

Washington Water Supply Outlook Report February 1, 2016



Chelan PUD Snow Surveyors, Erik Norland, Scott Buehn and Dave Nelson, chasing snowflakes by helicopter at Park Creek Ridge SNOTEL site in Stehekin River Basin – Photo Chelan PUD

Reminder: We are soliciting field work photos from our snow surveyors again this year. Each month we pick one to grace the cover of this report. The photographer will be given proper credit of course. Please include all specific information when submitting photos. Scott.pattee@wa.usda.gov

Water Supply Outlook Reports and Federal - State – Private Cooperative Snow Surveys

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How forecasts are made

Most of the annual streamflow in the western United States originates as snowfall that has accumulated in the mountains during the winter and early spring. As the snowpack accumulates, hydrologists estimate the runoff that will occur when it melts. Measurements of snow water equivalent at selected manual snow courses and automated SNOTEL sites, along with precipitation, antecedent streamflow, and indices of the El Niño / Southern Oscillation are used in computerized statistical and simulation models to prepare runoff forecasts. These forecasts are coordinated between hydrologists in the Natural Resources Conservation Service and the National Weather Service. Unless otherwise specified, all forecasts are for flows that would occur naturally without any upstream influences.

Forecasts of any kind, of course, are not perfect. Streamflow forecast uncertainty arises from three primary sources: (1) uncertain knowledge of future weather conditions, (2) uncertainty in the forecasting procedure, and (3) errors in the data. The forecast, therefore, must be interpreted not as a single value but rather as a range of values with specific probabilities of occurrence. The middle of the range is expressed by the 50% exceedance probability forecast, for which there is a 50% chance that the actual flow will be above, and a 50% chance that the actual flow will be below, this value. To describe the expected range around this 50% value, four other forecasts are provided, two smaller values (90% and 70% exceedance probability) and two larger values (30%, and 10% exceedance probability). For example, there is a 90% chance that the actual flow will be more than the 90% exceedance probability forecast. The others can be interpreted similarly.

The wider the spread among these values, the more uncertain the forecast. As the season progresses, forecasts become more accurate, primarily because a greater portion of the future weather conditions become known; this is reflected by a narrowing of the range around the 50% exceedance probability forecast. Users should take this uncertainty into consideration when making operational decisions by selecting forecasts corresponding to the level of risk they are willing to assume about the amount of water to be expected. If users anticipate receiving a lesser supply of water, or if they wish to increase their chances of having an adequate supply of water for their operations, they may want to base their decisions on the 90% or 70% exceedance probability forecasts, or something in between. On the other hand, if users are concerned about receiving too much water (for example, threat of flooding), they may want to base their decisions on the 30% or 10% exceedance probability forecasts, or something in between. Regardless of the forecast value users choose for operations, they should be prepared to deal with either more or less water. (Users should remember that even if the 90% exceedance probability forecast is used, there is still a 10% chance of receiving less than this amount.) By using the exceedance probability information, users can easily determine the chances of receiving more or less water.

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Washington Water Supply Outlook

March 2016

General Outlook

El Nino did a number on us this past month with temperatures ranging from 5-15 degrees warmer than normal. However rain was plentiful in most areas of the state. This combination not only melted low and mid elevation snow but also led to a decline in snowpack percentages. This was more due to the lack of normal snow accumulation for February and not the melt. These conditions also attributed to the sharp increase in snowpack density, or quantity of water in the snow, which means that we are about a month ahead of where we should be. (See density graphic on page 7) If these trends continue we will see an early start to spring melt and the possibility of rare spring flooding. The latest NWS short term forecasts are calling for cool and wet weather for the first half of March but then falling back into a warmer and possibly dryer second half. Long range forecasts for the spring continue to be warmer and dryer than normal with less certainty on precipitation amounts.
<http://www.cpc.ncep.noaa.gov/>

Snowpack

The March 1 statewide SNOTEL readings were 100% of normal, down from 109% on February 1 and 120% on January 1. The Skykomish River Basin reported the lowest readings at 62% of the 30-year median for March 1 and the Methow had the most snow with 135%. Most basins reported a net loss from last month primarily due to the lack of fresh snow. Westside medians from SNOTEL, and March 1 snow surveys, included the North Puget Sound river basins with 93% of normal, the Central and South Puget river basins with 84% and 82% respectively, and the Lower Columbia basins with 101% of normal. Snowpack along the east slopes of the Cascade Mountains included the Yakima area with 98% and the Wenatchee area with 108%. Snowpack in the Spokane River Basin was at 83% and the Walla Walla River Basin had 107% of the long term median.

BASIN	PERCENT OF MEDIAN	LAST YEAR PERCENT MEDIAN
Spokane	83	43
Newman Lake	81	20
Pend Oreille	93	89
Okanogan	128	78
Methow	135	90
Conconully Lake	128	58
Central Columbia	108	56
Upper Yakima	97	26
Lower Yakima	99	44
Ahtanum Creek	129	45
Walla Walla	107	46
Lower Snake	93	59
Cowlitz	97	30
Lewis	105	7
White	82	46
Green	81	8
Puyallup	82	38
Cedar	103	0
Snoqualmie	74	7
Skykomish	62	0
Skagit	109	63
Nooksack	80	15
Olympic Peninsula	97	2
Baker	79	21

Precipitation

For the most part the state received above normal precipitation for the month of February keeping year to date statewide SNOTEL averages above normal at 130%. Only north central and south east parts of the state fell below 100%. Quillayute State Airport measured 152% of normal rainfall. The wettest SNOTEL in the state was Skookum Creek, located in the Tolt River Basin, collected 23.5 inches of precipitation or 201% of normal during the month of February.

RIVER BASIN	MARCH PERCENT OF AVERAGE	WATER YEAR PERCENT OF AVERAGE
Spokane	111	101
Pend Oreille	111	100
Upper Columbia	84	118
Central Columbia	117	131
Upper Yakima	116	136
Lower Yakima	113	133
Walla Walla	93	107
Lower Snake	92	102
Lower Columbia	128	131
South Puget Sound	144	137
Central Puget Sound	167	134
North Puget Sound	176	125
Olympic Peninsula	119	130

Reservoir

Seasonal reservoir levels in Washington can vary greatly due to specific watershed management practices required in preparation for irrigation season, fisheries management, power generation, municipal demands and flood control. A very wet February helped buffer some reservoir levels, supplementing any chance of lower snow levels. March 1 Reservoir storage in the Yakima Basin was 580,000-acre feet, 129% of average for the Upper Reaches and 199,000-acre feet or 145% of average for Rimrock and Bumping Lakes. The power generation reservoirs included the following: Coeur d'Alene Lake, 171,000 acre feet, 129% of average and 72% of capacity; and the Skagit River reservoirs at 43% of average and 73% of capacity. Recent climate impacts and management procedures may affect these numbers on a daily or weekly basis.

BASIN	PERCENT OF CAPACITY	CURRENT STORAGE AS PERCENT OF AVERAGE
Spokane	72	56
Pend Oreille	43	86
Upper Columbia	60	95
Central Columbia	46	112
Upper Yakima	70	129
Lower Yakima	86	145
Lower Snake	77	113
North Puget Sound	43	73

For more information contact your local Natural Resources Conservation Service office.

Streamflow

March 1 marks a time where we are about 80% through winter thus making streamflow forecasting a much more attainable target. At times only a few degrees warmer or cooler than forecasted can make or break stream flow predictions. April-September forecasts for some Western Washington streams include the Cedar River near Cedar Falls, 109%; White River, 111%; and Skagit River, 114%. Some Eastern Washington streams include the Yakima River near Parker 114%, Wenatchee River at Plain 107%; and Spokane River near Post Falls 83%. Volumetric forecasts are developed using current, historic and average snowpack, precipitation and streamflow data collected and coordinated by organizations cooperating with NRCS.

BASIN	PERCENT OF AVERAGE (50 PERCENT CHANCE OF EXCEEDENCE)
Spokane	83-118
Pend Oreille	91-103
Upper Columbia	81-122
Central Columbia	102-111
Upper Yakima	96-113
Lower Yakima	111-145
Walla Walla	98-100
Lower Snake	95-104
Lower Columbia	97-115
South Puget Sound	92-111
Central Puget Sound	104-109
North Puget Sound	103-118
Olympic Peninsula	107-110

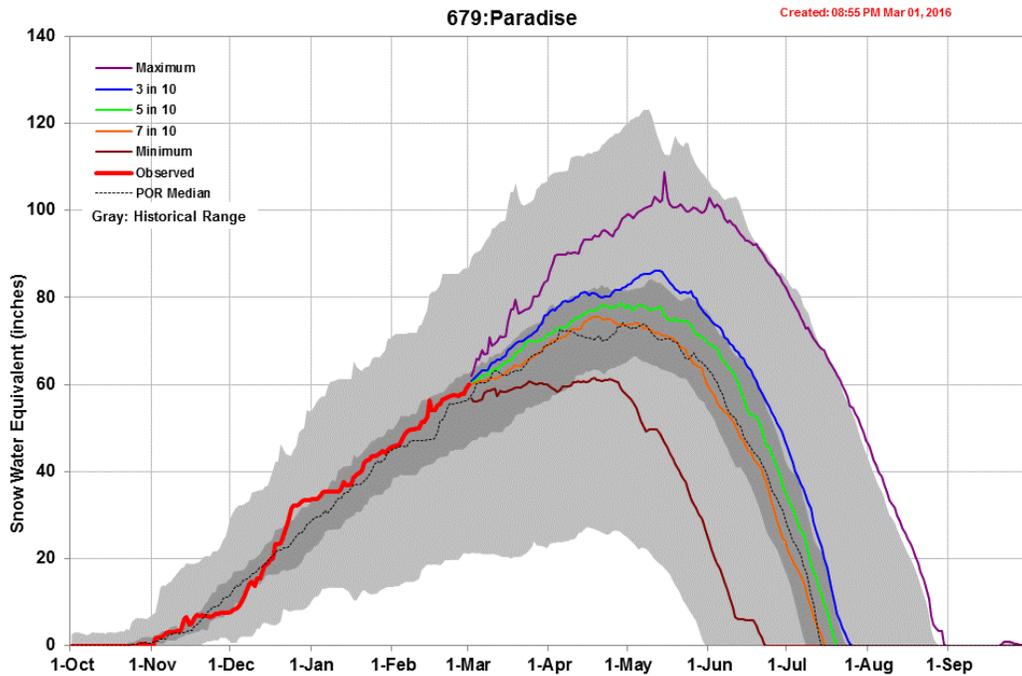
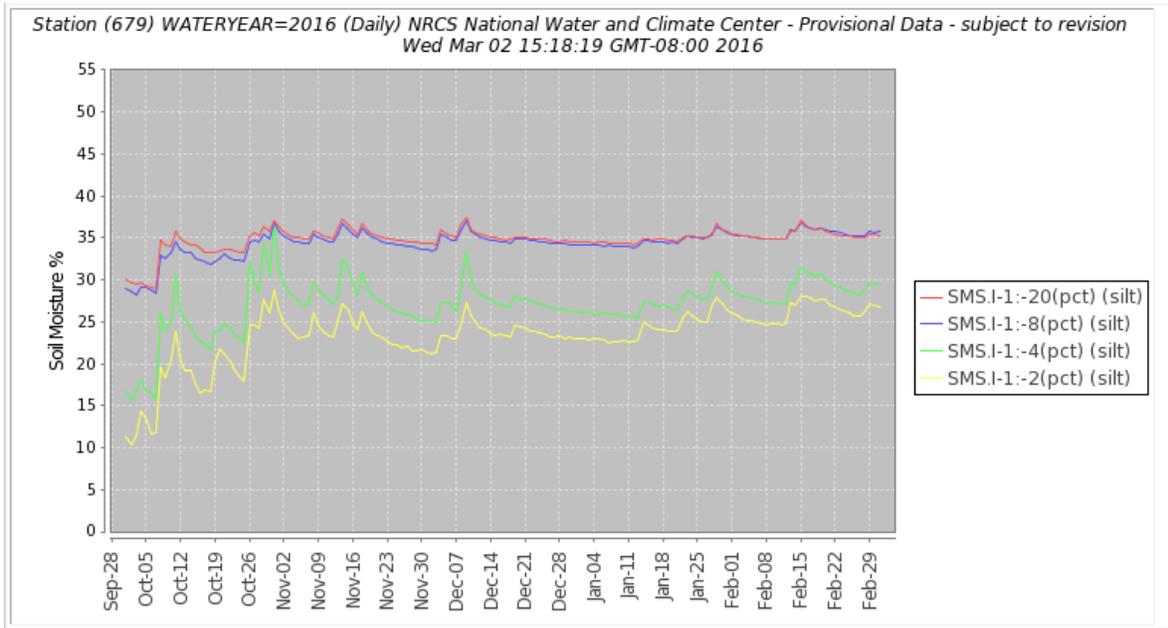
STREAM	PERCENT OF AVERAGE MARCH STREAMFLOWS
Pend Oreille at Albeni Fall Dam	130
Kettle at Laurier	174
Columbia at Birchbank	123
Spokane at Spokane	147
Similkameen at Nighthawk	223
Okanogan at Tonasket	135
Methow at Pateros	149
Chelan at Chelan	176
Wenatchee at Pashastin	213
Cle Elum near Roslyn	127
Yakima at Parker	214
Naches at Naches	227
Grande Ronde at Troy	132
Snake below Lower Granite Dam	104
Columbia River at The Dalles	118
Lewis at Merwin Dam	129
Cowlitz below Mayfield Dam	146
Skagit at Concrete	189
Dungeness near Sequim	156

For more information contact your local Natural Resources Conservation Service office.

Soil Moisture

Near to above normal fall precipitation provided for wet and nearly saturated soils (60-70% saturation) as the snow finally began to accumulate in mid-December. Great fall soil moisture conditions can help buffer low snowpack runoff come spring however it is too early in the season to count those chickens. Current soil moisture data is available from a limited number of SNOTEL sites scattered throughout each basin. As the effort continues to install additional sensors and more years of data are acquired this information will become invaluable to the streamflow forecasting community.

The following graph shows a very typical winter soil moisture profile at Paradise SNOTEL site. Notice the profile recharge when fall rains began. The additional peaks in the last month or so indicate rain on snow events where the rain percolated through the snow. The second graph is a snowpack projection for the same site.



This is an automated product based on SNOTEL data, provisional data are subject to change. This product combines the historical period of record data (gray background) with the recent daily data (heavy red, left) to project into the future (colored lines, right). This product does not consider climate information such as El Nino or short range weather forecasts and therefore should only be used as a seasonal planning tool. Contact Jim.Marron@por.usda.gov 503 414 3047



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Helpful Internet Addresses

NRCS Snow Survey and Climate Services Homepages

Washington:
<http://www.nrcs.usda.gov/wps/portal/nrcs/main/wa/snow/>

Oregon:
<http://www.nrcs.usda.gov/wps/portal/nrcs/main/or/snow/>

Idaho:
<http://www.nrcs.usda.gov/wps/portal/nrcs/main/id/snow/>

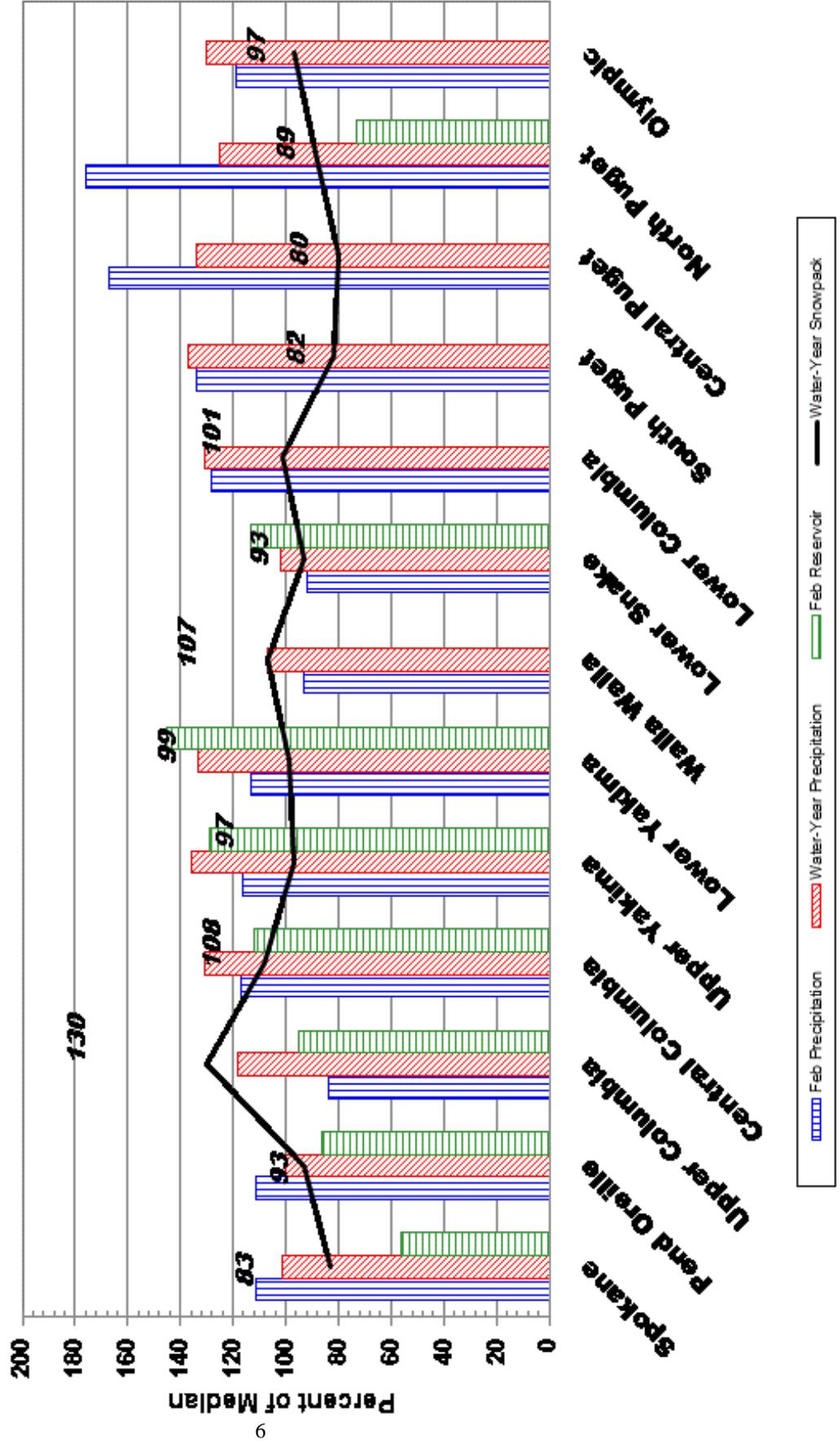
National Water and Climate Center (NWCC):
<http://www.wcc.nrcs.usda.gov>

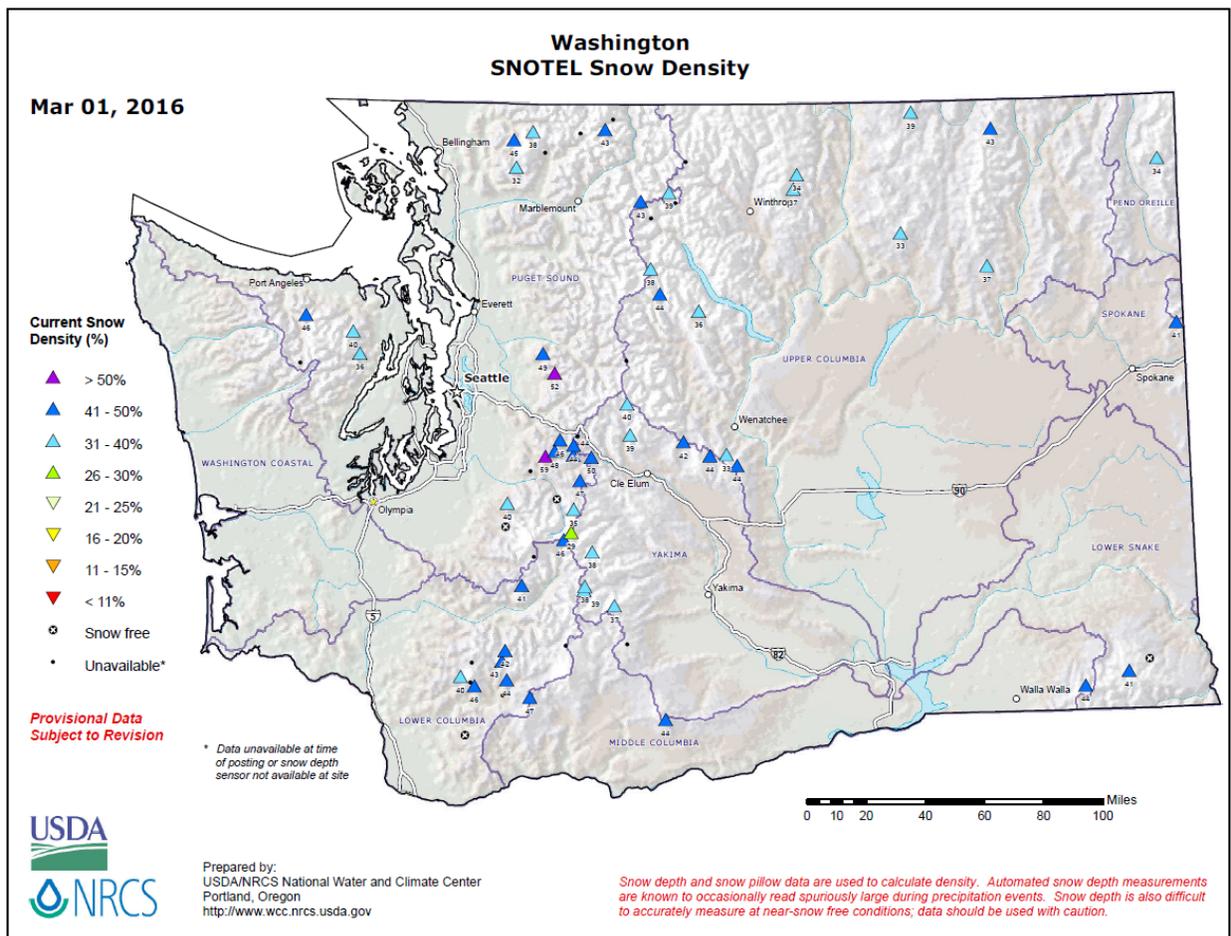
USDA-NRCS Agency Homepages

Washington:
<http://www.nrcs.usda.gov/wps/portal/nrcs/site/wa/home/>

NRCS National:
<http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/>

**March 1, 2016 -
Snowpack, Precipitation and Reservoir
Conditions at a Glance**
(Water Year = October 1, 2015 - Current Date)





Western Snow Conference

The Western Snow Conference is an annual tradition which started in 1932 as an international forum for individuals and organizations to share scientific, management and socio-political information on snow and runoff. The principal aim of the Western Snow Conference is to advance snow and hydrological sciences. The North Pacific Area Committee is making plans for the 84th Annual Western Snow Conference in 2016.

Dates: April 18-21, 2016

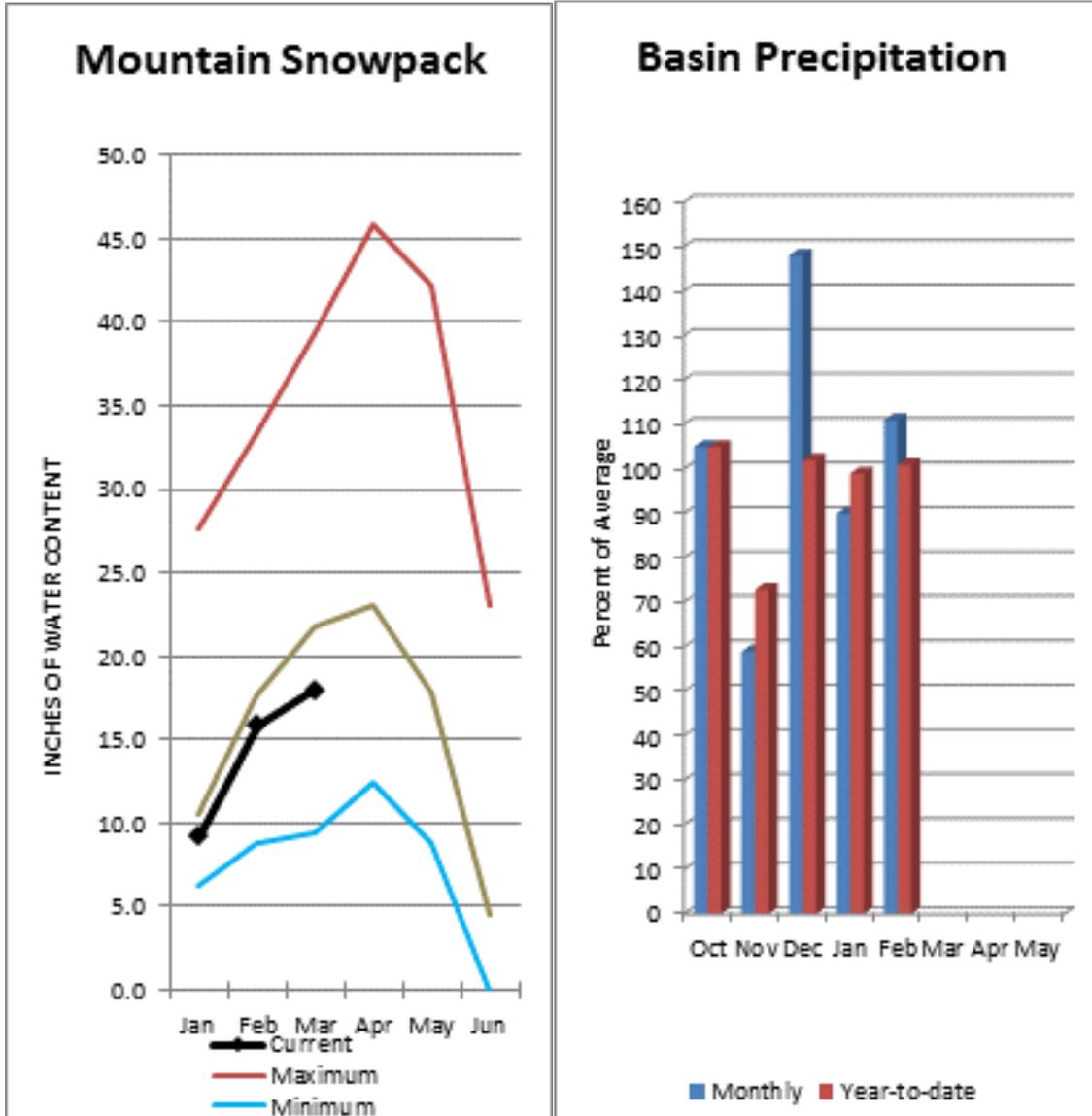
Location: Seattle, Washington

The Conference will begin Monday, April 18th with a short course and panel discussion on "Validation of the rain/snow Global Precipitation Measurements (GPM) satellite data in the Olympic Mountains: University of Washington and NASA" with several invited experts in the field. Tuesday and Wednesday will include formal paper and poster presentations on a variety of topics, including snow drought, climatology of drought, forecasting in drought conditions, dichotomy of precipitation and snow conditions, impacts and mitigation of low snow packs and record events in the snow environment. Thursday will include a technical of northwest geology and hydropower complexes in the North Cascade Mountains.

Additional information about the conference and the Call for Papers will be posted on the WSC web page at <http://www.westernsnowconference.org/>

We can be found on Facebook and twitter as well.

Spokane River Basin



The March 1 forecasts for summer runoff within the Spokane River Basin are 83% of average near Post Falls and 86% at Long Lake. The Chamokane River near Long Lake forecasted to have 118% of average flows for the May-August period. The forecast is based on a basin snowpack that is 83% of normal and precipitation that is 101% of average for the water year. Precipitation for February was slightly above normal at 111% of average. Streamflow on the Spokane River at Spokane was 147% of average for February. March 1 storage in Coeur d'Alene Lake was 171,000 acre feet, 129% of average and 72% of capacity. Snowpack at Quartz Peak SNOTEL site was 109% of average with 21.2 inches of water content. Average temperatures in the Spokane basin were 4-6 degrees above normal for February and 2-4 degrees above for the water year.

For more information contact your local Natural Resources Conservation Service office.

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Spokane Streamflow Forecasts - March 1, 2016

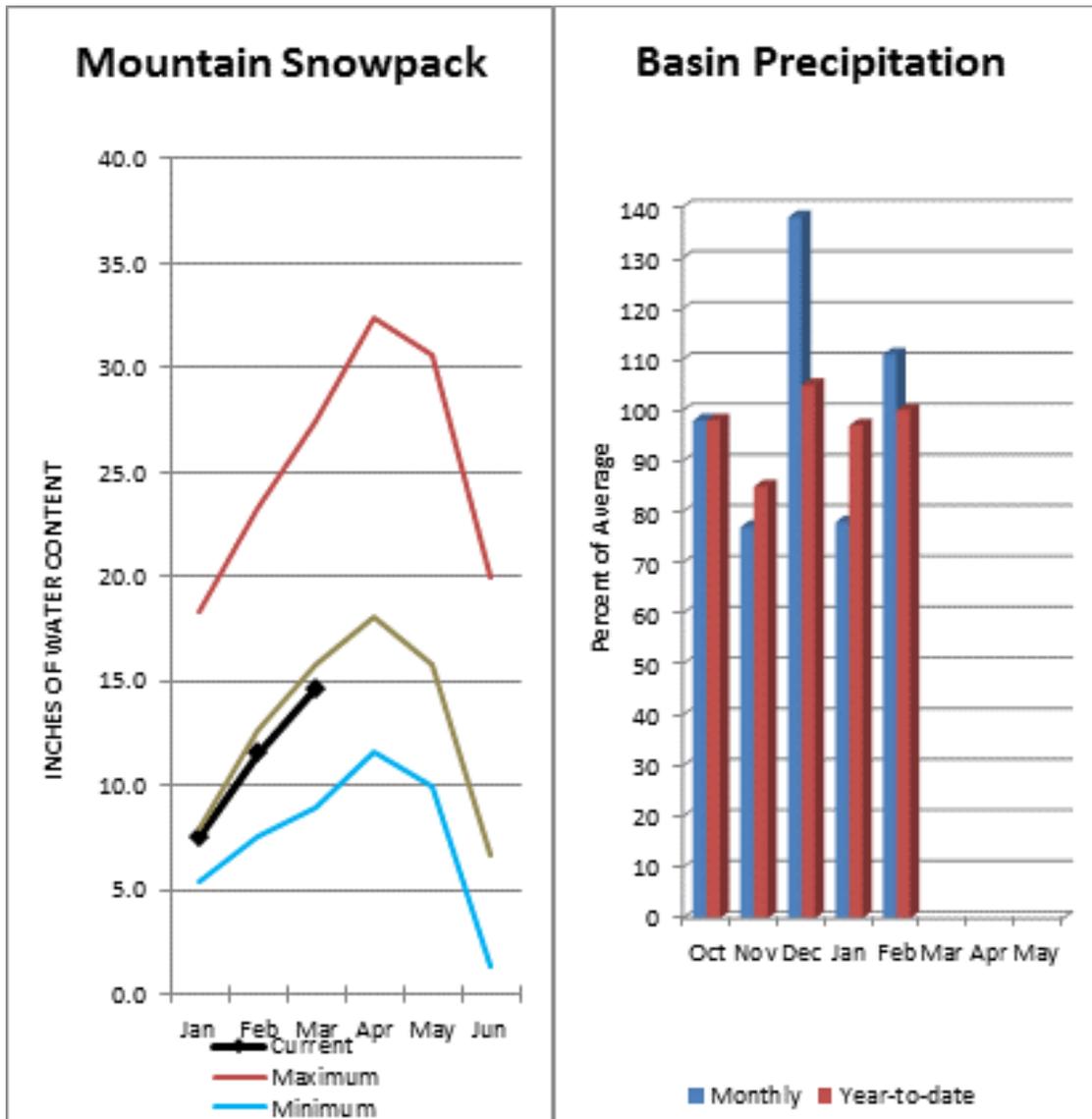
Spokane	Forecast Period	Forecast Exceedance Probabilities for Risk Assessment Chance that actual volume will exceed forecast						30yr Avg (KAF)
		90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	
Spokane R nr Post Falls	APR-JUL	1310	1720	2010	84%	2290	2700	2390
	APR-SEP	1370	1790	2070	83%	2360	2780	2480
Spokane R at Long Lake	APR-JUL	1510	1960	2270	87%	2580	3030	2620
	APR-SEP	1680	2140	2450	86%	2770	3230	2850
Chamokane Ck nr Long Lake	MAY-AUG	5.8	8.9	11	118%	13.1	16.2	9.3

- 1) 90% and 10% exceedance probabilities are actually 95% and 5%
- 2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions
- 3) Median value used in place of average

Reservoir Storage End of February, 2016	Current (KAF)	Last Year (KAF)	Average (KAF)	Capacity (KAF)
Lake Coeur d' Alene	171.4	144.1	132.8	238.5
Basin-wide Total	171.4	144.1	132.8	238.5
# of reservoirs	1	1	1	1

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
Spokane	15	83%	43%
Newman Lake	3	81%	20%

Pend Oreille River Basins



The April – September average forecast for the Priest River near the town of Priest River is 103% and the Pend Oreille below Box Canyon is 92%. February streamflow was 103% of average on the Pend Oreille River and 123% on the Columbia at Birchbank. March 1 snow cover was 93% of normal in the Pend Oreille Basin River Basin. Bunchgrass Meadows SNOTEL site had 22.9 inches of snow water on the snow pillow. Normally Bunchgrass would have 22.5 inches on March 1. Precipitation during February was 111% of average, dropping the year-to-date precipitation at 100% of average. Reservoir storage in the basin, including Lake Pend Oreille and Priest Lake was 86% of normal. Average temperatures were 4-6 degrees above normal for February and 2-4 degrees above for the water year.

For more information contact your local Natural Resources Conservation Service office.

Pend Oreille River Basins

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Pend Oreille Basins Streamflow Forecasts - March 1, 2016

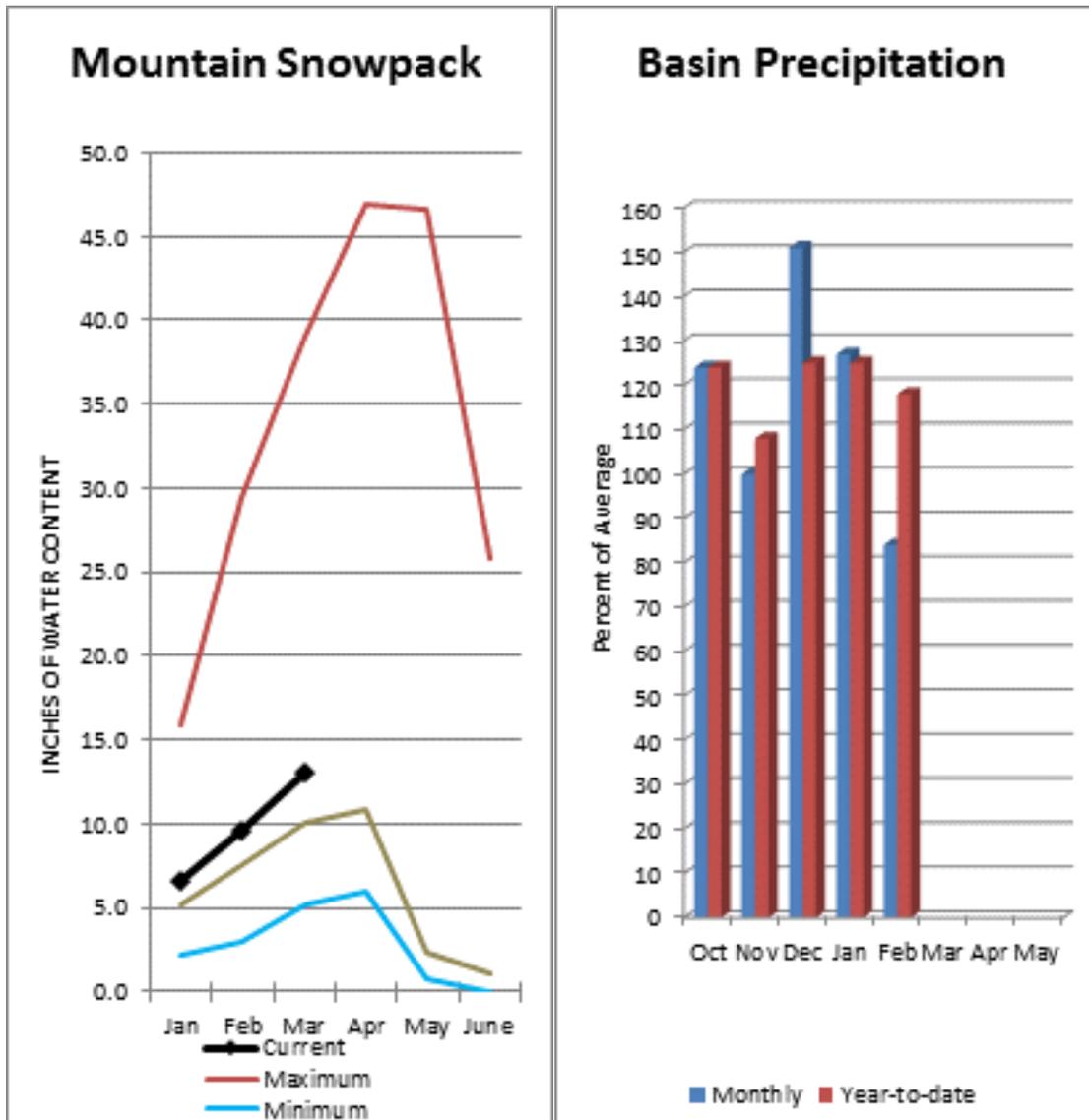
Forecast Exceedance Probabilities for Risk Assessment Chance that actual volume will exceed forecast

Pend Oreille Basins	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Pend Oreille Lake Inflow	APR-JUL	8730	9950	10800	92%	11600	12800	11800
	APR-SEP	9460	10800	11700	91%	12600	13900	12800
Priest R nr Priest River	APR-JUL	665	750	805	103%	865	950	780
	APR-SEP	705	795	855	103%	920	1010	830
Pend Oreille R bl Box Canyon	APR-JUL	8870	10100	10900	92%	11800	13000	11900
	APR-SEP	9560	10900	11900	92%	12800	14100	13000

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- 2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions
- 3) Median value used in place of average

Reservoir Storage End of February, 2016	Current (KAF)	Last Year (KAF)	Average (KAF)	Capacity (KAF)
Lake Pend Oreille	665.3	610.0	792.6	1561.3
Priest Lake	64.1	78.9	57.1	119.3
Basin-wide Total	729.5	688.8	849.7	1680.6
# of reservoirs	2	2	2	2

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
Pend Oreille Basins	76	93%	88%
Colville River	2	84%	28%
Pend Oreille River	74	93%	89%
Kettle River	5	122%	69%



Summer runoff average forecast for the Okanogan River is 99%, Similkameen River is 81%, and Methow River is 122%. March 1 snow cover on the Okanogan was 128% of normal, Omak Creek was 130% and the Methow was 135%. February precipitation in the Upper Columbia was 84% of average, with precipitation for the water year at 118% of average. February streamflow for the Methow River was 149% of average, 135% for the Okanogan River and 223% for the Similkameen. Snow-water content at Salmon Meadows SNOTEL was 11.2 inches or 129% of normal for March 1. Combined storage in the Conconully Reservoirs was 10,000 acre-feet or 95% of normal. Temperatures were 1-2 degrees above normal for February and for the water year.

Upper Columbia River Basins

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Upper Columbia Basins Streamflow Forecasts - March 1, 2016

Forecast Exceedance Probabilities for Risk Assessment Chance that actual volume will exceed forecast

Upper Columbia Basins	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Kettle R nr Laurier	APR-JUL	1710	1920	2070	115%	2220	2430	1800
	APR-SEP	1760	2000	2160	115%	2320	2560	1880
Colville R at Kettle Falls	APR-JUL	60	97	122	103%	147	184	119
	APR-SEP	65	105	133	102%	161	200	131
Columbia R at Grand Coulee ¹	APR-JUL	41600	47500	50200	98%	52800	58800	51015
	APR-SEP	50100	57200	60400	100%	63600	70600	60110
Similkameen R nr Nighthawk ¹	APR-JUL	630	865	970	81%	1080	1320	1200
	APR-SEP	690	930	1040	81%	1150	1390	1280
Okanogan R nr Tonasket ¹	APR-JUL	930	1260	1410	95%	1550	1880	1480
	APR-SEP	1040	1400	1560	95%	1730	2090	1650
Okanogan R at Malott ¹	APR-JUL	960	1300	1460	101%	1610	1950	1450
	APR-SEP	1060	1440	1610	99%	1780	2160	1620
Methow R nr Pateros	APR-JUL	860	950	1010	121%	1080	1170	835
	APR-SEP	930	1020	1090	122%	1150	1250	895
Columbia R at Birchbank ¹	APR-JUL	29100	32600	34200	101%	35700	39200	33840
	APR-SEP	36300	40600	42600	102%	44600	48900	41750

1) 90% and 10% exceedance probabilities are actually 95% and 5%

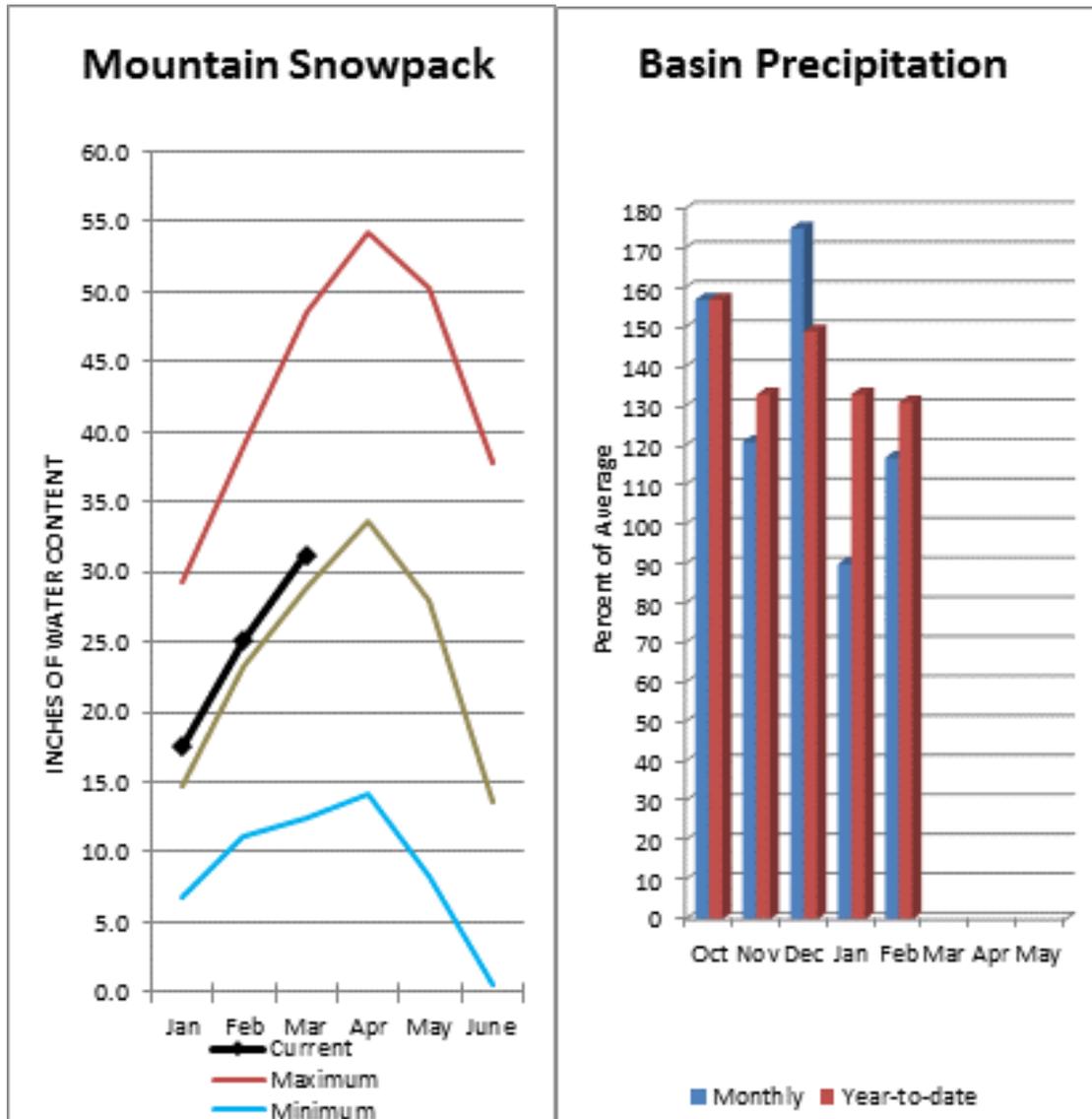
2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions

3) Median value used in place of average

Reservoir Storage End of February, 2016	Current (KAF)	Last Year (KAF)	Average (KAF)	Capacity (KAF)
Conconully Lake (Salmon Lake Dam)	7.2	6.9	7.3	10.5
Conconully Reservoir	6.8	10.7	7.4	13.0
Basin-wide Total	14.0	17.6	14.7	23.5
# of reservoirs	2	2	2	2

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
Upper Columbia Basins	25	124%	75%
Okanogan River	14	128%	78%
Omak Creek	3	130%	43%
Sanpoil River	1	0%	0%
Similkameen River	4	103%	82%
Toats Coulee Creek	4	141%	86%
Conconully Lake	3	128%	58%
Methow River	7	134%	84%

Central Columbia River Basins



Precipitation during February was 123% of average in the basin and 132% for the year-to-date. Runoff for Entiat River is forecast to be 111% of average for the summer. The April-September average forecast for Chelan River is 107%, Wenatchee River at Plain is 107%, Stehekin River is 111% and Icicle Creek is 103%. February average streamflow on the Chelan River was 176% and on the Wenatchee River 213%. March 1 snowpack in the Wenatchee River Basin was 102% of normal; the Chelan, 118%; the Entiat, 90%; Stemilt Creek, 108% and Colockum Creek, 166%. Reservoir storage in Lake Chelan was 112% of average and 46% of capacity. Lyman Lake SNOTEL had the most snow water with 54.1 inches of water. This site would normally have 48.6 inches on March 1. Temperatures were 2-4 degrees above normal for February and 1-2 degrees above for the water year.

For more information contact your local Natural Resources Conservation Service office.

Central Columbia River Basins

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Central Columbia Basins Streamflow Forecasts - March 1, 2016

Forecast Exceedance Probabilities for Risk Assessment
Chance that actual volume will exceed forecast

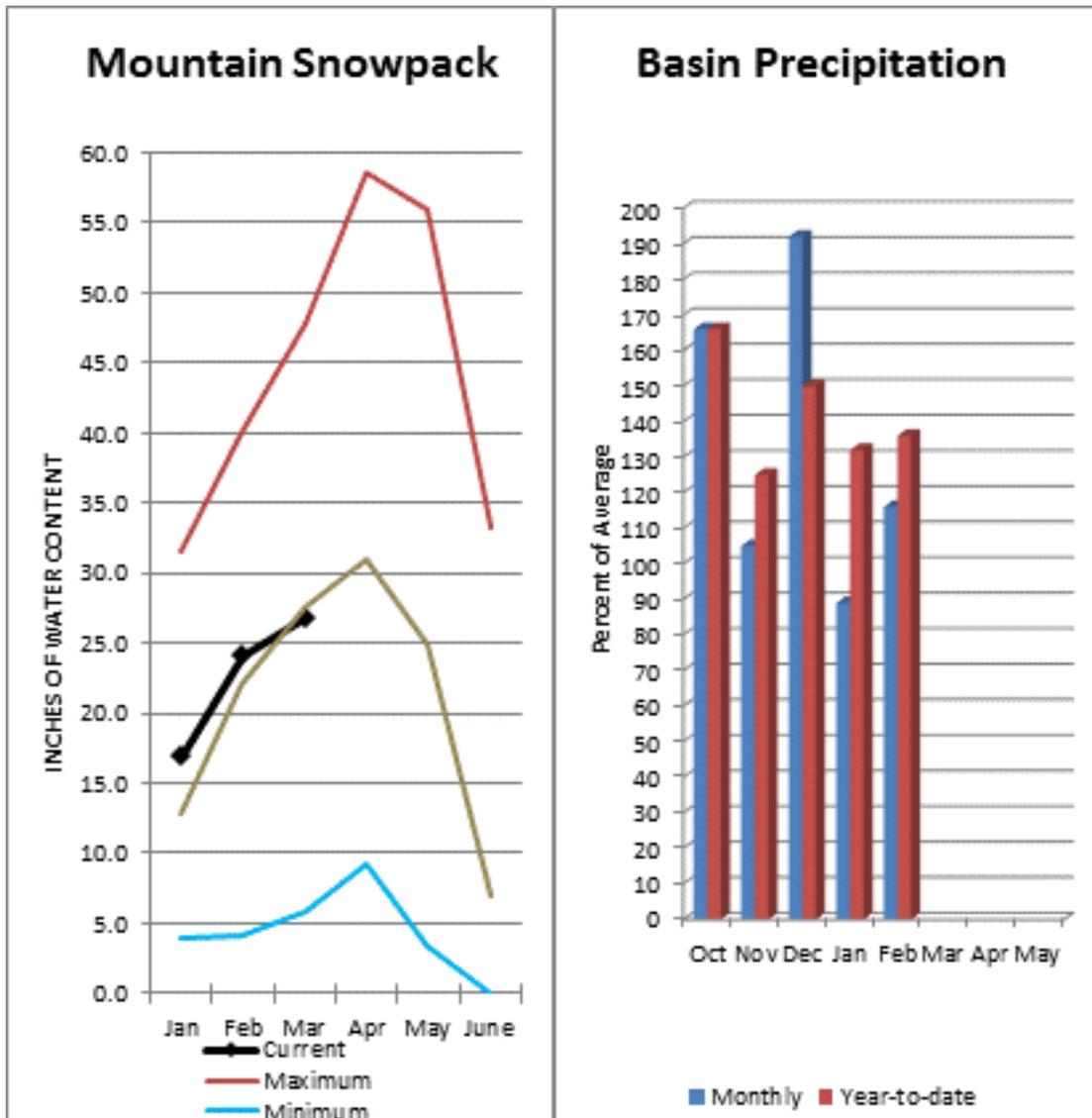
Central Columbia Basins	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Stehekin R at Stehekin	APR-JUL	630	700	750	110%	800	870	680
	APR-SEP	750	825	875	111%	925	1000	790
Chelan R at Chelan	APR-JUL	925	1010	1060	106%	1120	1200	1000
	APR-SEP	1040	1130	1200	107%	1260	1350	1120
Entiat R nr Ardenvoir	APR-JUL	190	210	220	110%	235	255	200
	APR-SEP	210	230	245	111%	255	275	220
Wenatchee R at Plain	APR-JUL	905	1000	1060	107%	1120	1210	990
	APR-SEP	995	1090	1160	107%	1220	1320	1080
Icicle Ck nr Leavenworth	APR-JUL	245	270	285	104%	305	325	275
	APR-SEP	265	290	310	103%	330	355	300
Wenatchee R at Peshastin	APR-JUL	1250	1370	1460	107%	1540	1660	1370
	APR-SEP	1370	1500	1590	107%	1680	1810	1490
Columbia R bl Rock Island Dam	APR-JUL	47800	52500	55600	100%	58700	63400	55770
	APR-SEP	57200	62600	66300	102%	70000	75500	65200

- 1) 90% and 10% exceedance probabilities are actually 95% and 5%
- 2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions
- 3) Median value used in place of average

Reservoir Storage End of February, 2016	Current (KAF)	Last Year (KAF)	Average (KAF)	Capacity (KAF)
Lake Chelan	312.7	425.6	279.8	676.1
Basin-wide Total	312.7	425.6	279.8	676.1
# of reservoirs	1	1	1	1

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
Central Columbia Basins	4	118%	79%
Chelan Lake Basin	4	118%	79%
Entiat River	1	90%	63%
Wenatchee River	7	102%	51%
Stemilt Creek	1	108%	54%
Colockum Creek	1	166%	49%

Upper Yakima River Basin



March 1 reservoir storage for the Upper Yakima reservoirs was 580,000-acre feet, 129% of average. Forecasts for the Yakima River at Cle Elum are 96% of average and the Teanaway River near Cle Elum is at 113%. Lake inflows are all forecasted to be near average this summer as well. February streamflow's within the basin were Cle Elum River near Roslyn at 127%. March 1 snowpack was 97% based upon 8 snow course and SNOTEL readings within the Upper Yakima Basin. Precipitation was 132% of average for February and 133% for the water-year. Volume forecasts for the Yakima Basin are for natural flow. As such, they may differ from the U.S. Bureau of Reclamation's forecast for the total water supply available, which includes irrigation return flow.

For more information contact your local Natural Resources Conservation Service office.

Upper Yakima River Basin

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Upper Yakima River Streamflow Forecasts - March 1, 2016

Forecast Exceedance Probabilities for Risk Assessment Chance that actual volume will exceed forecast

Upper Yakima River	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Keechelus Reservoir Inflow	APR-JUL	84	101	113	97%	125	143	116
	APR-SEP	93	111	123	98%	135	153	126
Kachess Reservoir Inflow	APR-JUL	78	92	102	98%	112	126	104
	APR-SEP	86	100	109	96%	119	133	113
Cle Elum Lake Inflow	APR-JUL	315	350	375	97%	400	440	385
	APR-SEP	340	380	405	98%	435	475	415
Yakima R at Cle Elum	APR-JUL	545	650	725	96%	800	910	755
	APR-SEP	590	710	795	96%	875	1000	830
Teanaway R. bl Forks nr Cle Elum	APR-JUL	116	135	147	113%	160	178	130
	APR-SEP	119	137	150	113%	163	181	133

1) 90% and 10% exceedance probabilities are actually 95% and 5%

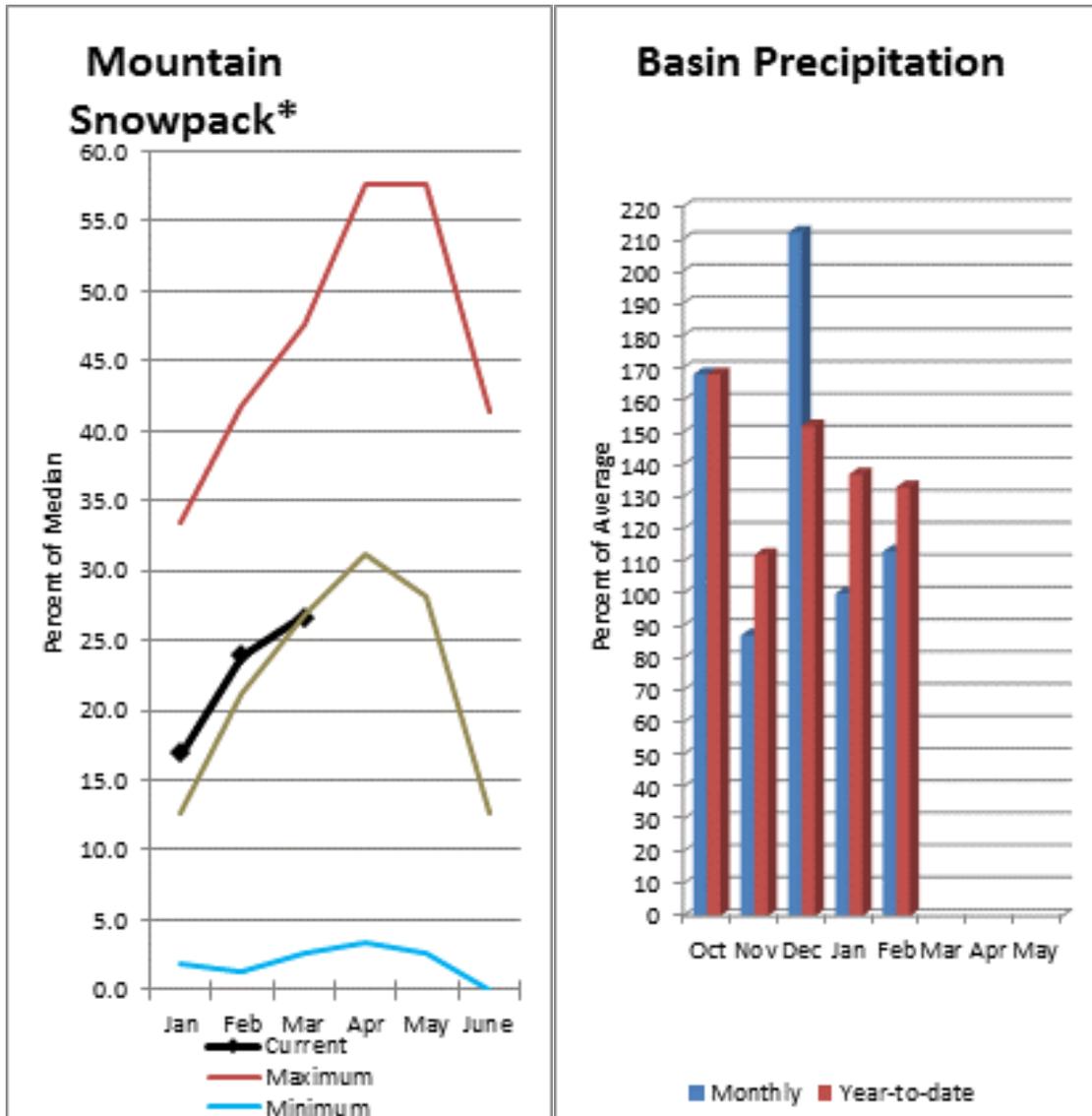
2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions

3) Median value used in place of average

Reservoir Storage End of February, 2016	Current (KAF)	Last Year (KAF)	Average (KAF)	Capacity (KAF)
Keechelus	128.5	157.8	92.3	157.8
Kachess	150.1	223.4	143.6	239.0
Cle Elum	301.9	394.8	214.4	436.9
Basin-wide Total	580.5	776.0	450.3	833.7
# of reservoirs	3	3	3	3

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
Upper Yakima River	8	97%	26%

Lower Yakima River Basin



February average streamflow's within the basin were: Yakima River near Parker, 214% and the Naches River near Naches, 227%. March 1 reservoir storage for Bumping and Rimrock reservoirs was 199,000-acre feet, 145% of average. Forecast averages for Yakima River near Parker are 114%; American River near Nile, 113%; Ahtanum Creek, 145%; and Klickitat River near Glenwood, 111%. March 1 snowpack was 114% based upon 7 snow course and SNOTEL readings within the Lower Yakima Basin and Ahtanum Creek reported in at 110% of normal. Precipitation was 113% of average for February and 133% for the water-year. Temperatures were 2-4 degrees above normal for February and for 1-2 degrees above normal for the water year. Volume forecasts for Yakima Basin are for natural flow. As such, they may differ from the U.S. Bureau of Reclamation's forecast for the total water supply available, which includes irrigation return flow.

For more information contact your local Natural Resources Conservation Service office.

Lower Yakima River Basin

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Lower Yakima River Streamflow Forecasts - March 1, 2016

Forecast Exceedance Probabilities for Risk Assessment Chance that actual volume will exceed forecast

Lower Yakima River	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Bumping Lake Inflow	APR-JUL	108	122	131	115%	141	155	114
	APR-SEP	119	133	143	116%	153	167	123
American R nr Nile	APR-JUL	94	106	114	112%	123	135	102
	APR-SEP	103	116	124	113%	133	146	110
Rimrock Lake Inflow	APR-JUL	189	205	215	115%	230	245	187
	APR-SEP	225	245	255	116%	270	290	220
Naches R nr Naches	APR-JUL	660	740	795	114%	850	930	700
	APR-SEP	720	805	865	114%	925	1010	760
Ahtanum Ck at Union Gap	APR-JUL	31	36	40	148%	44	50	27
	APR-SEP	33	39	42	145%	46	52	29
Yakima R nr Parker	APR-JUL	1550	1750	1900	114%	2040	2240	1660
	APR-SEP	1720	1930	2080	114%	2230	2440	1820
Klickitat R nr Glenwood	APR-JUL	116	130	140	111%	150	164	126
	APR-SEP	128	144	154	111%	165	180	139
Klickitat R nr Pitt	APR-JUL	415	465	500	115%	530	580	435
	APR-SEP	500	560	600	115%	635	695	520

1) 90% and 10% exceedance probabilities are actually 95% and 5%

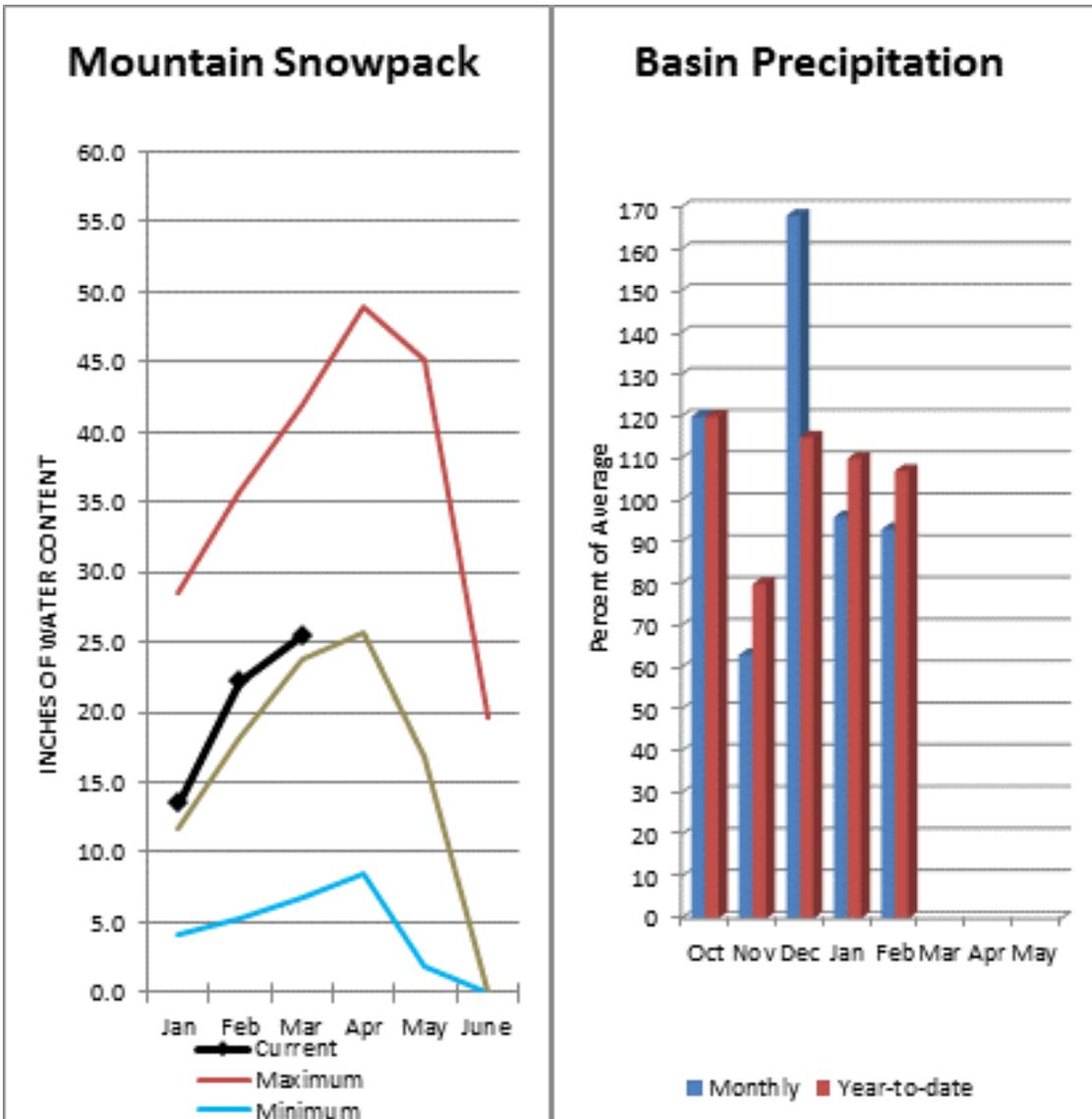
2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions

3) Median value used in place of average

Reservoir Storage End of February, 2016	Current (KAF)	Last Year (KAF)	Average (KAF)	Capacity (KAF)
Bumping Lake	20.8	33.8	13.3	33.7
Rimrock	177.8	197.8	123.3	198.0
Basin-wide Total	198.6	231.6	136.6	231.7
# of reservoirs	2	2	2	2

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
Lower Yakima River	7	114%	34%
Ahtanum Creek	2	110%	30%

Walla Walla River Basin



February precipitation was 93% of average, maintaining the year-to-date precipitation at 107% of average. Snowpack in the basin was 107% of normal. Streamflow forecasts are 100% of average for Mill Creek and 98% for the SF Walla Walla near Milton-Freewater. Average temperatures were 4-6 degrees above normal for February and 2-4 degrees above for the water year.

For more information contact your local Natural Resources Conservation Service office.

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Walla Walla River Streamflow Forecasts - March 1, 2016

Forecast Exceedance Probabilities for Risk Assessment
Chance that actual volume will exceed forecast

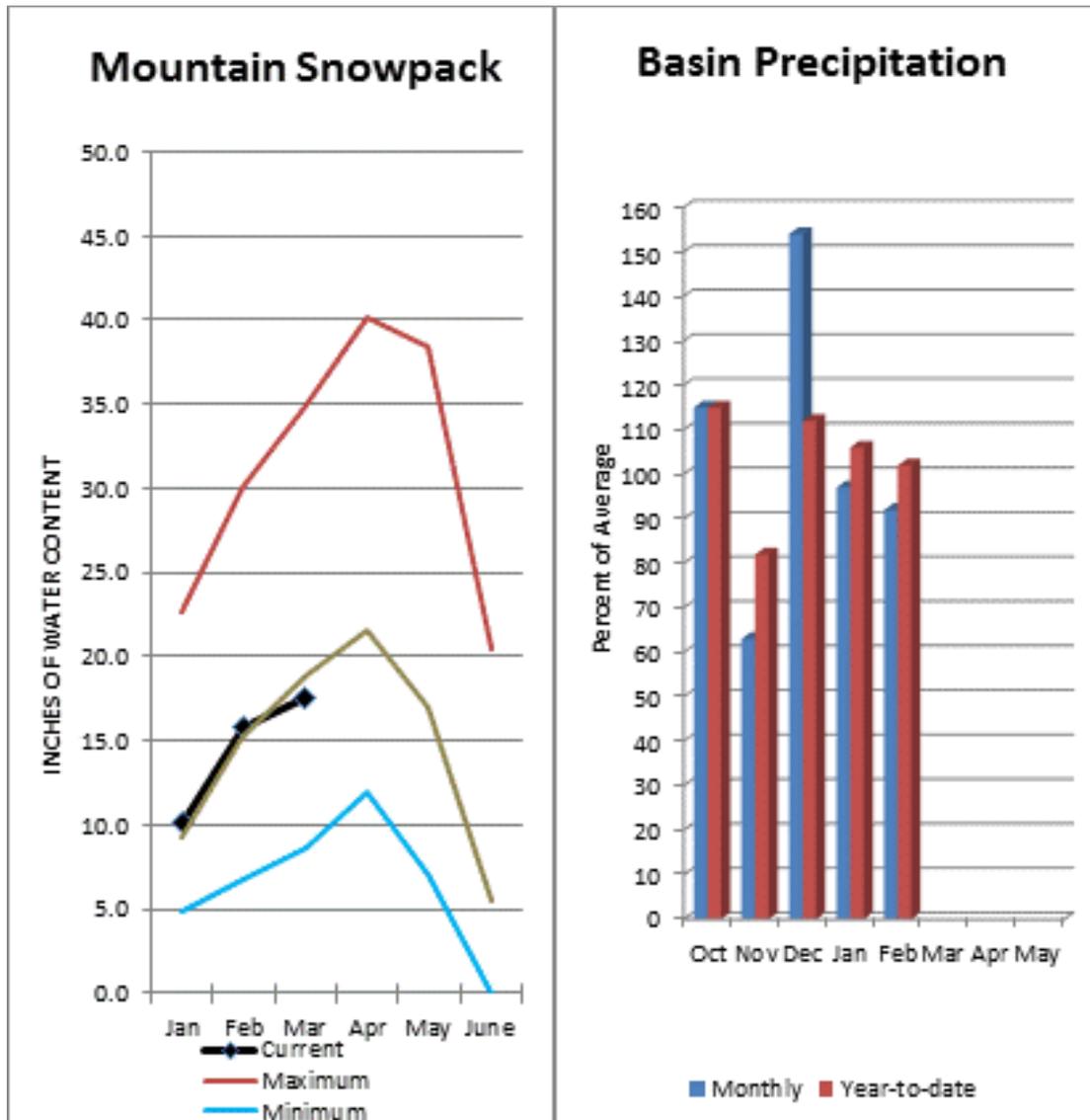
Walla Walla River	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
<hr/>								
SF Walla Wall R nr Milton-Freewater	MAR-SEP	66	74	79	99%	84	92	80
	APR-JUL	43	49	53	98%	57	63	54
	APR-SEP	54	60	65	98%	70	76	66
Mill Ck nr Walla Walla	APR-JUL	17.2	21	24	100%	27	31	24
	APR-SEP	19.7	24	27	100%	30	34	27

1) 90% and 10% exceedance probabilities are actually 95% and 5%

2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions

3) Median value used in place of average

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
Walla Walla River	2	107%	46%



The Grande Ronde River can expect summer flows to be about 104% of normal. The forecast for Asotin Creek at Asotin predicts 97% of average flows for the April – July runoff period. February precipitation was 92% of average, bringing the year-to-date precipitation to 102% of average. March 1 snowpack readings averaged 93% of normal. February streamflow was 104% of average for Snake River below Lower Granite Dam and 132% for Grande Ronde River near Troy. Dworshak Reservoir storage was 113% of average. Average temperatures were 4-6 degrees above normal for February and 2-4 degrees above for the water year.

For more information contact your local Natural Resources Conservation Service office.

Lower Snake River Basin

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Lower Snake, Grande Ronde, Clearwater Basins Streamflow Forecasts - March 1, 2016

Forecast Exceedance Probabilities for Risk Assessment Chance that actual volume will exceed forecast

Lower Snake, Grande Ronde, Clearwater Basins	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Grande Ronde R at Troy	MAR-JUL	1250	1450	1580	105%	1710	1910	1510
	APR-SEP	1030	1220	1360	104%	1500	1690	1310
Asotin Ck at Asotin	APR-JUL	19.4	28	34	97%	40	49	35
Clearwater R at Spalding	APR-JUL	4990	5910	6540	95%	7180	8100	6890
	APR-SEP	5310	6280	6930	95%	7580	8550	7270
Snake R bl Lower Granite Dam ¹	APR-JUL	12000	17000	19300	97%	21600	26600	19848
	APR-SEP	13800	19400	22000	99%	24600	30200	22280

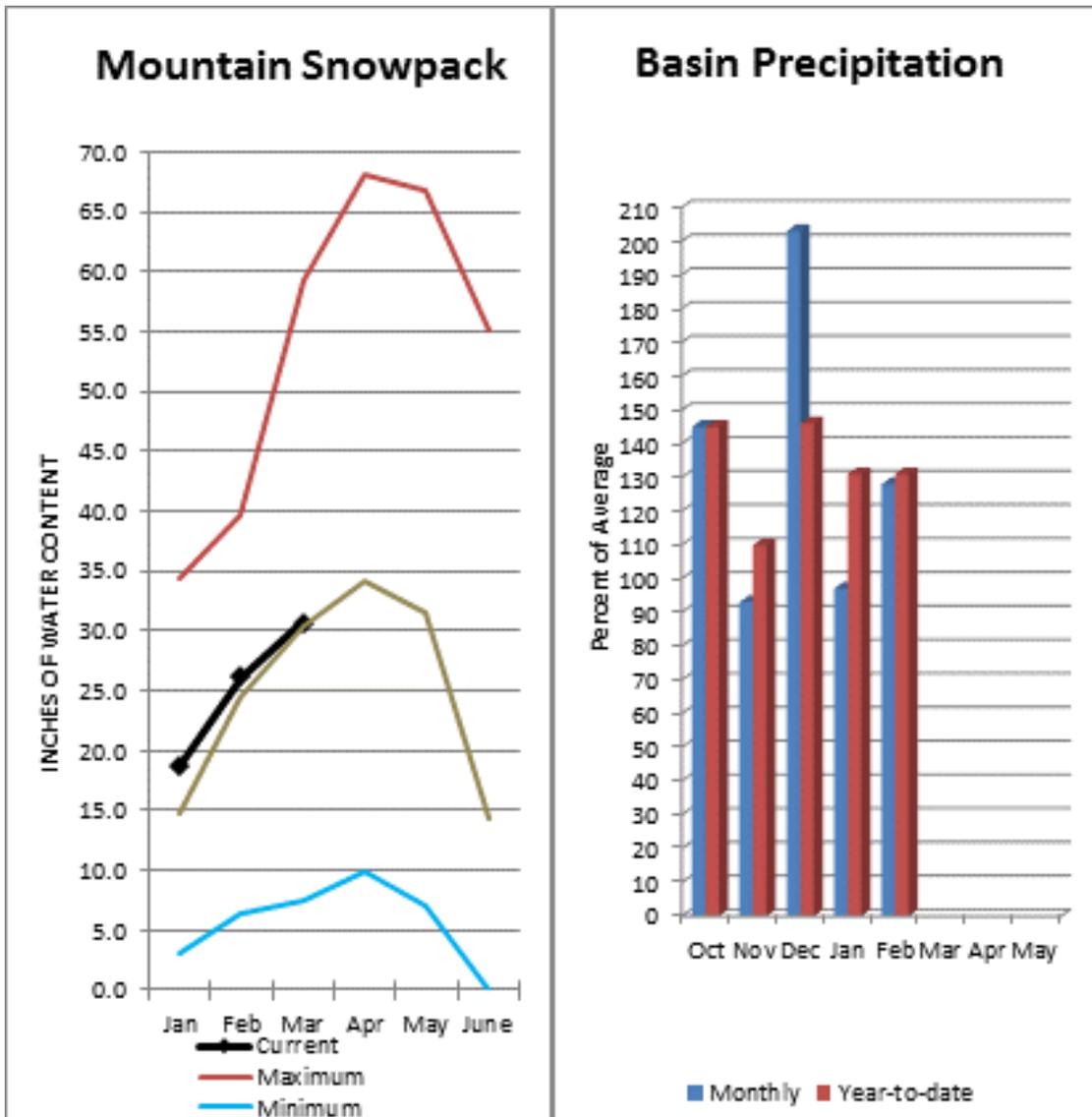
1) 90% and 10% exceedance probabilities are actually 95% and 5%

2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions

3) Median value used in place of average

Reservoir Storage End of February, 2016	Current (KAF)	Last Year (KAF)	Average (KAF)	Capacity (KAF)
Dworshak Reservoir	2670.9	2880.4	2358.0	3468.0
Basin-wide Total	2670.9	2880.4	2358.0	3468.0
# of reservoirs	1	1	1	1

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
Lower Snake, Grande Ronde, Clearwater Basins	14	93%	59%



Forecasts for April – September streamflows within the basin are Lewis River at Ariel, 97% and Cowlitz River at Castle Rock, 104% of average. The Columbia at The Dalles is forecasted to have average flows this summer according to the River Forecast Center. February average streamflow for Cowlitz River was 146%. The Columbia River at The Dalles was 118% of average. February precipitation was 130% of average and the water-year average was 131%. March 1 snow cover for Cowlitz River was 100%, and Lewis River was 105% of normal. Temperatures were 1-3 degrees above normal during February and for the water year.

Lower Columbia River Basins

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Lower Columbia Basins Streamflow Forecasts - March 1, 2016

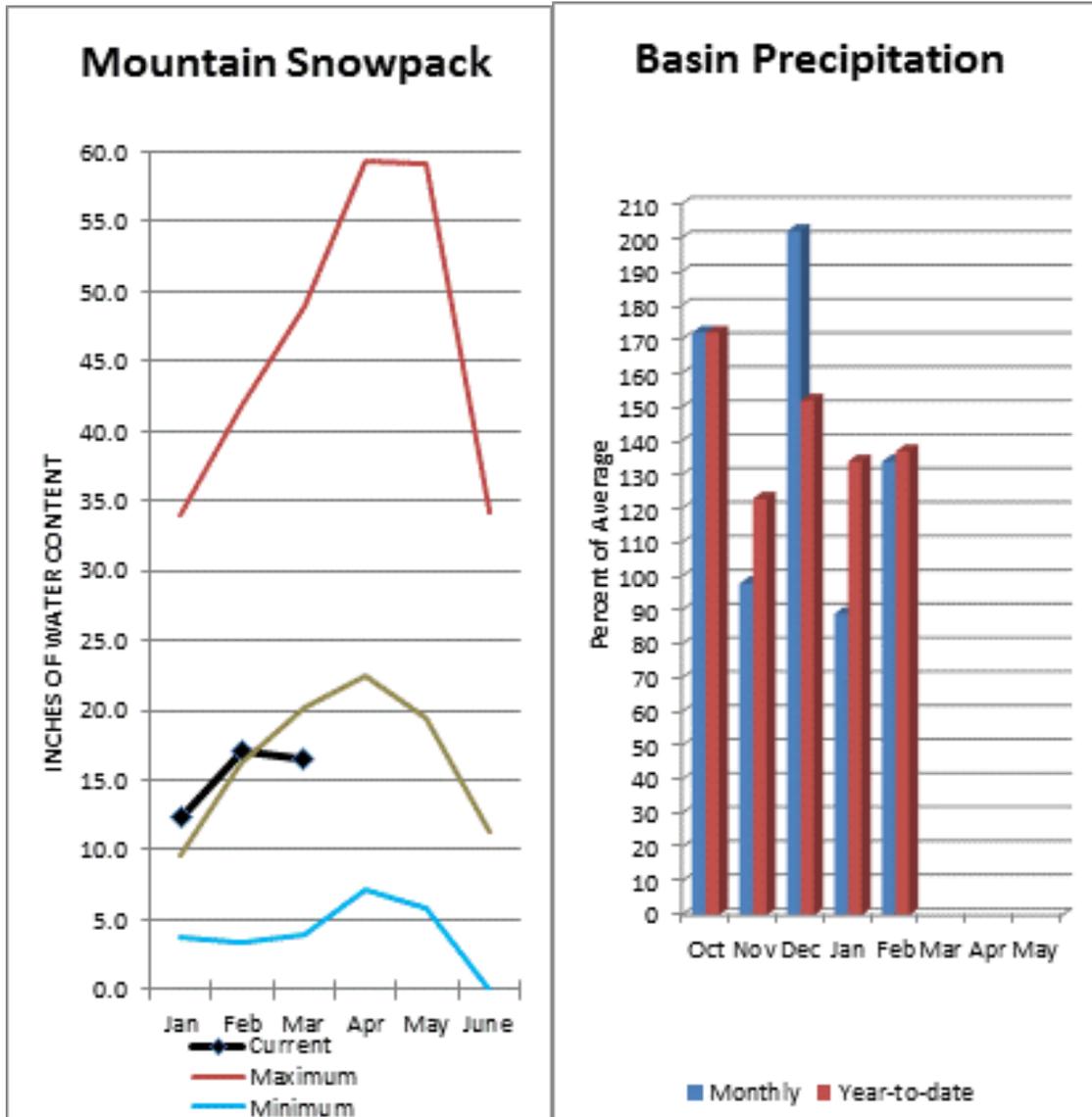
Forecast Exceedance Probabilities for Risk Assessment
Chance that actual volume will exceed forecast

Lower Columbia Basins	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Columbia R at The Dalles	APR-JUL	67700	74700	79500	100%	84300	91300	79855
	APR-SEP	79400	87600	93100	100%	98700	107000	92704
Klickitat R nr Glenwood	APR-JUL	116	130	140	111%	150	164	126
	APR-SEP	128	144	154	111%	165	180	139
Klickitat R nr Pitt	APR-JUL	415	465	500	115%	530	580	435
	APR-SEP	500	560	600	115%	635	695	520
Lewis R at Ariel	APR-JUL	670	835	950	98%	1060	1230	970
	APR-SEP	795	970	1090	97%	1210	1380	1120
Cowlitz R bl Mayfield	APR-JUL	1200	1450	1620	100%	1790	2040	1620
	APR-SEP	1400	1700	1900	103%	2100	2400	1840
Cowlitz R at Castle Rock	APR-JUL	1780	2060	2250	101%	2440	2720	2230
	APR-SEP	2110	2410	2620	104%	2830	3130	2520

- 1) 90% and 10% exceedance probabilities are actually 95% and 5%
- 2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions
- 3) Median value used in place of average

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
Lower Columbia Basins	10	100%	21%
Lewis River	4	100%	7%
Cowlitz River	6	100%	32%

South Puget Sound River Basins



Summer runoff is forecast to be 92% of normal for the Green River below Howard Hanson Dam and 111% for the White River near Buckley. March 1 snowpack was 101% of average for the White River, 98% for Puyallup River and 81% in the Green River Basin. February precipitation was 143% of average, bringing the water year-to-date to 135% of average for the basins. Average temperatures in the area were 2-4 degrees above normal for February and 1-2 degrees above for the water-year.

For more information contact your local Natural Resources Conservation Service office.

South Puget Sound River Basins

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South Puget Sound Basins Streamflow Forecasts - March 1, 2016

Forecast Exceedance Probabilities for Risk Assessment Chance that actual volume will exceed forecast

South Puget Sound Basins	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
White R nr Buckley ¹	APR-JUL	365	440	480	112%	515	590	430
	APR-SEP	440	530	570	111%	610	700	515
Green R bl Howard A Hanson Dam ¹	APR-JUL	119	186	215	91%	245	315	235
	APR-SEP	138	205	240	92%	270	340	260

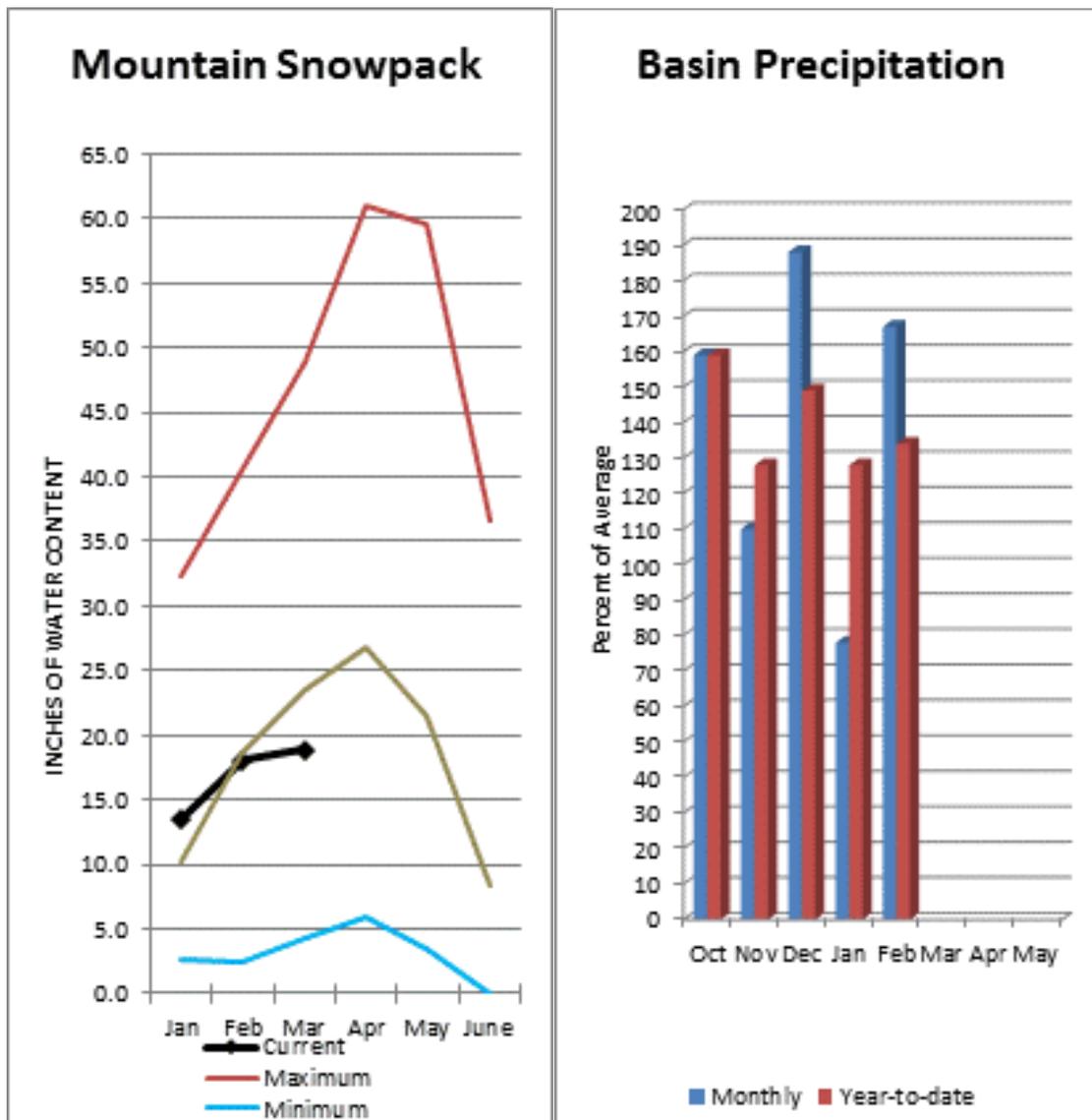
1) 90% and 10% exceedance probabilities are actually 95% and 5%

2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions

3) Median value used in place of average

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
South Puget Sound Basins	10	95%	34%
White River	3	101%	46%
Green River	2	81%	8%

Central Puget Sound River Basins



Forecast for spring and summer flows are: 109% for Cedar River near Cedar Falls; 107% for Rex River; 106% for South Fork of the Tolt River; and 104% for Taylor Creek near Selleck. Basin-wide precipitation for February was 162% of average, bringing water-year-to-date to 133% of average. March 1 median snow cover in Cedar River Basin was 103%, Tolt River Basin was 59%, Snoqualmie River Basin was 74%, and Skykomish River Basin was 69%. Temperatures were 2-4 degrees above normal for February and 1-2 degrees above for the water-year.

For more information contact your local Natural Resources Conservation Service office.

Central Puget Sound River Basins

Data Current as of: 3/3/2016 4:02:35 PM

Central Puget Sound Basins Streamflow Forecasts - March 1, 2016

Forecast Exceedance Probabilities for Risk Assessment Chance that actual volume will exceed forecast

Central Puget Sound Basins	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Cedar R nr Cedar Falls	APR-JUL	59	70	77	110%	84	94	70
	APR-SEP	65	76	83	109%	90	101	76
Rex R nr Cedar Falls	APR-JUL	19	24	27	113%	30	35	24
	APR-SEP	21	26	29	107%	33	38	27
Taylor Ck nr Selleck	APR-JUL	16.1	19.2	21	105%	23	26	20
	APR-SEP	19.5	23	25	104%	27	30	24
SF Tolt R nr Index	APR-JUL	10.7	13.1	14.7	104%	16.3	18.6	14.2
	APR-SEP	12.5	15.2	17	106%	18.8	21	16.1

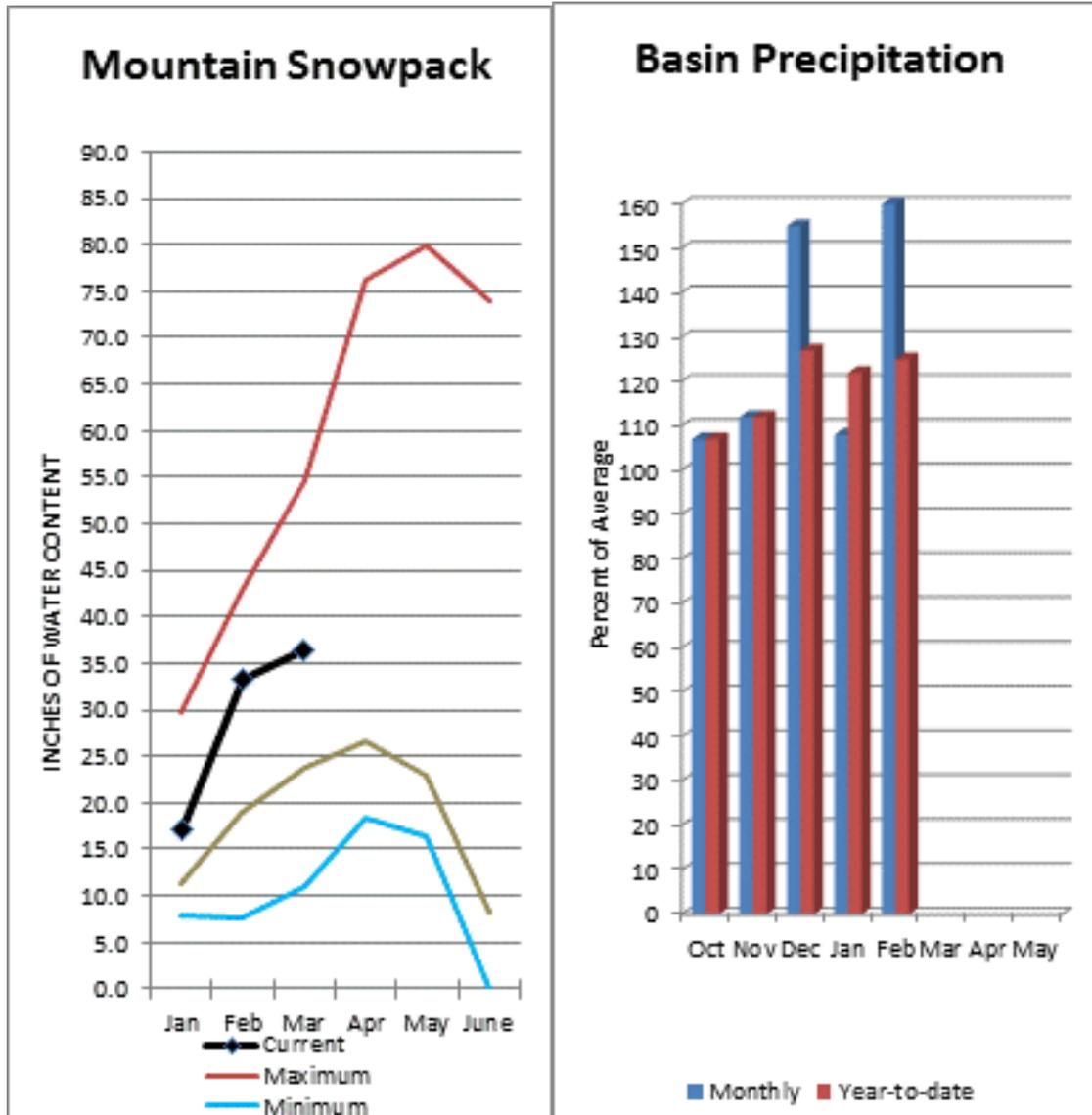
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2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions

3) Median value used in place of average

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
Central Puget Sound Basins	16	87%	14%
Puyallup River	5	98%	38%
Cedar River	5	103%	0%
Tolt River	3	59%	0%
Snoqualmie River	5	74%	7%
Skykomish River	3	69%	11%

North Puget Sound River Basins



Forecast for Skagit River streamflow at Newhalem is 112% of average for the spring and summer period. February streamflow in Skagit River was 189% of average. Other forecast points included Baker River at 118% and Thunder Creek at 103% of average. Basin-wide precipitation for February was 176% of average, bringing water-year-to-date to 125% of average. March 1 average snow cover in Skagit River Basin was 109%, Nooksack River Basin was 85% and Baker River Basin was 79% of normal. March 1 Skagit River reservoir storage was 73% of average and 43% of capacity. Average temperatures were 2-4 degrees above normal for February and near normal for the water year.

For more information contact your local Natural Resources Conservation Service office.

North Puget Sound River Basins

Data Current as of: 3/3/2016 4:02:36 PM

North Puget Sound Basins Streamflow Forecasts - March 1, 2016

Forecast Exceedance Probabilities for Risk Assessment Chance that actual volume will exceed forecast

North Puget Sound Basins	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Thunder Ck nr Newhalem	APR-JUL	210	230	245	104%	255	275	235
	APR-SEP	305	325	340	103%	355	380	330
Skagit R at Newhalem	APR-JUL	1670	1820	1920	114%	2020	2170	1680
	APR-SEP	1990	2160	2270	112%	2380	2550	2030
Baker R at Concrete	APR-JUL	705	800	865	111%	925	1020	780
	APR-SEP	940	1070	1160	118%	1240	1370	980

1) 90% and 10% exceedance probabilities are actually 95% and 5%

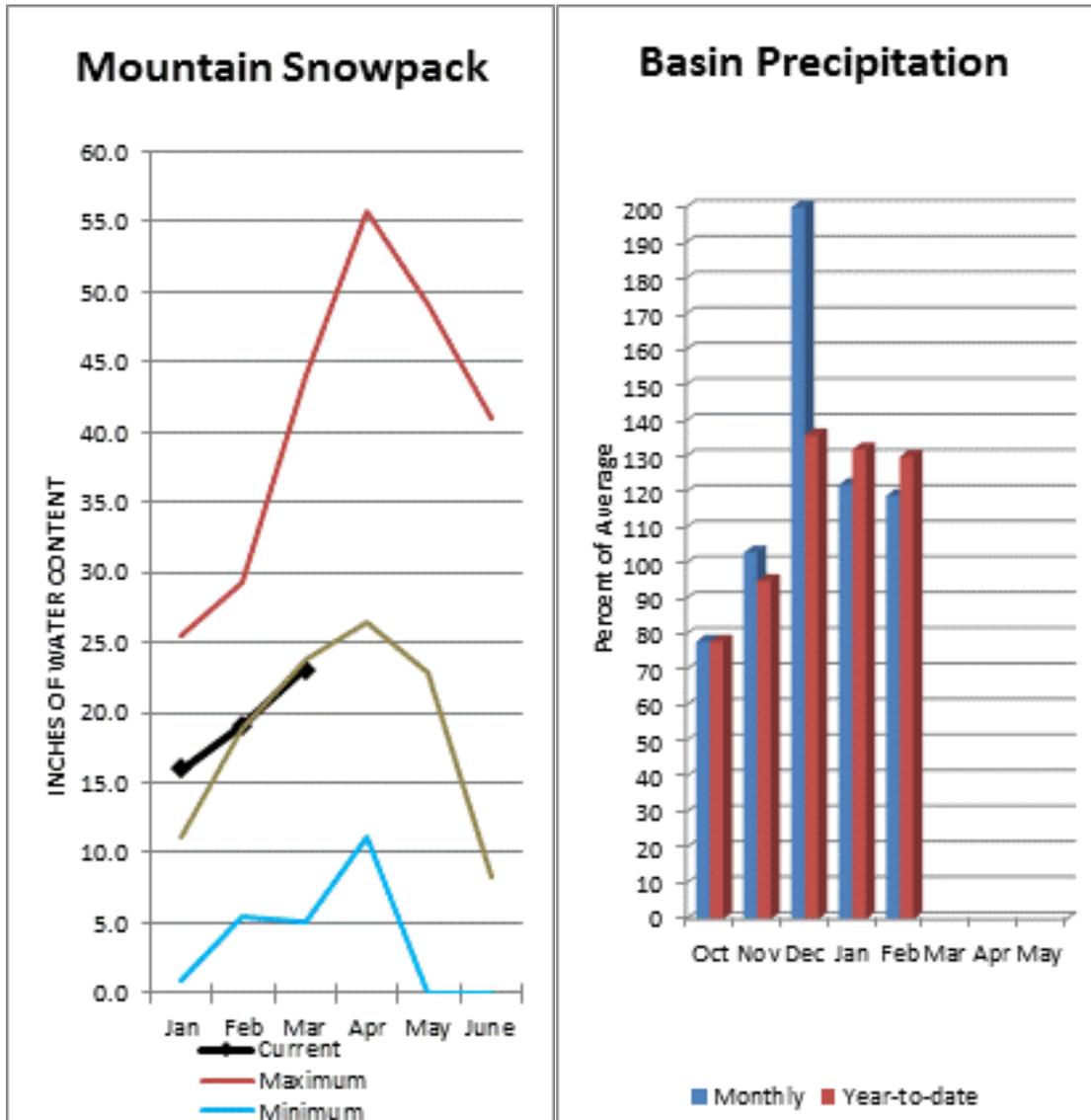
2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions

3) Median value used in place of average

Reservoir Storage End of February, 2016	Current (KAF)	Last Year (KAF)	Average (KAF)	Capacity (KAF)
Ross	604.8	798.1	832.4	1404.1
Diablo Reservoir			86.2	90.6
Basin-wide Total	604.8	798.1	832.4	1404.1
# of reservoirs	1	1	1	1

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
North Puget Sound Basins	23	93%	38%
Skagit River	14	109%	63%
Baker River	6	79%	21%
Nooksack River	3	85%	15%

Olympic Peninsula River Basins



Forecasted average runoff for streamflow for the Dungeness River is 110% and Elwha River is 107%. February runoff in the Dungeness River was 156% of normal. Big Quilcene and Wynoochee rivers may expect near average runoff this summer as well. February precipitation was 119% of average. Precipitation has accumulated at 130% of average for the water year. February precipitation at Quillayute was 152% of normal. Olympic Peninsula snowpack averaged 97% of normal on March 1. Temperatures were 4-6 degrees above average and 1-3 degrees above normal for the water year.

For more information contact your local Natural Resources Conservation Service office.

Olympic Peninsula River Basins

Data Current as of: 3/3/2016 4:02:37 PM

Olympic Peninsula Streamflow Forecasts - March 1, 2016

Forecast Exceedance Probabilities for Risk Assessment Chance that actual volume will exceed forecast

Olympic Peninsula	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Dungeness R nr Sequim	APR-JUL	111	124	133	111%	142	155	120
	APR-SEP	132	149	160	110%	171	188	145
Elwha R at McDonald Bridge nr Port Angeles	APR-JUL	365	405	435	109%	465	505	400
	APR-SEP	415	470	505	107%	540	595	470

1) 90% and 10% exceedance probabilities are actually 95% and 5%

2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions

3) Median value used in place of average

Watershed Snowpack Analysis March 1, 2016	# of Sites	% Median	Last Year % Median
Olympic Peninsula	6	97%	2%

Issued by

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Chief
Natural Resources Conservation Service
U.S. Department of Agriculture

Released by

Roylene Rides At The Door
State Conservationist
Natural Resources Conservation Service
Spokane, Washington

The Following Organizations Cooperate with the Natural Resources Conservation Service in Snow Survey Work*:

Canada	Snow Survey Network Program – British Columbia Ministry of Environment River Forecast Center – British Columbia Ministry of Forests, Lands and Natural Resource Operations
State	Washington State Department of Ecology Washington State Department of Natural Resources
Federal	Department of the Army Corps of Engineers U.S. Department of Agriculture Forest Service U.S. Department of Commerce NOAA, National Weather Service U.S. Department of Interior Bonneville Power Administration Bureau of Reclamation Geological Survey National Park Service Bureau of Indian Affairs Recourse Conservation & Development Councils
Local	City of Tacoma City of Seattle Chelan County P.U.D. Pacific Power and Light Company Puget Sound Energy Washington Water Power Company Snohomish County P.U.D. Colville Confederated Tribes Spokane County Yakama Indian Nation Whatcom County Pierce County Kalispel Tribe of Indians Spokane Indian Tribe Jamestown S'klallum Tribe
Private	Okanogan Irrigation District Wenatchee Heights Irrigation District Newman Lake Homeowners Association Whitestone Reclamation District

*Other organizations and individuals furnish valuable information for the snow survey reports. Their cooperation is gratefully acknowledged.



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Washington Water Supply Outlook Report

Natural Resources Conservation Service
Spokane, WA

