% normal snowpack



"We rely heavily on the snowpack. Our snowpack is way down."
-Philip Stuckert, deputy state engineer for Wyoming

67% normal snowpack

"We would be missing an opportunity if we didn't look towards California and Washington right now and see what they're doing."
-Taryn Finnessey, the climate change specialist for the Colorado Water Conservation Board.

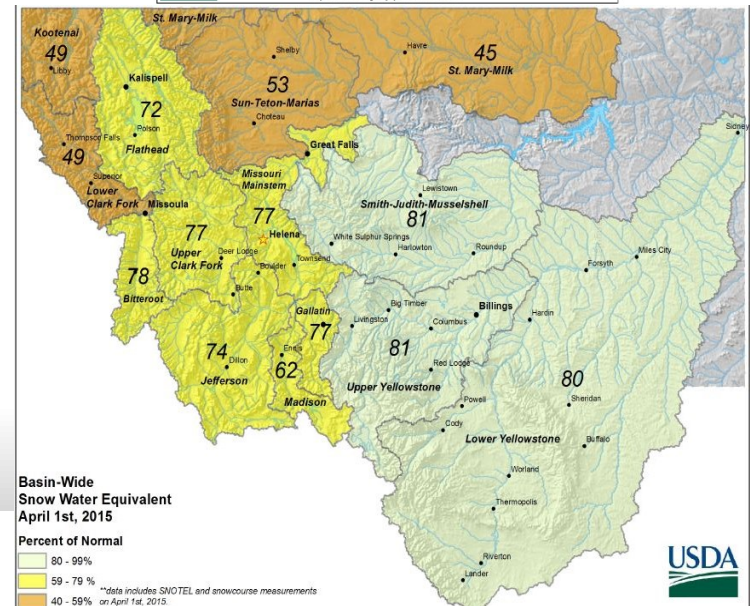
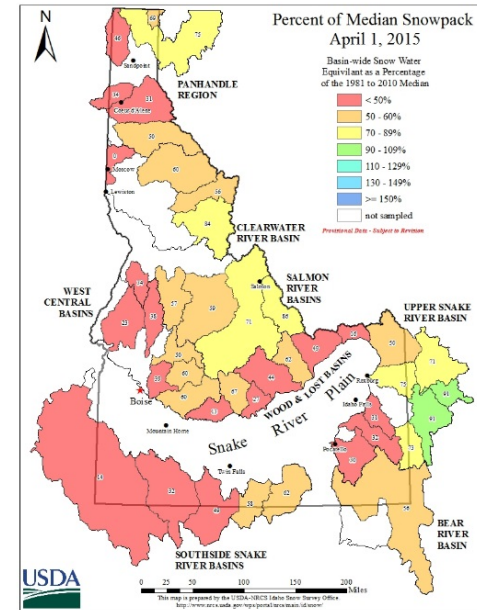
69% normal snowpack

Reservoir levels in New Mexico rose in March, to just 59 percent of normal. Cities like Albuquerque and Santa Fe could see smaller water allocations than normal.

58% normal snowpack

State Snowpack Conditions

- Idaho: Half basins in state reporting <50% of median snowpack
- Hardest hit areas are central Idaho basins
- Montana: Warm temps and rain have depleted snowpack to 68% of avg
- Ski areas closed early



State Snowpack Conditions

- Oregon: 76% of snow sites in state have lowest snowpack ever
- Nearly two-thirds of sites on April 1st report no snow at all
- Washington: Statewide snowpack has declined to 22% of normal, worse than in drought of 2005

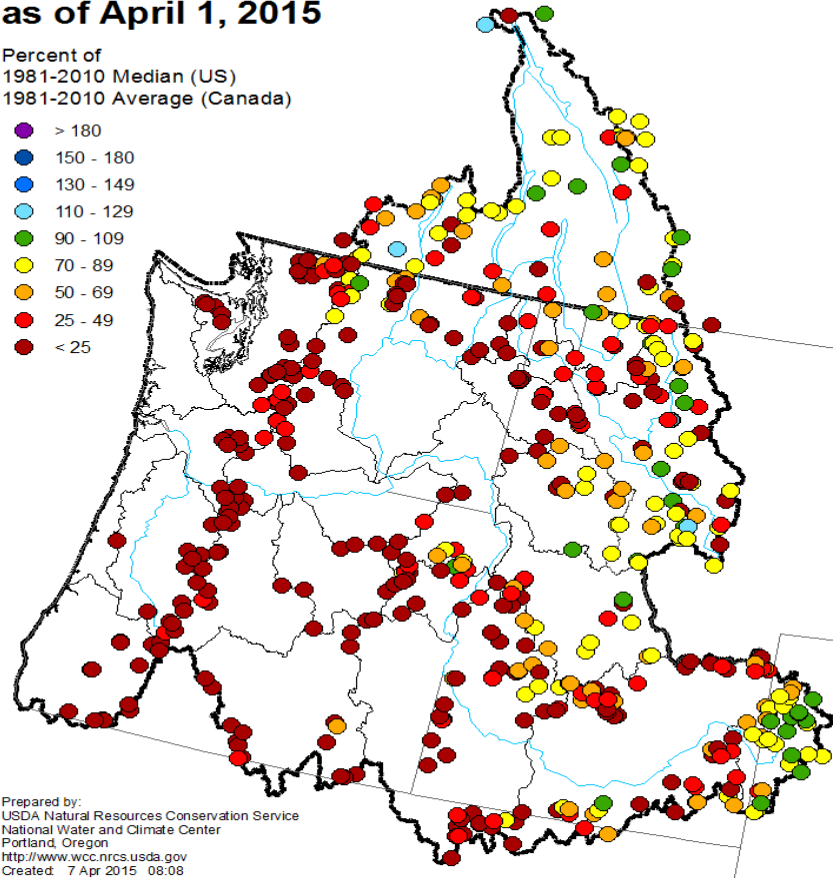


Hydrologic Conditions -- Snowpack

Columbia River and Pacific Coastal Basins Mountain Snowpack as of April 1, 2015

Percent of
1981-2010 Median (US)
1981-2010 Average (Canada)

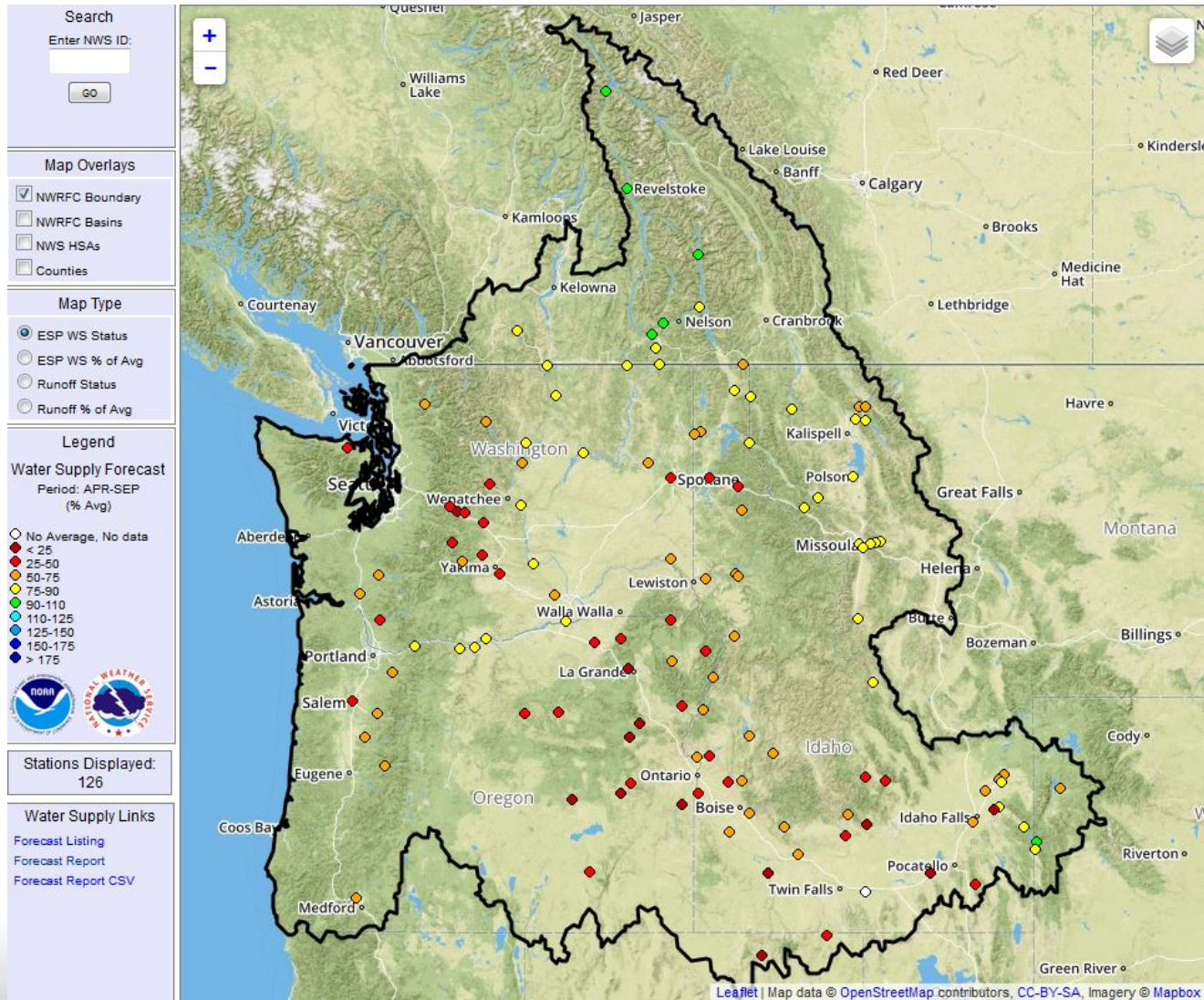
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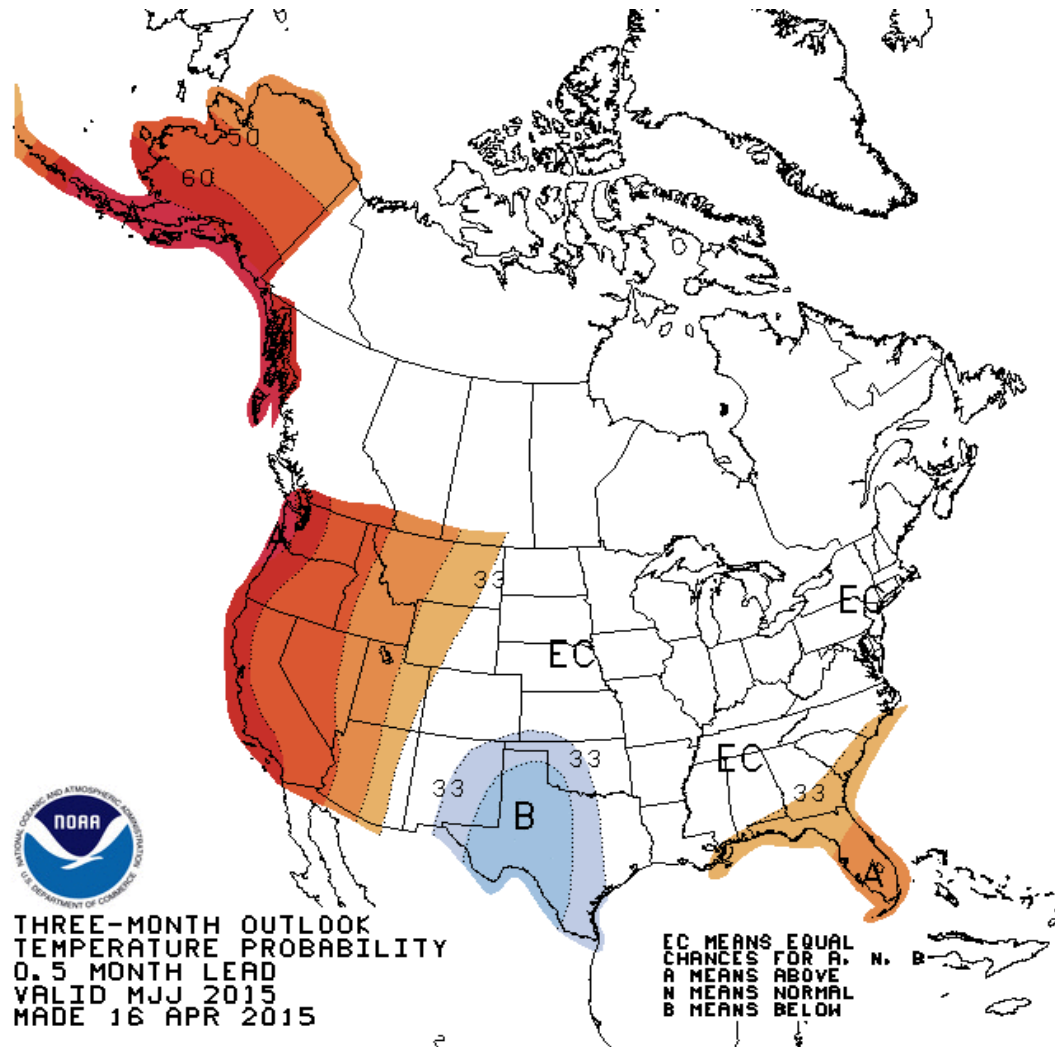
April 2015 Water Supply Forecasts

<u>River and/or Station</u>	<u>Forecast Period</u>	<u>Runoff Forecast, in Maf</u>	<u>Percent of 30-year Average</u>	<u>% Change from 2014 Observed Runoff</u>
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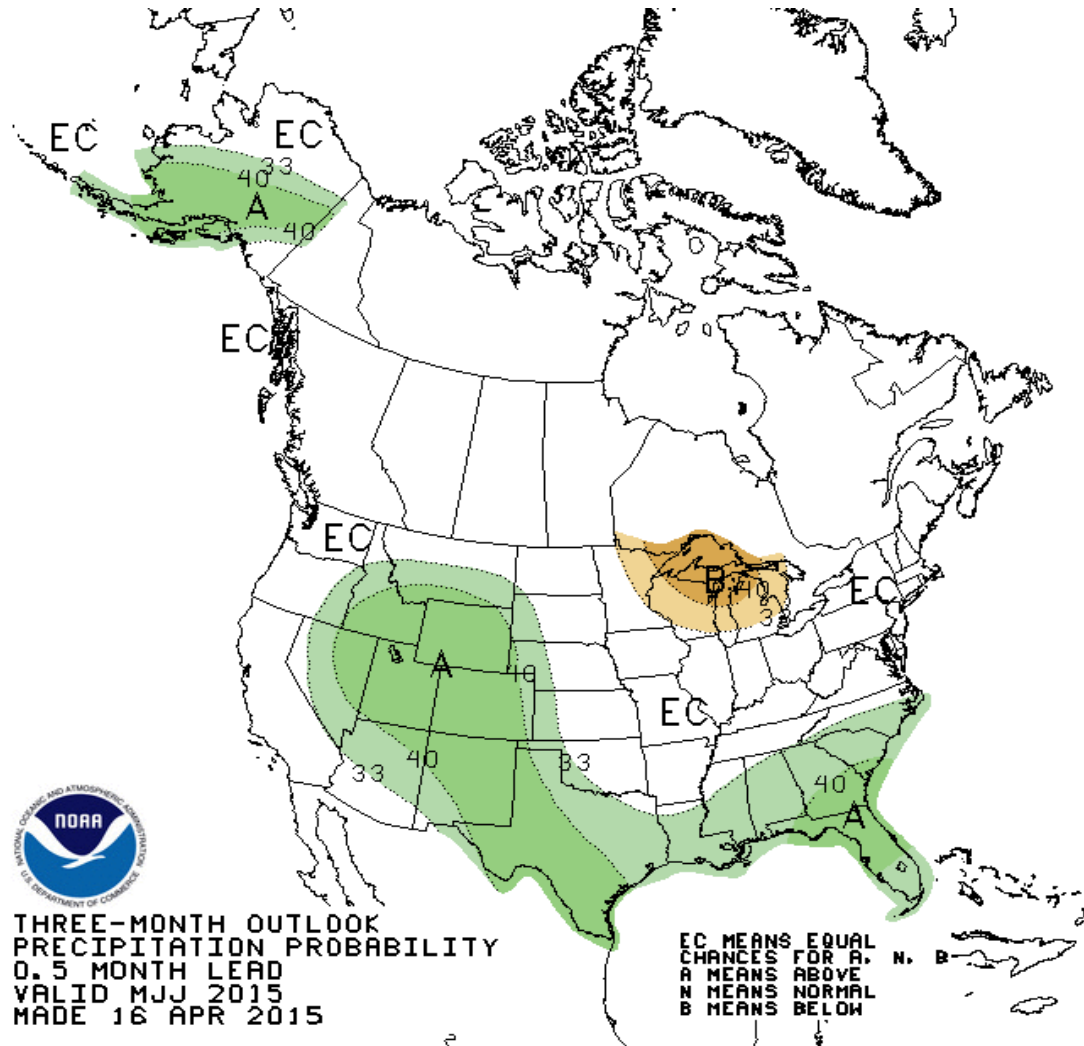
2015 Runoff Forecast Map



M-J-J Temperature Outlook for NW



M-J-J Precipitation Outlook for NW



Warm Temps in Pacific Ocean – “The Blob”

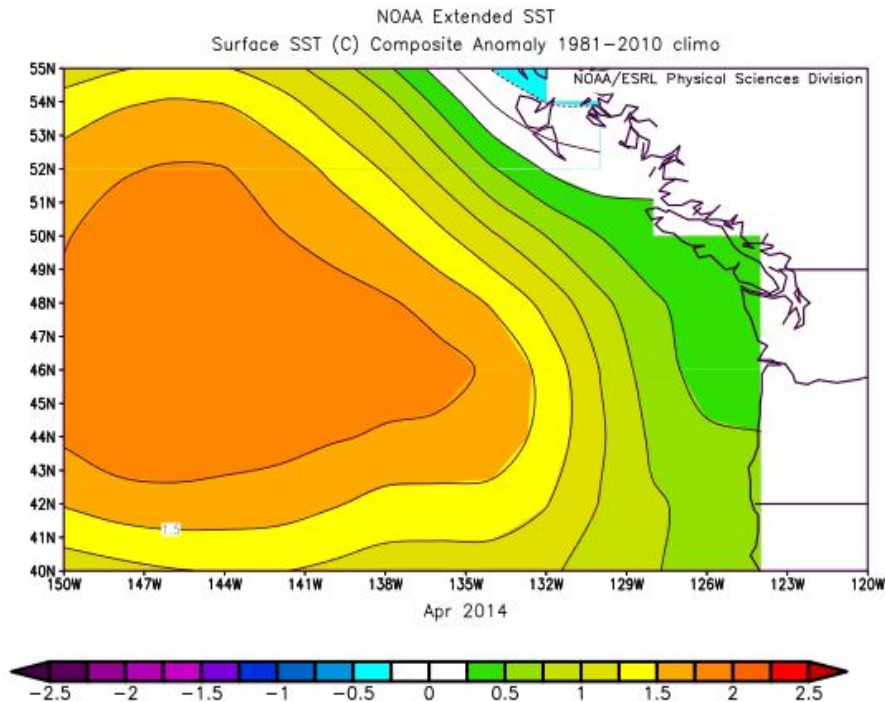
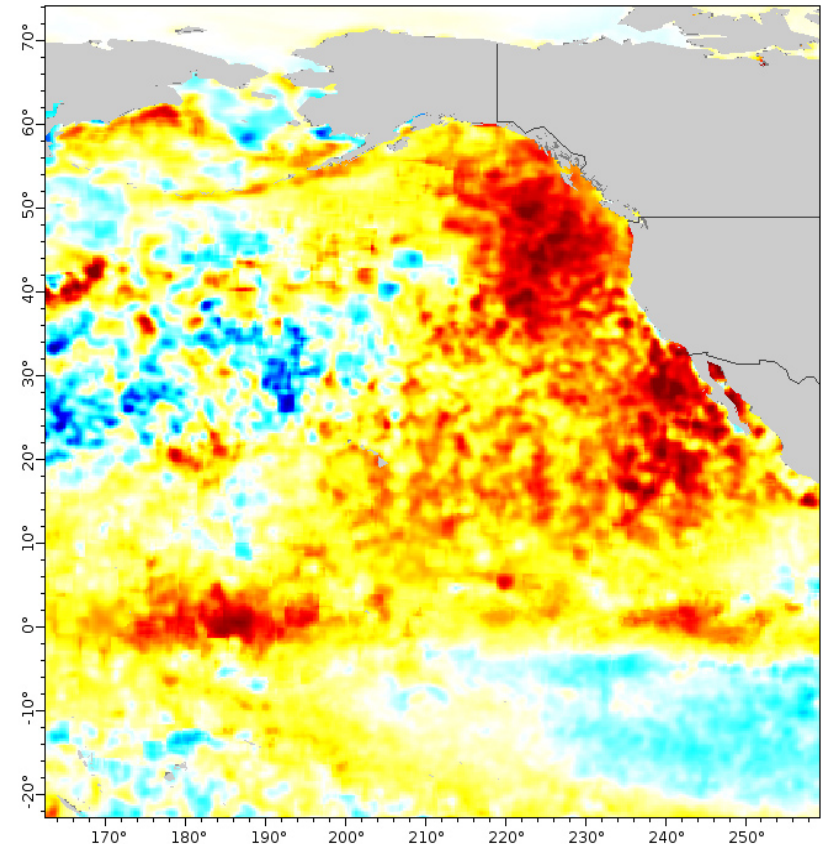


Figure 2: The SST anomaly pattern (compared to 1981-2010) off the coast of Washington and Oregon for April 2014 (from ESRL).



-3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3

Daily Sea Surface Temperature Anomalies (degree_C)
SST, Daily Optimum Interpolation (OI), AVHRR Only, Version 2, Final+Preliminary
(2015-04-07T00:00:00Z, Altitude=0.0 m)
Data courtesy of NOAA NCDC

Summary

- Over this spring and summer, expect much below average stream flows in the Snake River Basin, in eastern OR sub-basins & in lower Columbia R. tribs.
- Expect below average flows in the mainstem Columbia River
- Expect slightly below average flows in the upper Columbia tributaries
- No anticipation of power supply shortages this year
- 2015 out-migrants and returning adults will face warm and below average stream flows together with an ocean ecosystem much different than usual
- Cumulative effect on salmon in 2015?

Questions?

