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July 7, 2021

MEMORANDUM

TO: Council Members

FROM: Leslie Bach and Patty O'Toole

SUBJECT: Basin climate and water supply summary and outlook

BACKGROUND:

Presenters: Ryan Lucas, Northwest River Forecast Center and Aaron Marshall, U.S. Army Corps of Engineers

Summary: Most of the Pacific Northwest is experiencing abnormally dry or drought conditions, with conditions worsening in recent weeks. According to the June 22, 2021 U.S. Drought Monitor, 79.8% of the region is in drought, up from 40.8% at the start of 2021. Staff from NOAA's Northwest River Forecast Center and the Army Corps of Engineers' Reservoir Control Center will provide an update on the current climatic conditions in the Basin and the status and plans for mainstem Columbia and Snake River reservoir operations over the next several months. In addition, Council staff will provide information from fisheries management entities on fish management actions they are taking around the basin to address effects of high water temperatures and low stream flows.

Relevance: The Climate Change strategy of the 2014/2020 Program calls for the action agencies to implement a number of measures to better understand and track climate and river conditions and to assess the impacts of those conditions on fish and wildlife. It also calls for utilizing adaptive management to identify and implement alternative management actions, as needed. The Program's Public Engagement Strategy calls for the

Council to inform and involve the public on topics related to the Program through a variety of media formats.

Background: Climate and water supply forecasting is a critical component of annual water management for Columbia River system operations. It also informs long-term planning and decision-making on operations that affect fish passage and survival. Forecast information and maps can be found on the [Northwest River Forecast Center website](#). Annual planned actions for reservoir operations and fish passage during the fish migration seasons are described in the Corps of Engineers' [Water Management Plan](#) and [Fish Operations Plan](#) and include routine operations that are designed with climate and water supply challenges in mind. In-season adjustments on dam and reservoir operations to accommodate changing conditions are discussed and considered through regional forum processes such as the [Technical Management Team](#).

Fisheries managers are evaluating conditions in the mainstem Columbia and Snake Rivers, along with the tributaries and initiating emergency management actions where needed including implementing trap and haul to help fish avoid warm water which can impact survival, altering hatchery operations and implementing modified harvest regulations. Staff will provide real-time example of these actions at the meeting next week.



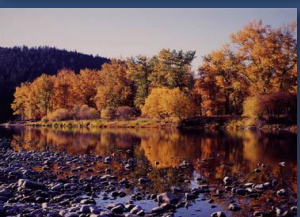
Northwest River Forecast Center



Northwest Power and Conservation Council July 14, 2021



Ryan Lucas, PhD
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NWRFC.watersupply@noaa.gov





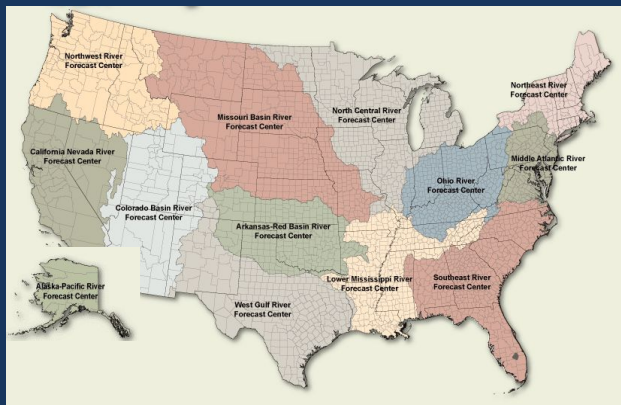
Take Home Messages

- At the end of February much of the Columbia basin had near to above normal WS forecasts. Snake basin had largely below normal volume forecasts; Middle Snake tributaries exhibited especially low volume forecasts.
- With few exceptions, WY precipitation to date was below normal across the RFC domain—good snow building in the northern Cascades and in the Upper Columbia basins helped keep WS volume forecasts up. The WA and northern OR cascades, Blue and Wallowa ranges all benefited from a healthy snow building in February.
- Very dry conditions since the beginning of March have reduced water supply forecasts domain wide. Currently the only basins with normal to above normal Apr-Sept forecasts are found in the Clark Fork and in the snow-fed portions of the WA cascades.
- Many Natural volume forecasts on the west side of the OR cascades, in the Middle and Lower Snake, and MC lower tribs have Apr-Sep volume forecasts that rank in the single digits for driest volumes in the historical record; many of these forecasts--should they verify--would be the driest Apr-Sep volume on record.

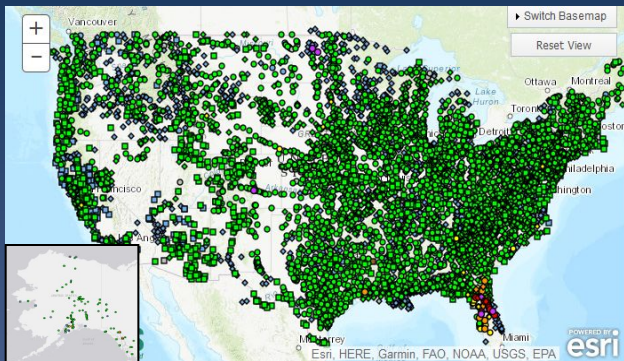


NOAA / NWS River Forecast Centers (RFCs)

13 River Forecast Centers (RFCs) Northwest River Forecast Center



~4000 River Forecast Locations

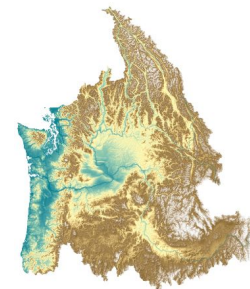


326,000 Square Miles

- 2 Countries
- 2 NWS Regions
- 6+ States
- 10 WFOs

Geographic Diversity

- Summit to Surf
- Rainforest to Desert
- Flood and Drought



Suite of Services at ~400 Forecast Locations



NWRFC Forecasts

10-day deterministic

Uses previous ten days of observed and next ten days of forecasted precipitation and temperature

Primary tool for flood forecasting



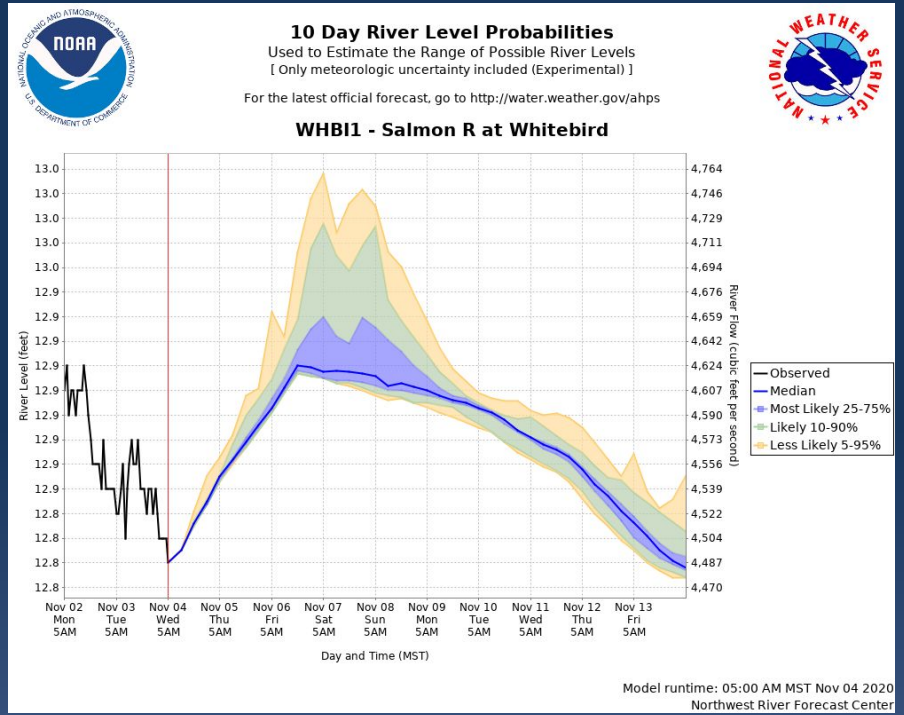


NWRFC Forecasts

Hydrologic Ensemble Forecast Service (HEFS)

Experimental

Short to long range ensemble forecast. HEFS attempts to quantify and bias correct for meteorological uncertainty.



https://water.weather.gov/ahps2/probability_information.php?wfo=MSO&gage=WHB11&graph_id=3



NWRFC Forecasts

Seasonal Volume

Water Supply Forecasts

Limited adjustments

<https://www.nwrfc.noaa.gov/ws/>

Natural Volume Forecast

Adjustments for anthropogenic impacts (consumptive use, water diversions).

<https://www.nwrfc.noaa.gov/natural/>

Home Data/Normals Rankings ENSO / Runoff Adjustments Verification Verify All Years Archive Monthly Water Supply Forecasts Help

Choose Date: 11/04/2020 Archive: Water Year

SALMON - AT WHITEBIRD (WHB1)

Forecasts for Water Year 2021

Official Water Supply
ESP with 10 Days QPF Ensemble: 2020-11-04 Issued: 2020-11-04

Forecast Period	Forecasts Are in KAF				30 Year Average (1981-2010)
	90 %	50 %	% Average	10 %	
APR-SEP	3987	6530	110	9314	5935
APR-JUL	3522	5941	111	8467	5369
JAN-SEP	4740	7405	108	10291	6833
JAN-JUL	4276	6816	109	9484	6267
OCT-SEP	5547	8228	107	11152	7683

Experimental Water Supply
HEFS with 15 days EQPF Ensemble: 2020-11-04 Issued: 2020-11-04

APR-SEP	3210	5669	96	8298	5935
APR-JUL	2790	5127	95	7492	5369
JAN-SEP	4019	6511	95	9081	6833
JAN-JUL	3600	5969	95	8287	6267
OCT-SEP	4823	7326	95	9887	7683

Reference
ESP with 0 Days QPF Ensemble: 2020-11-04 Issued: 2020-11-04

APR-SEP	3395	5667	95	8193	5935
APR-JUL	2923	5109	95	7393	5369
JAN-SEP	4141	6422	94	8959	6833
JAN-JUL	3669	5878	94	8176	6267
OCT-SEP	4948	7237	94	9769	7683

Move the mouse over the desired "Forecast Period" to display a graph.

Overlay

ESP10 HEFS ESP0

Data Files

CSV (ESP10 / OCT-SEP)

Forecast Ensemble

Water Supply Forecasts

SALMON - AT WHITEBIRD
Period OCT to SEP -- Water Year 2021

Seasonal Volumes, KAF

Most Recent Forecast for ESP10: Issued Date 11/04/2020

Date of Ensemble

Plot Created 11/04/2020 11:53 PST

Max Scale Scale To Data Scale To Last 45 Days Show Min/Max Ensemble Volume Show Tooltips Help

https://www.nwrfc.noaa.gov/water_supply/ws_forecasts.php?id=WHB1



Some Terminology

Model Forcings-inputs that drive the model. Our forcings include precipitation and temperature.

Model States-conditions in the model that influence model response. Our model states are snow pack and soil moisture.

QPF-quantitative precipitation forecast

QTF-quantitative temperature forecast

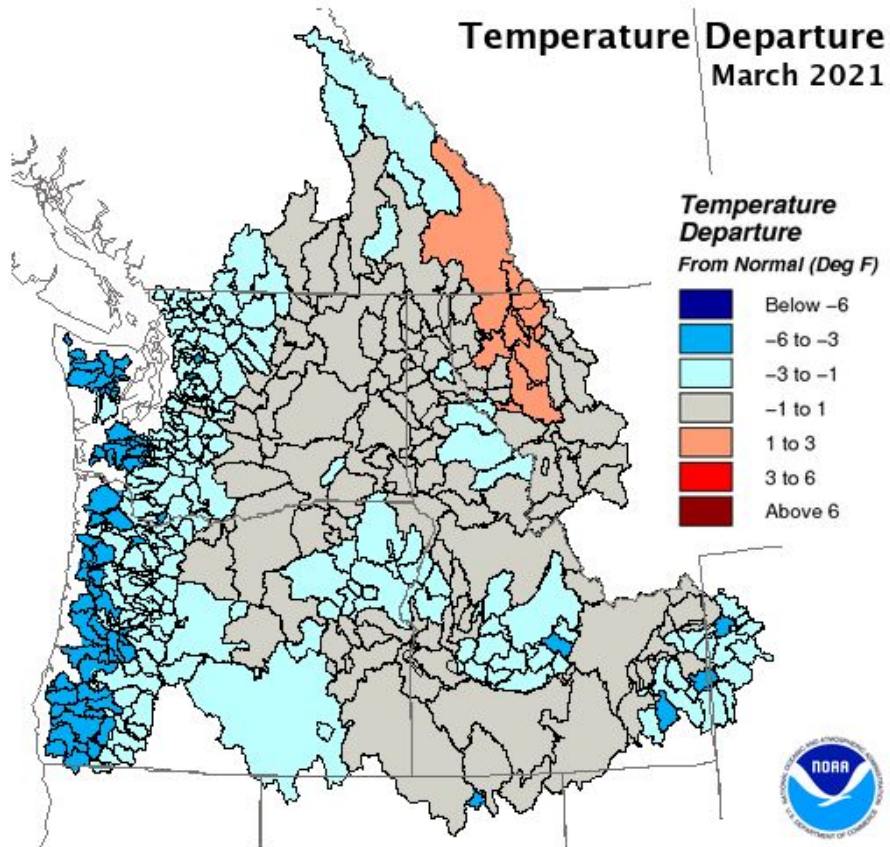
QPE-quantitative precipitation estimate

QTE-quantitative temperature estimate



Monthly Temperatures

Temperature Departure March 2021

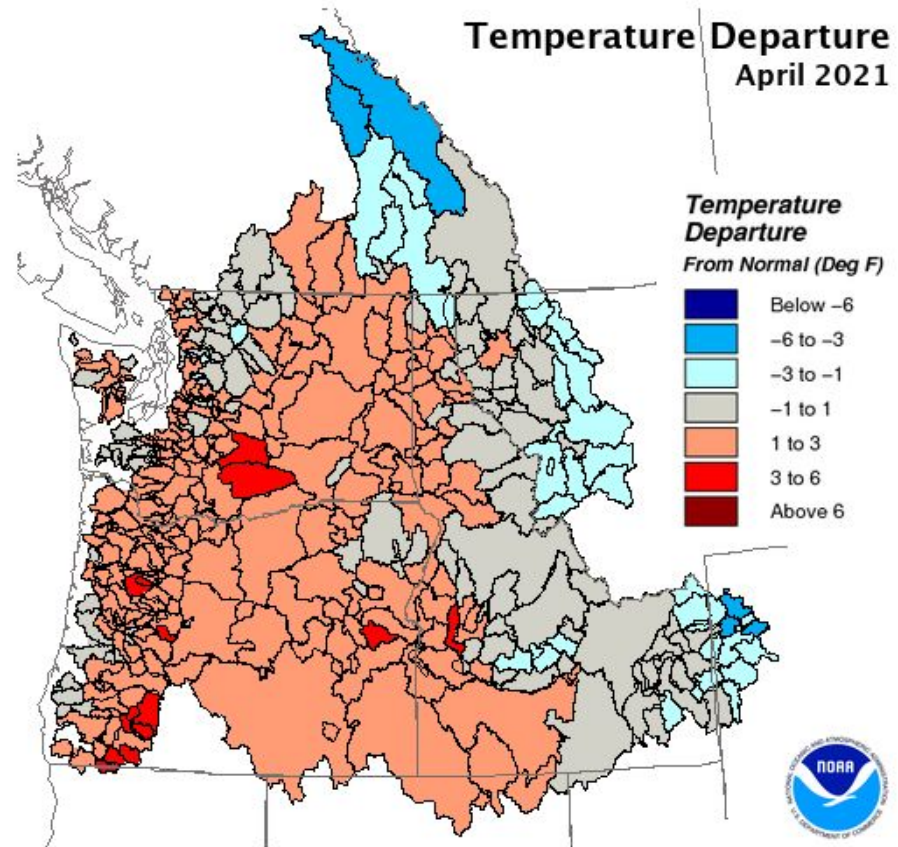


Creation Time: Thursday, Apr 1, 2021

Northwest River Forecast Center



Temperature Departure April 2021



Creation Time: Saturday, May 1, 2021

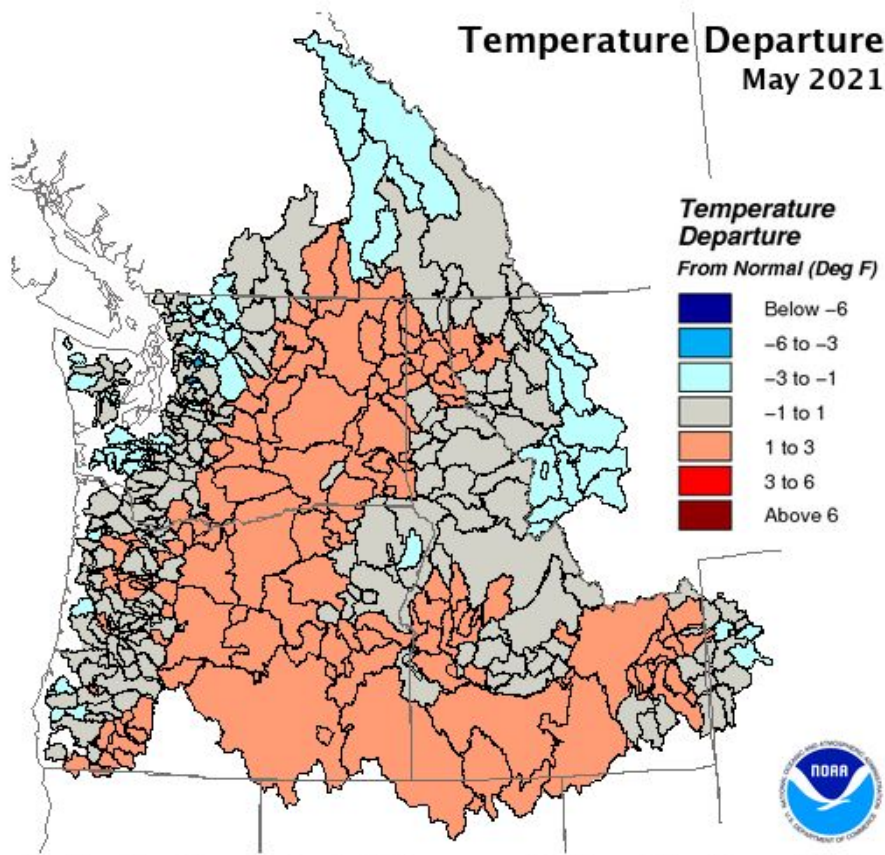
Northwest River Forecast Center





Monthly Temperatures

Temperature Departure May 2021

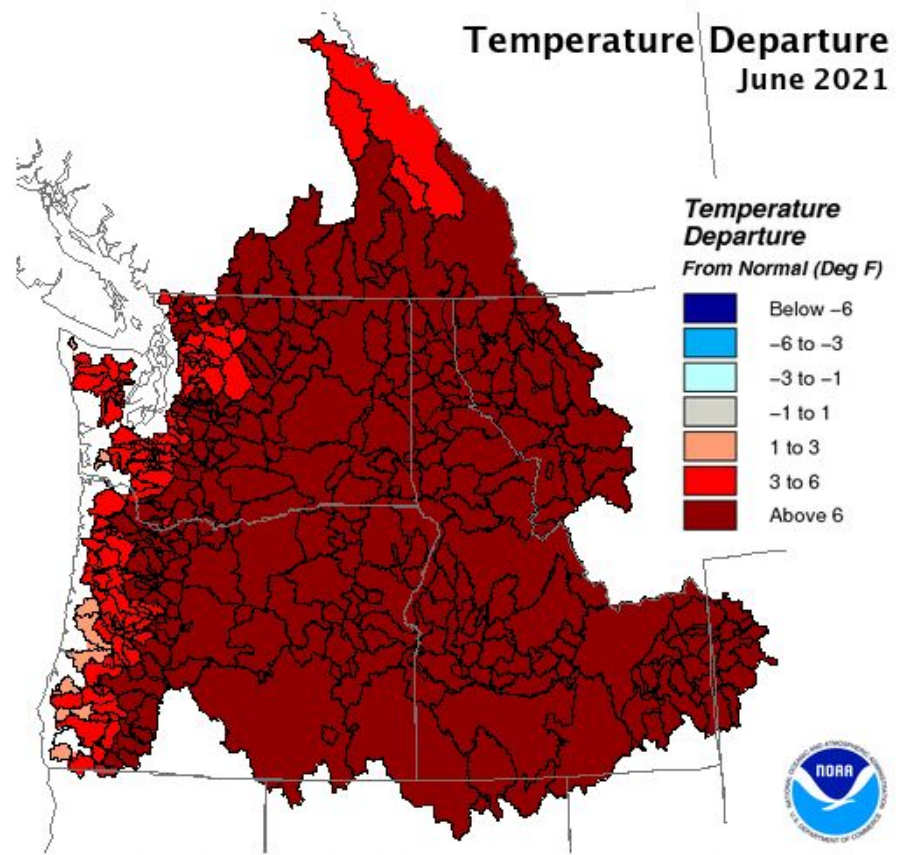


Creation Time: Tuesday, Jun 1, 2021

Northwest River Forecast Center



Temperature Departure June 2021



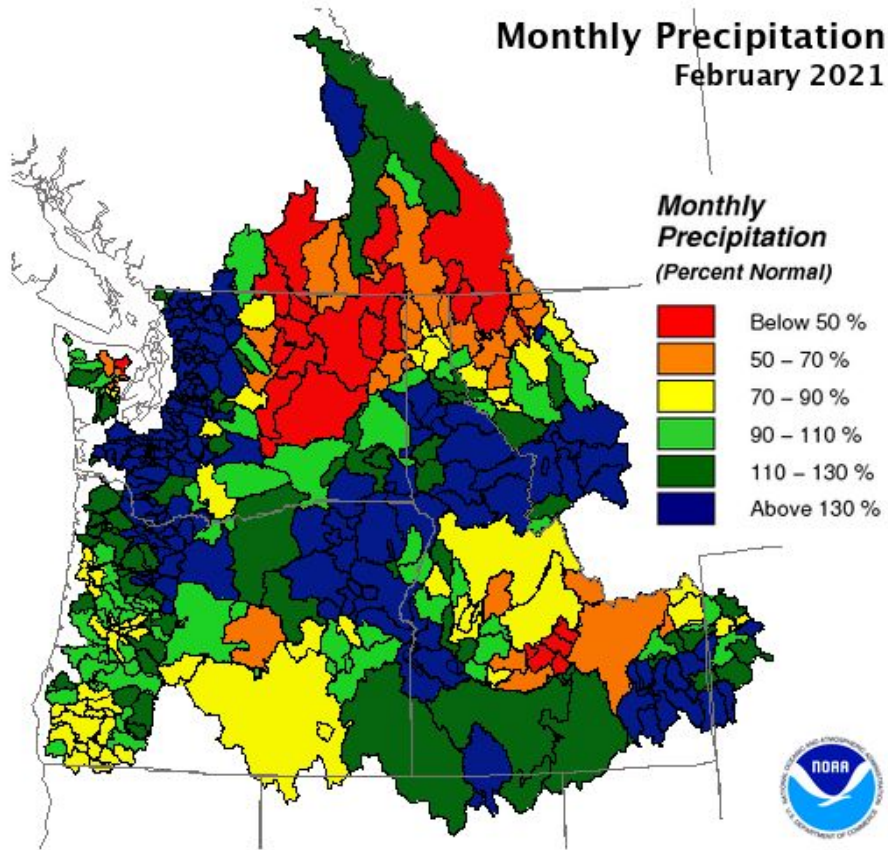
Creation Time: Thursday, Jul 1, 2021

Northwest River Forecast Center



Monthly Precipitation

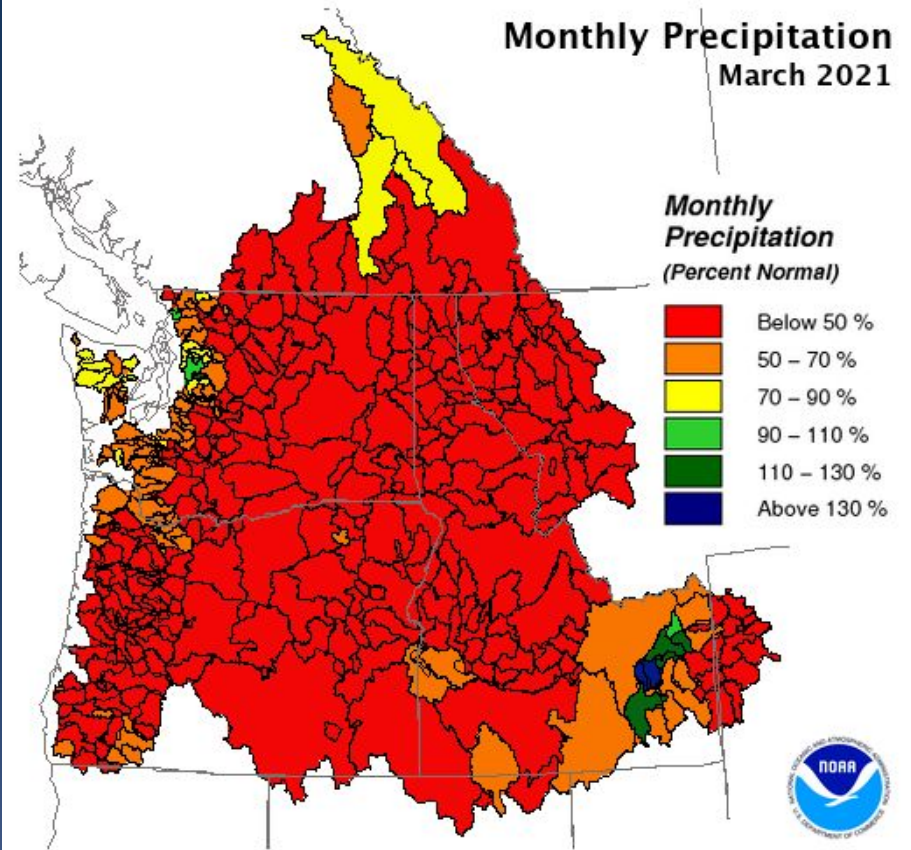
Monthly Precipitation February 2021



Creation Time: Monday, Mar 1, 2021

Northwest River Forecast Center

Monthly Precipitation March 2021



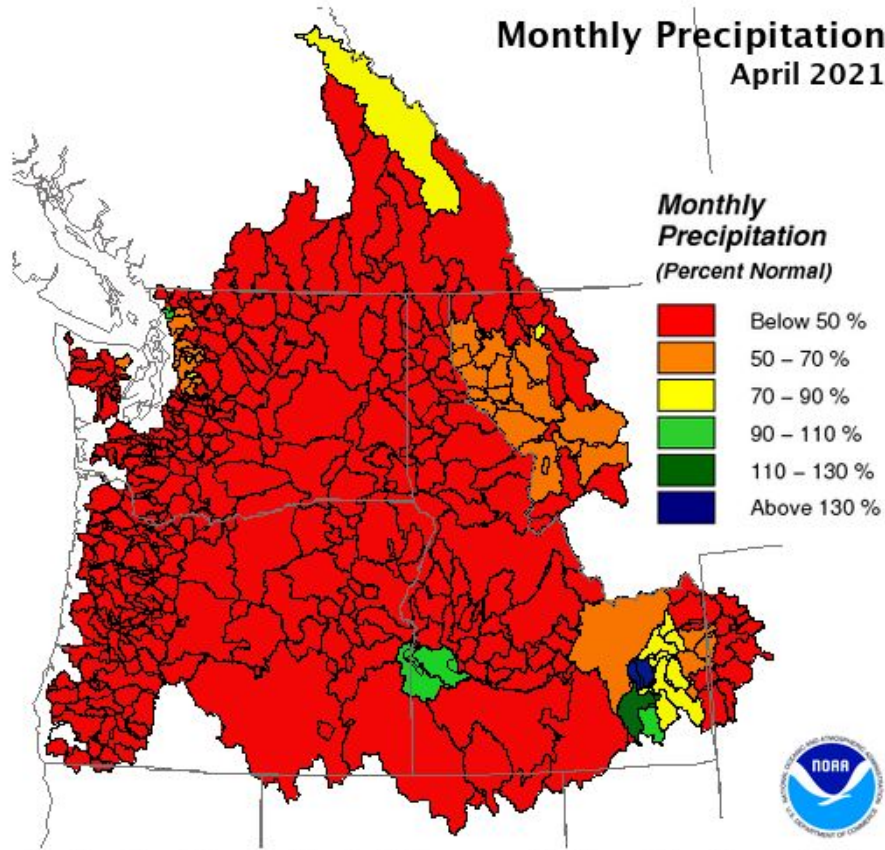
Creation Time: Thursday, Apr 1, 2021

Northwest River Forecast Center



Monthly Precipitation

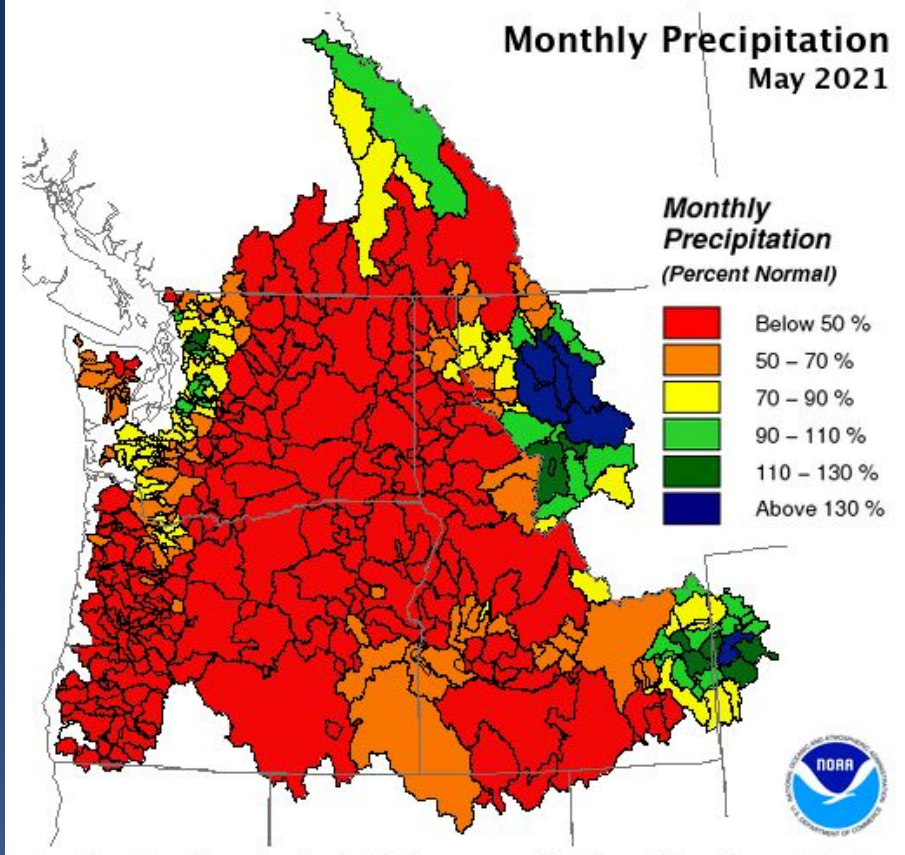
Monthly Precipitation April 2021



Creation Time: Saturday, May 1, 2021

Northwest River Forecast Center

Monthly Precipitation May 2021



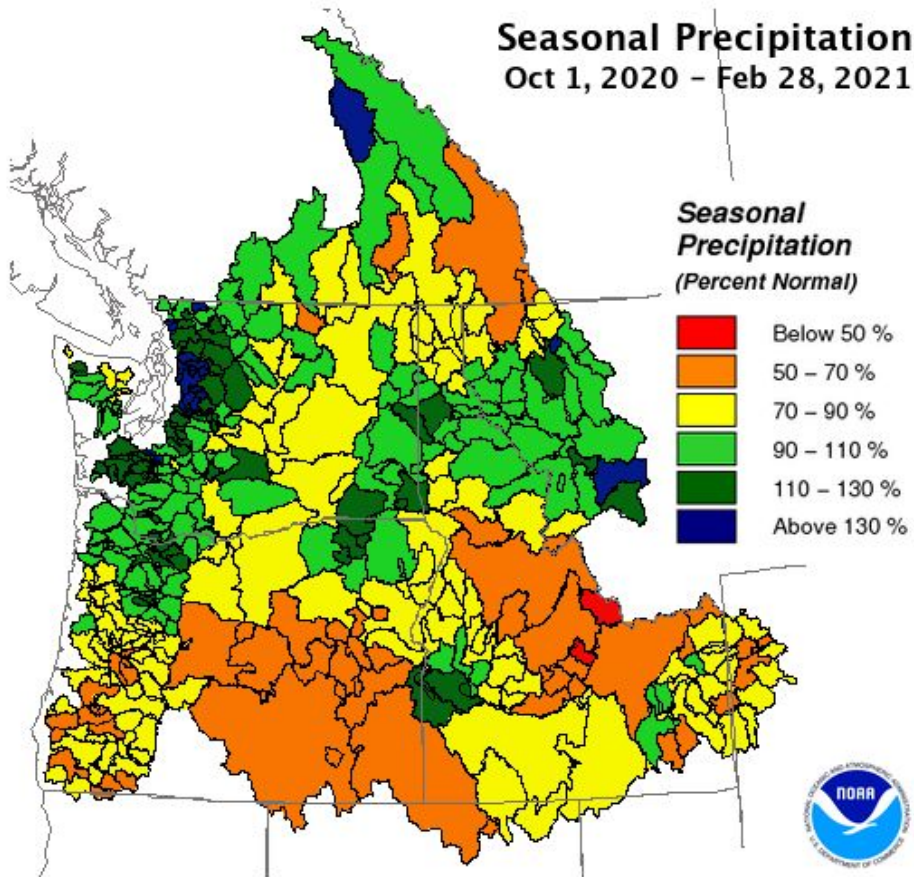
Creation Time: Tuesday, Jun 1, 2021

Northwest River Forecast Center



Water Year Precipitation

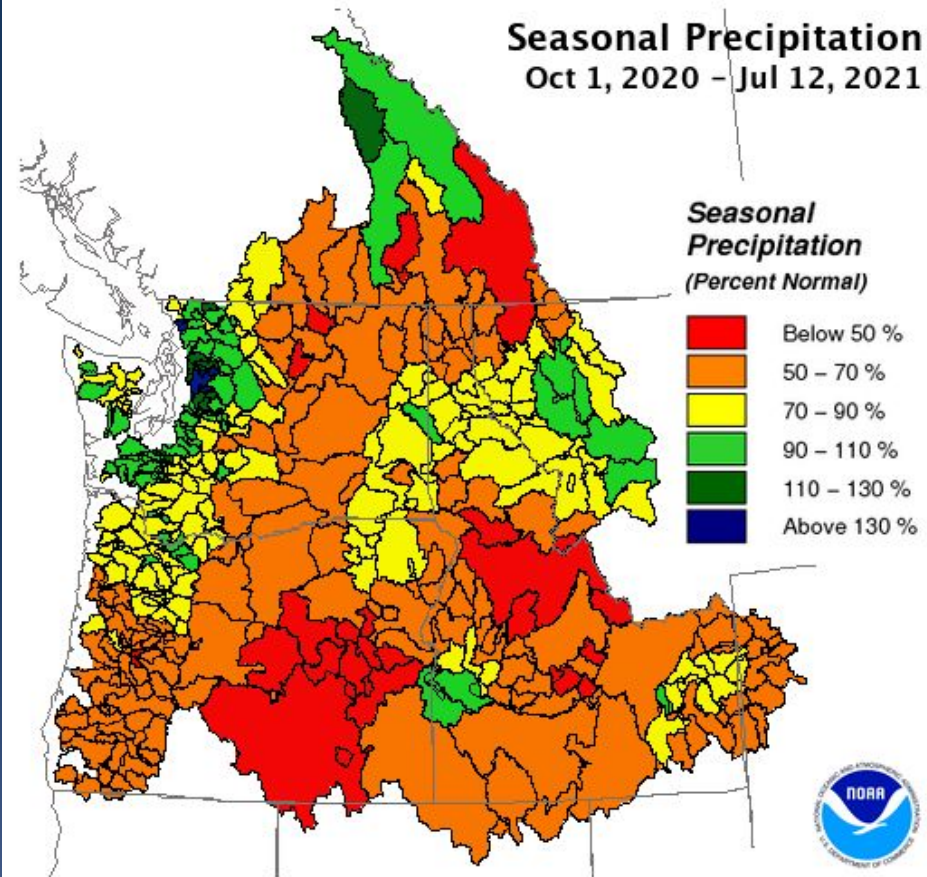
Seasonal Precipitation
Oct 1, 2020 - Feb 28, 2021



Creation Time: Monday, Mar 1, 2021

Northwest River Forecast Center

Seasonal Precipitation
Oct 1, 2020 - Jul 12, 2021

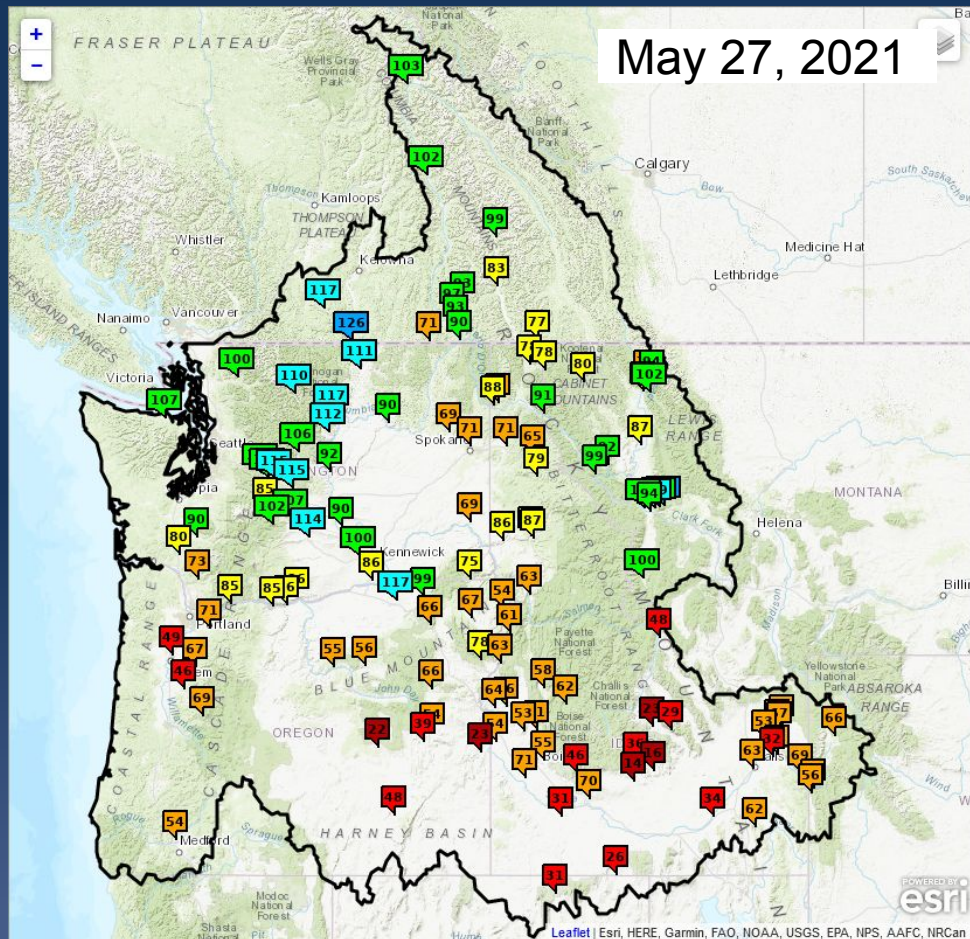
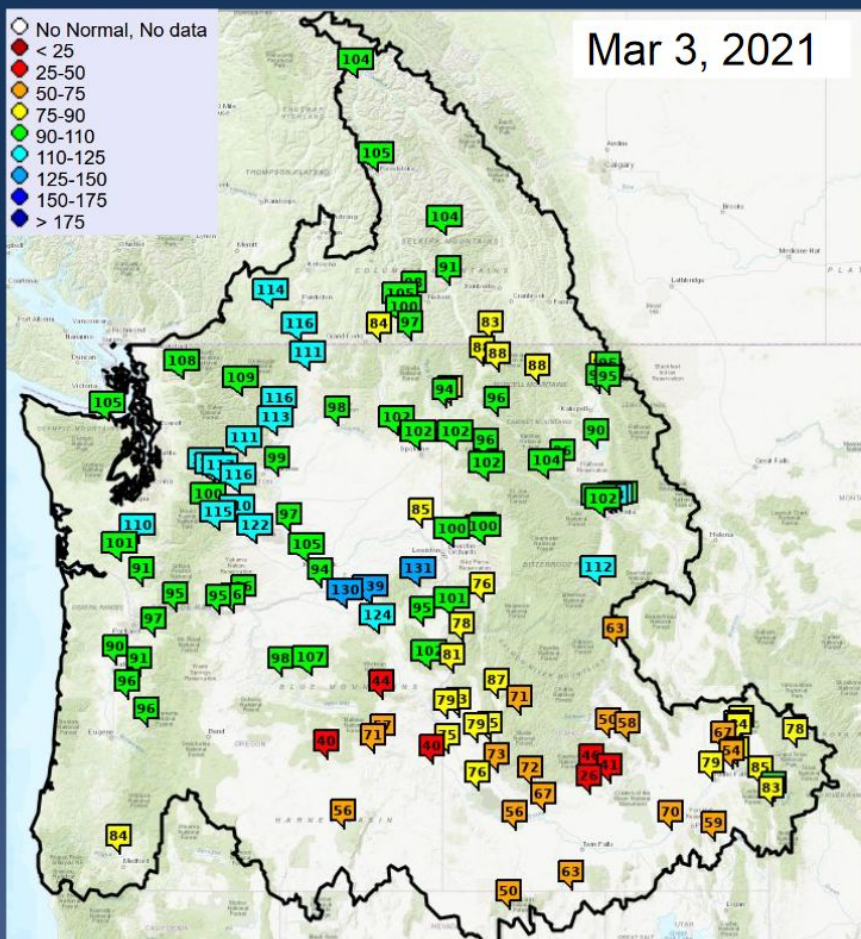


Creation Time: Tuesday, Jul 13, 2021

Northwest River Forecast Center

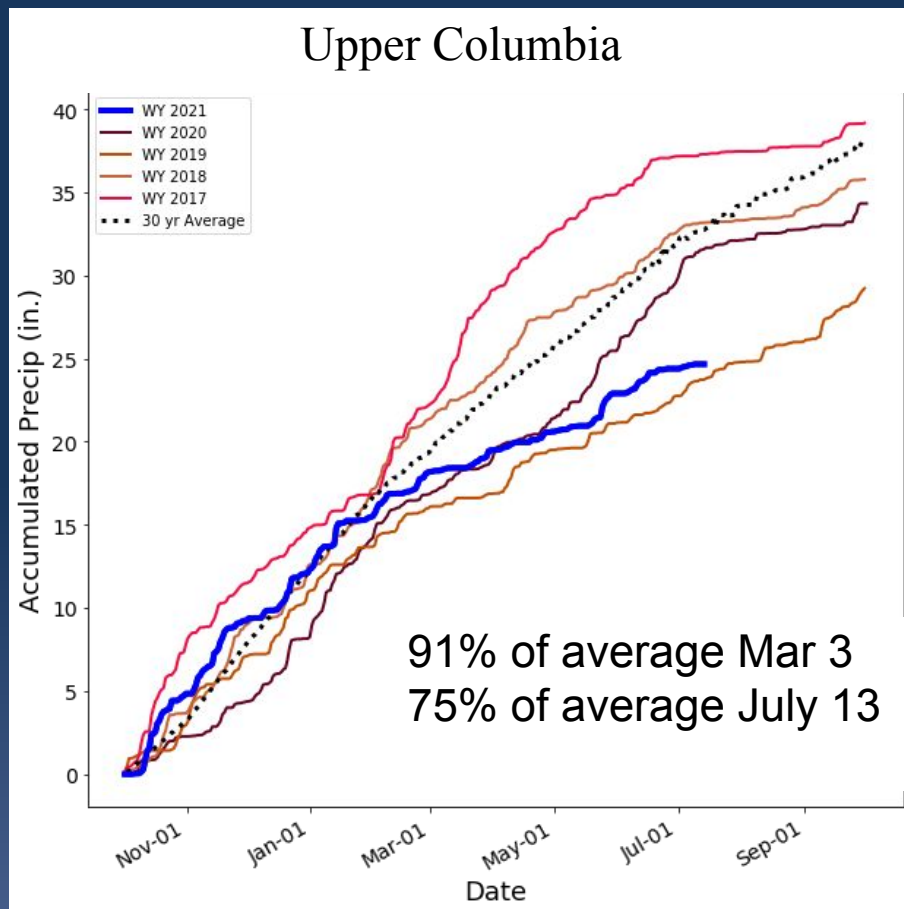
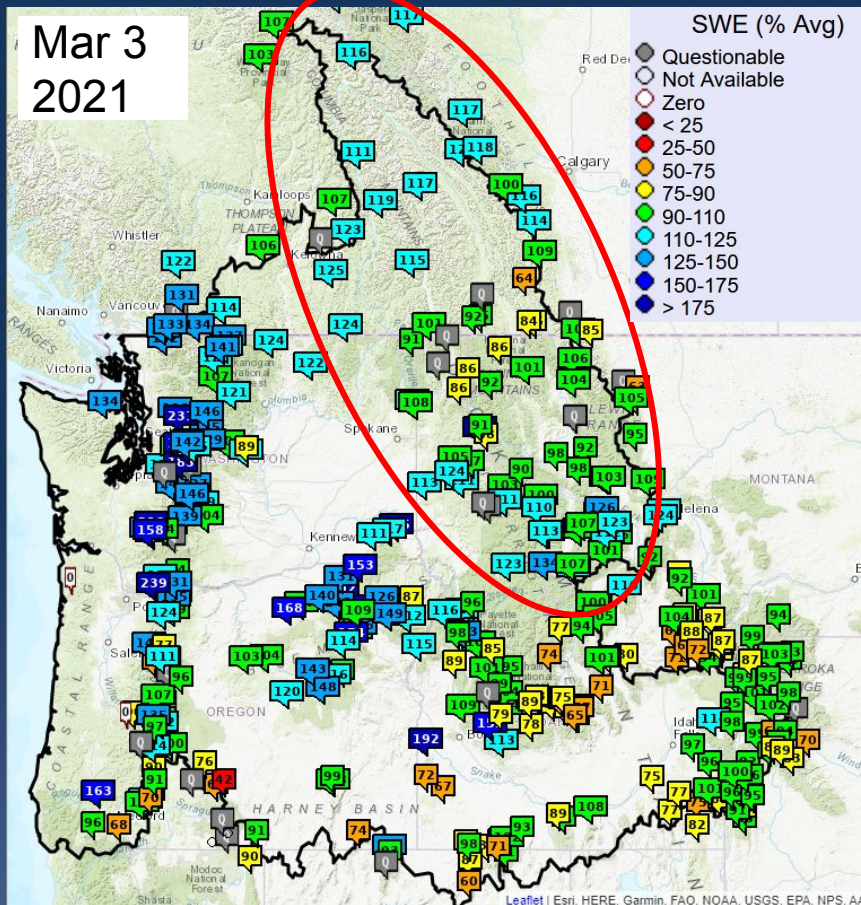


Snowpack and Seasonal Precipitation





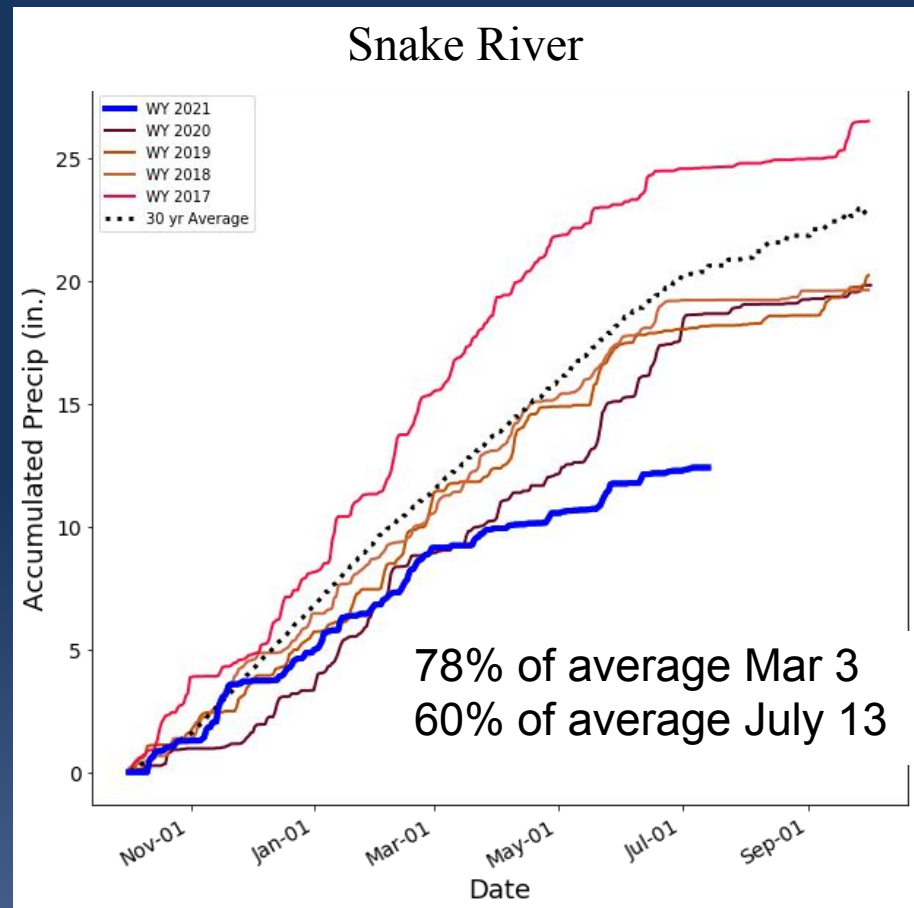
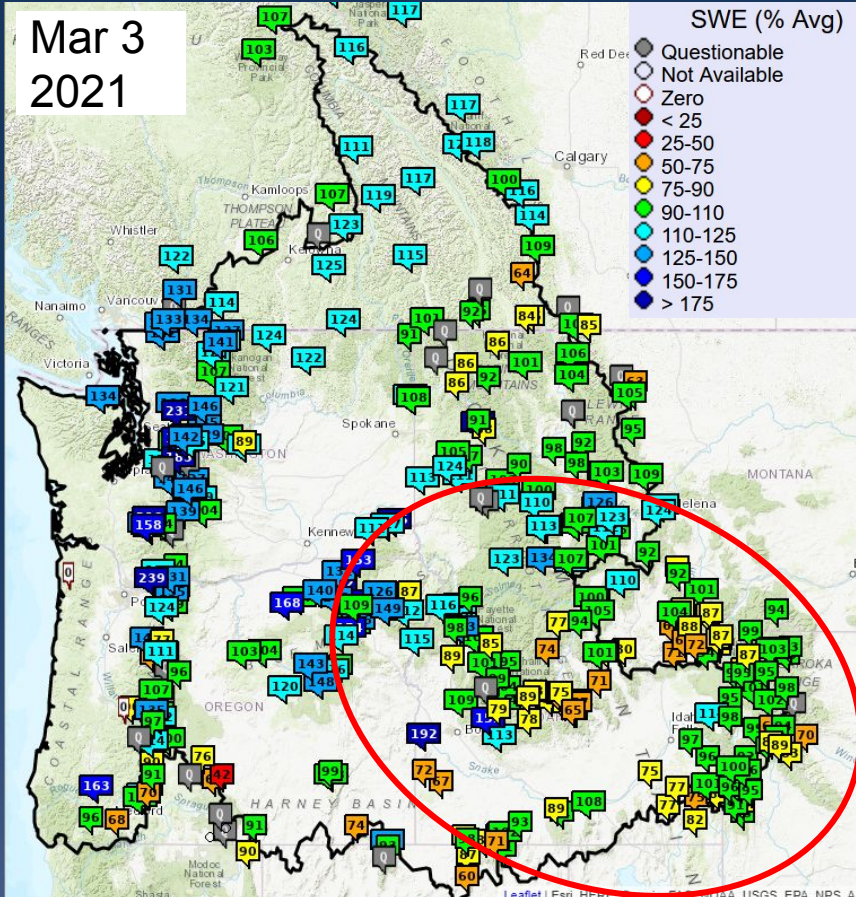
Snowpack and Seasonal Precipitation



Snow data from NRCS, BC Hydro, and Alberta EP.

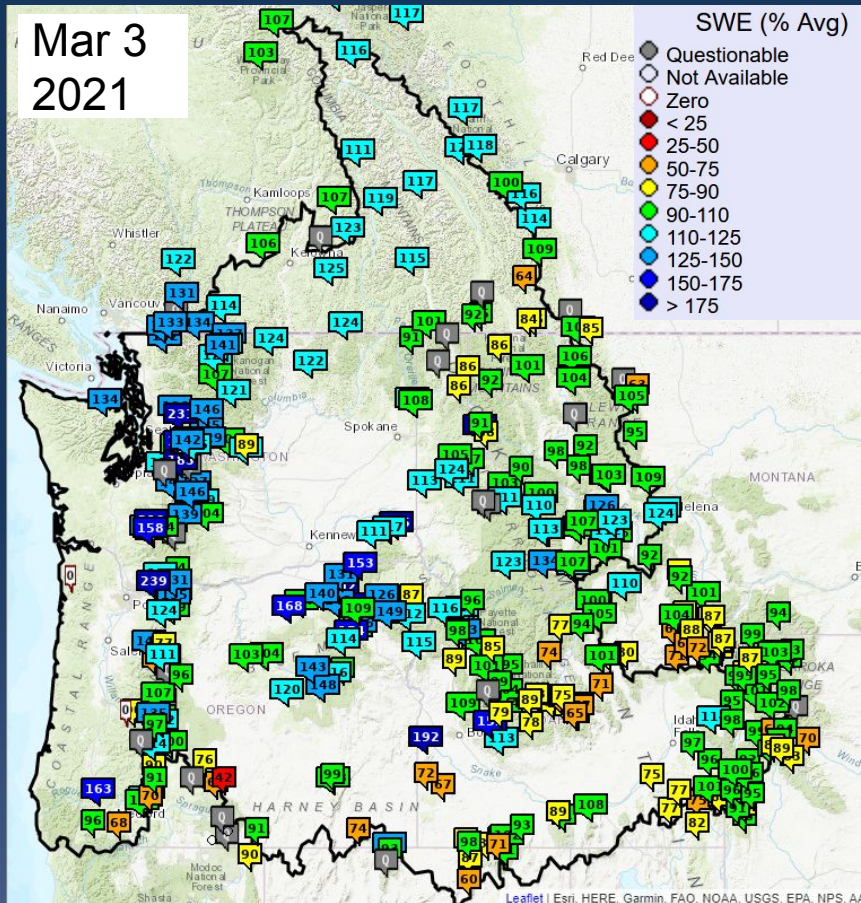


Snowpack and Seasonal Precipitation

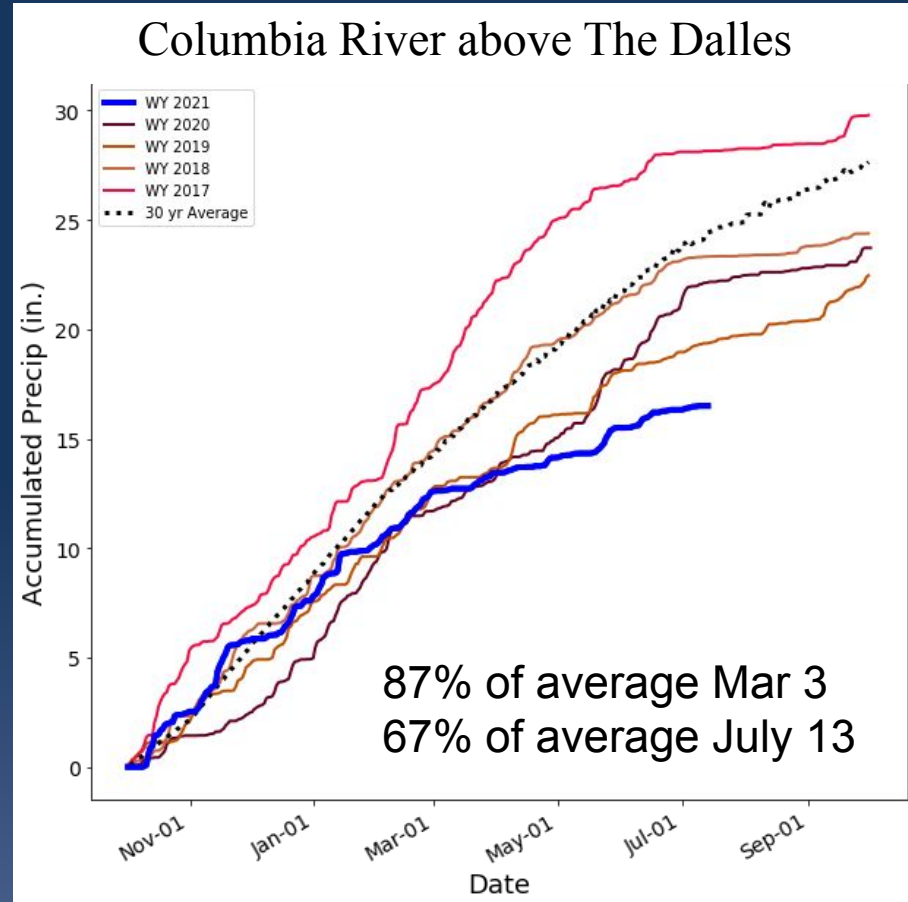


Snow data from NRCS, BC Hydro, and Alberta EP.

Snowpack and Seasonal Precipitation

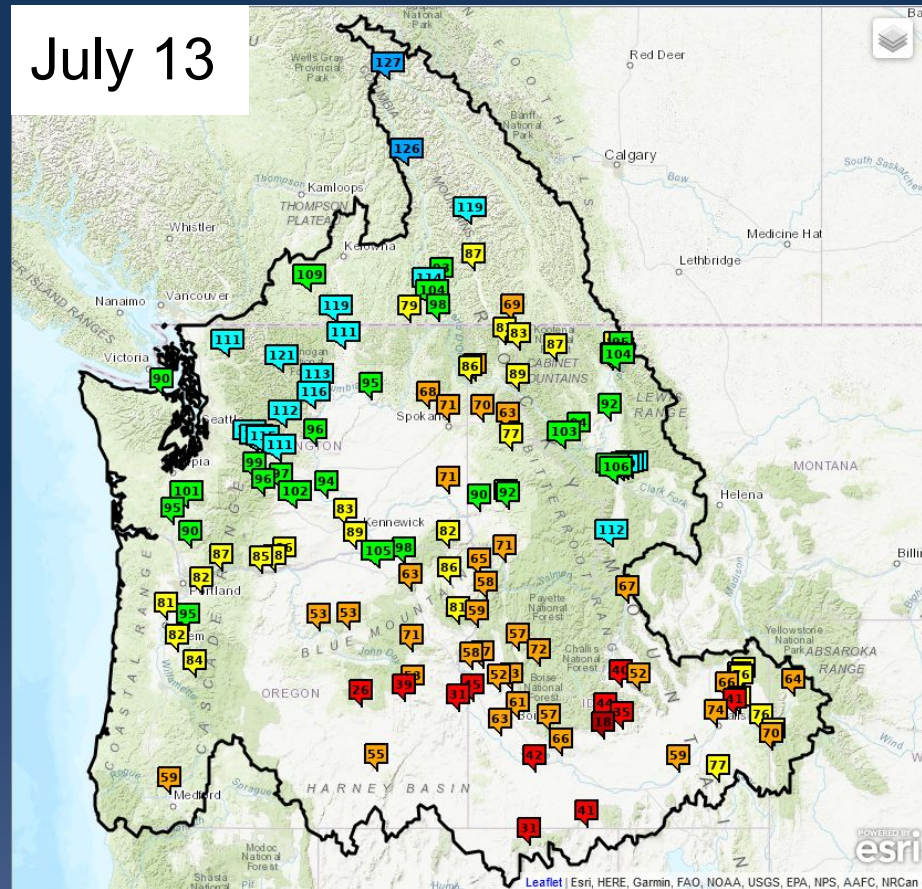


Snow data from NRCS, BC Hydro, and Alberta EP.



Water Year to Date Adjusted Runoff

July 13



% Normal Runoff Oct 1- Jul 13

Upper Columbia Basin

Δ (since March 3)

Mica	127	--
Duncan	119	--
Queens Bay	87	-1
Libby	87	+4
Hungry Horse	104	-19
Grand Coulee	95	-8

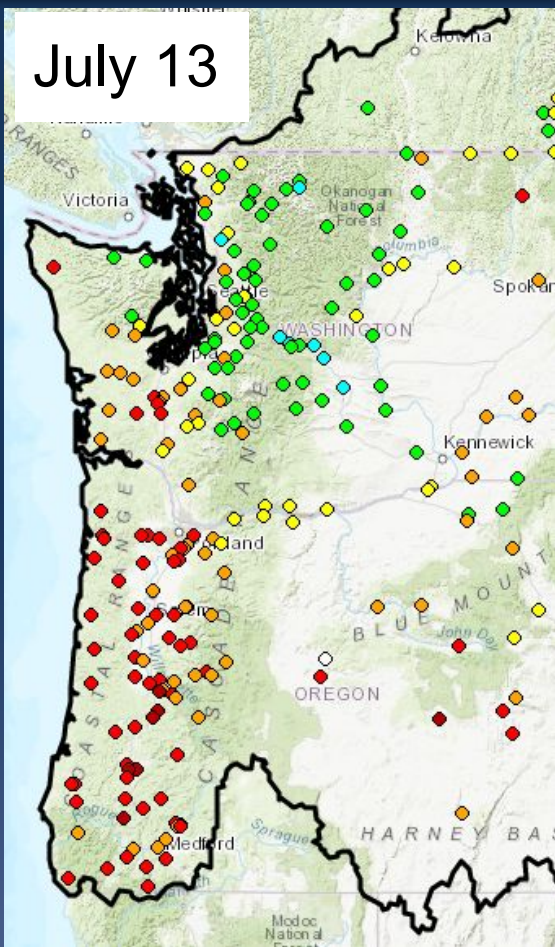
Snake River Basin

American Falls	59	-26
Lucky Peak	61	-19
Dworshak	84	-1
Lower Granite	71	-5

Lower Columbia Basin

The Dalles	85	-2
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Water Year to Date Adjusted Natural Runoff



% Normal Runoff Oct 1- Jul 13

Washington

		<u>Δ (since March 3)</u>
Skagit nr Mt Vernon	113	-8
Dungeness nr Sequim	90	+5
Chehalis at Porter	100	-16
Okanogan at Malott	112	-20
Methow nr Pateros	113	-16
Yakima at Parker	103	+2
Walla Wall nr Touchet	80	-9

Oregon

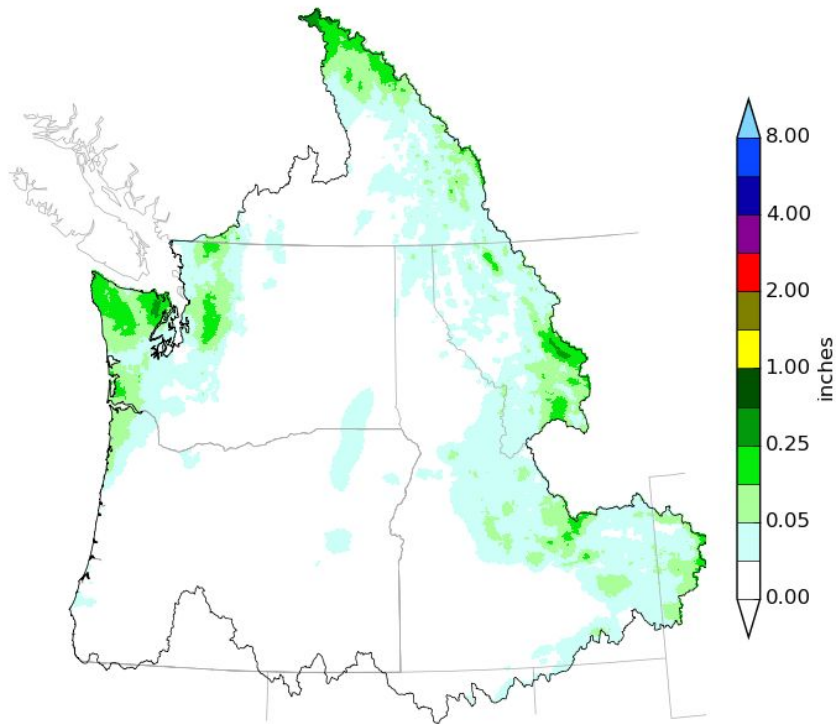
Willamette at Salem	73	-13
Rogue at Raygold	60	-5
Umatilla at Pendleton	106	+14
Grande Ronde at Troy	82	+4
Owyhee Dam	36	-8



Precipitation Forecast (July 12-22)



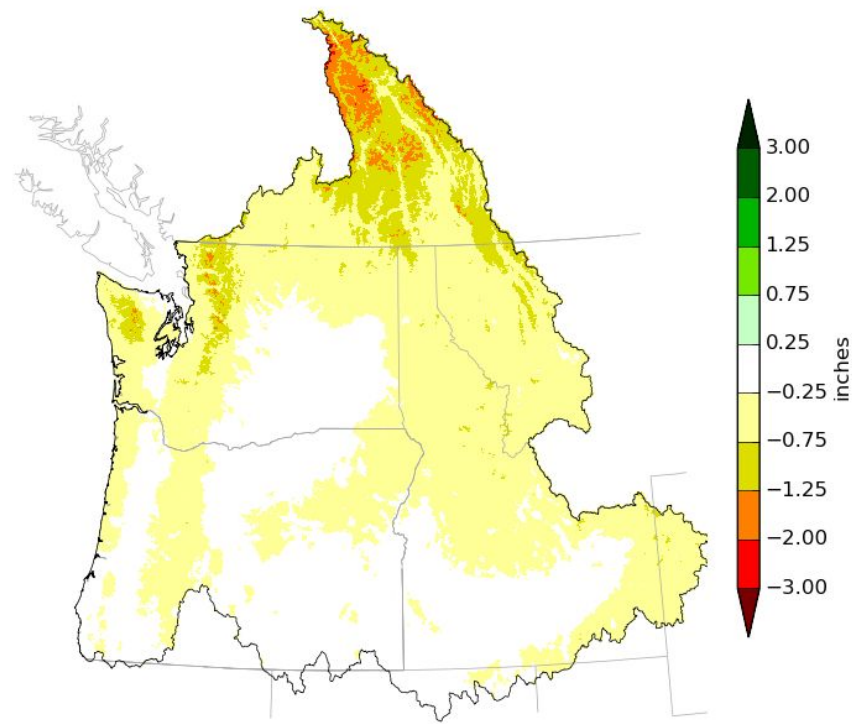
Northwest River Forecast Center
10 Day QPF, Ending 12Z, 07/23/21



Creation Time: Tue Jul 13 16:48:30 UTC 2021



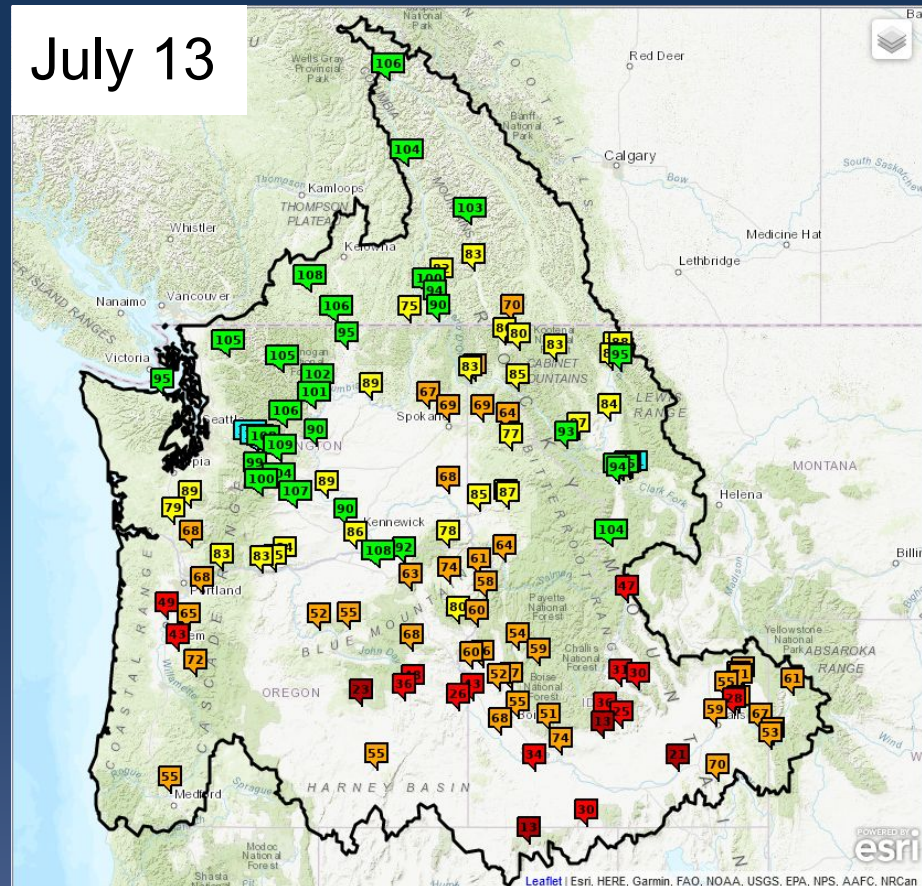
Northwest River Forecast Center
10 Day QPF (Deviation from Climatology), Ending 12Z, 07/23/21



Creation Time: Tue Jul 13 16:49:48 UTC 2021

ESP10 Water Supply Forecasts

July 13



% Normal Apr-Sep Volume

Upper Columbia Basin

Δ (since March 3)

Mica	104	--
Duncan	103	-1
Queens Bay	83	-8
Libby	83	-5
Hungry Horse	95	--
Grand Coulee	89	-9

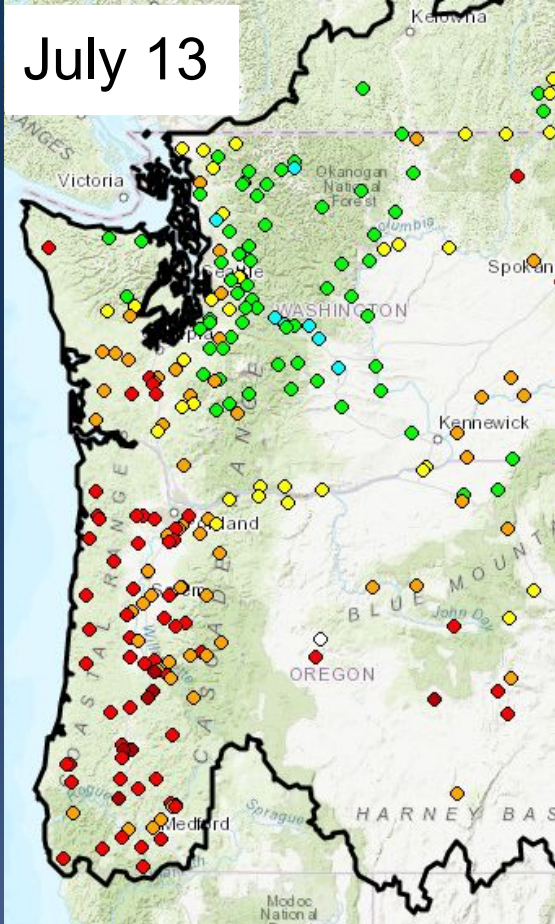
Snake River Basin

American Falls	21	-49
Lucky Peak	55	-18
Dworshak	80	-15
Lower Granite	68	-17

Lower Columbia Basin

The Dalles	83	-12
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ESP10 Natural Forecasts



% Normal Apr-Sep Volume

Washington

Location	% Normal Apr-Sep Volume	<u>Δ (since March 3)</u>
Skagit nr Mt Vernon	102	-9
Dungeness nr Sequim	95	-10
Chehalis at Porter	58	-34
Okanogan at Malott	95	-13
Methow nr Pateros	102	-14
Yakima at Parker	105	-7
Walla Wall nr Touchet	50	-50

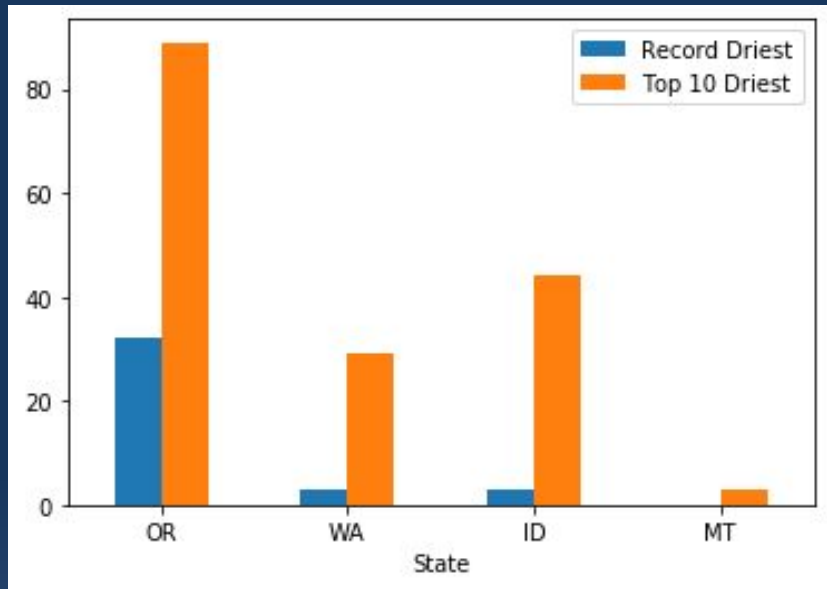
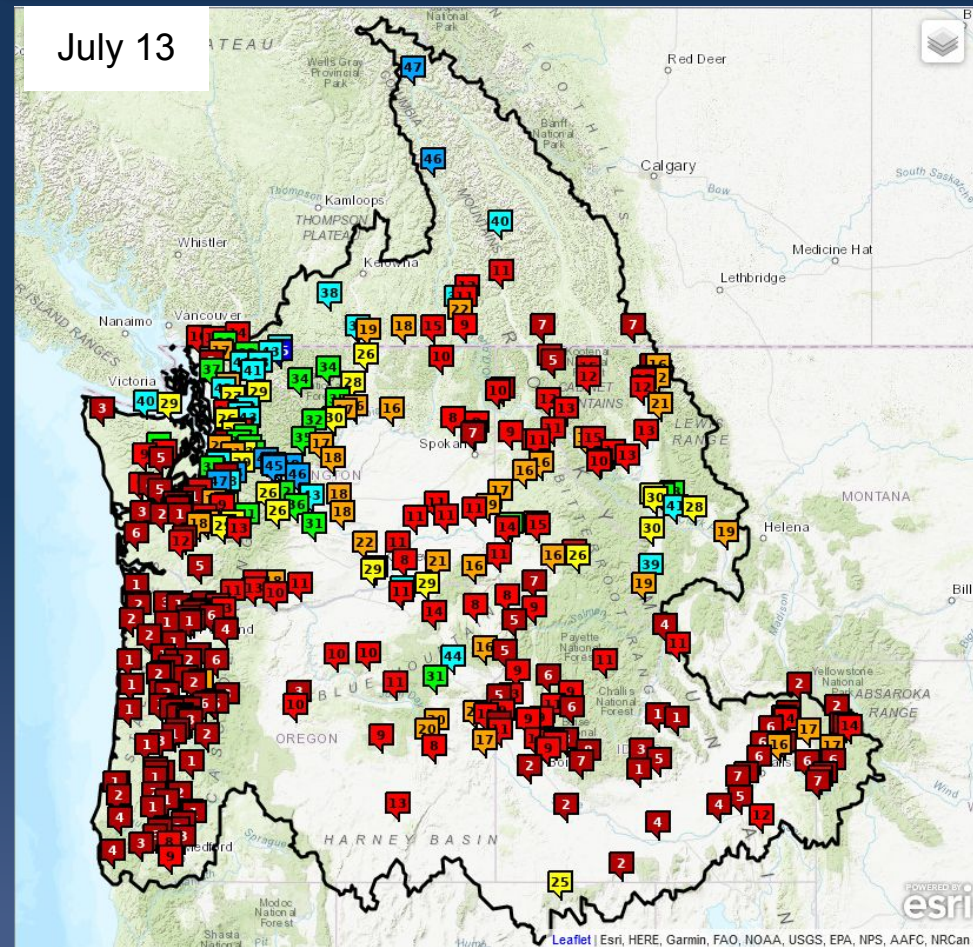
Oregon

Willamette at Salem	50	-36
Rogue at Raygold	56	-18
Umatilla at Pendleton	106	-21
Grande Ronde at Troy	78	-53
Owyhee Dam	37	-3



Apr-Sep ESP10 Natural Volume Forecast Rank (desc).

July 13



	OR	WA	ID	MT
Record	32	3	3	0
Top 10	89	29	44	3



ESP10 Apr-Sep Water Supply Forecasts

Choose Date: 07/13/2021 Archive: Water Year ▾

COLUMBIA - GRAND COULEE DAM (GCDW1) Forecasts for Water Year 2021

Official Water Supply

ESP with 10 Days QPF Ensemble: 2021-07-13 Issued: 2021-07-13

Forecast Period	Forecasts Are in KAF				30 Year Average (1981-2010)
	90 %	50 %	% Average	10 %	
APR-SEP	53072	53569	89	54776	60110
APR-JUL	46280	46398	91	46513	51015
APR-AUG	50480	50703	89	51283	56763
JAN-SEP	60324	60820	89	62027	68694
JAN-JUL	53531	53649	90	53764	59599
OCT-SEP	69110	69606	91	70813	76824

Experimental Water Supply

HEFS with 15 days EQPF Ensemble: 2021-07-13 Issued: 2021-07-13

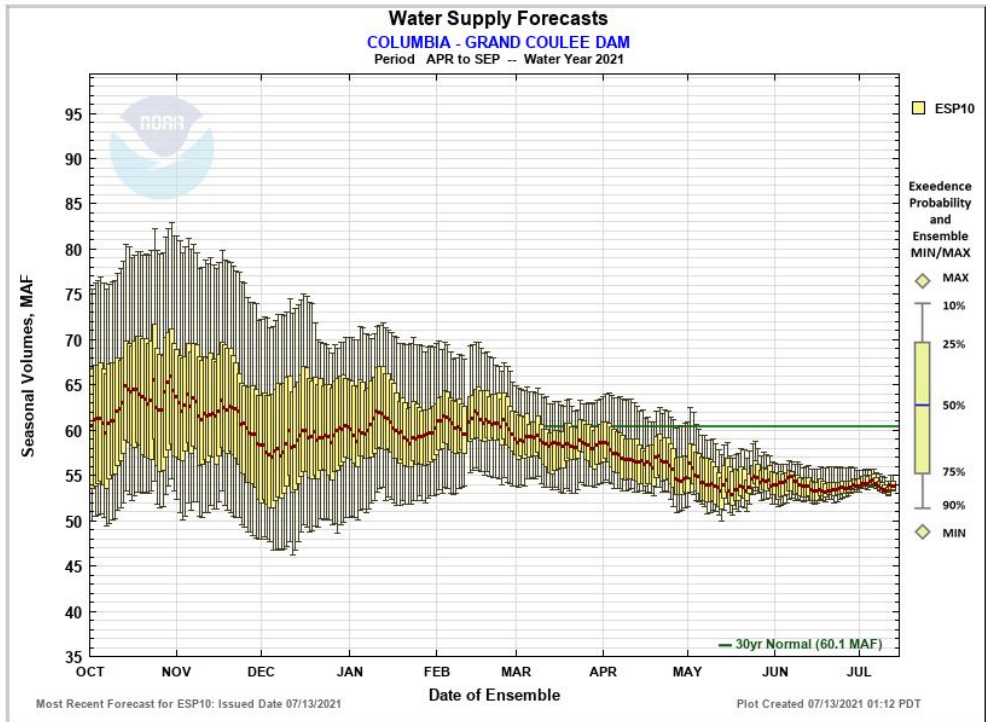
APR-SEP	53073	53442	89	54729	60110
APR-JUL	46209	46392	91	46573	51015
APR-AUG	50455	50720	89	51287	56763
JAN-SEP	60325	60694	88	61980	68694
JAN-JUL	53460	53644	90	53824	59599
OCT-SEP	69110	69480	90	70766	76824

Reference

ESP with 0 Days QPF Ensemble: 2021-07-13 Issued: 2021-07-13

APR-SEP	53113	53734	89	55344	60110
APR-JUL	46108	46421	91	46859	51015
APR-AUG	50413	50917	90	51685	56763
JAN-SEP	60365	60986	89	62595	68694
JAN-JUL	53360	53672	90	54110	59599
OCT-SEP	69150	69772	91	71381	76824

Move the mouse over the desired "Forecast Period" to display a graph.



Max Scale Scale To Data Scale To Last 45 Days Show Min/Max Ensemble Volume Show Tooltips Help



ESP10 Apr-Sep Water Supply Forecasts

Choose Date: 07/13/2021 Archive: Water Year ▾

SNAKE - LOWER GRANITE DAM (LGDW1) Forecasts for Water Year 2021

Official Water Supply

ESP with 10 Days QPF Ensemble: 2021-07-13 Issued: 2021-07-13

Forecast Period	Forecasts Are in KAF				30 Year Average (1981-2010)
	90 %	50 %	% Average	10 %	
APR-SEP	15154	15227	68	15432	22279
APR-JUL	13168	13172	66	13176	19848
APR-AUG	14134	14174	67	14252	21091
JAN-SEP	20431	20504	69	20709	29872
JAN-JUL	18445	18449	67	18454	27440
OCT-SEP	24528	24602	71	24807	34667

Experimental Water Supply

HEFS with 15 days EQPF Ensemble: 2021-07-13 Issued: 2021-07-13

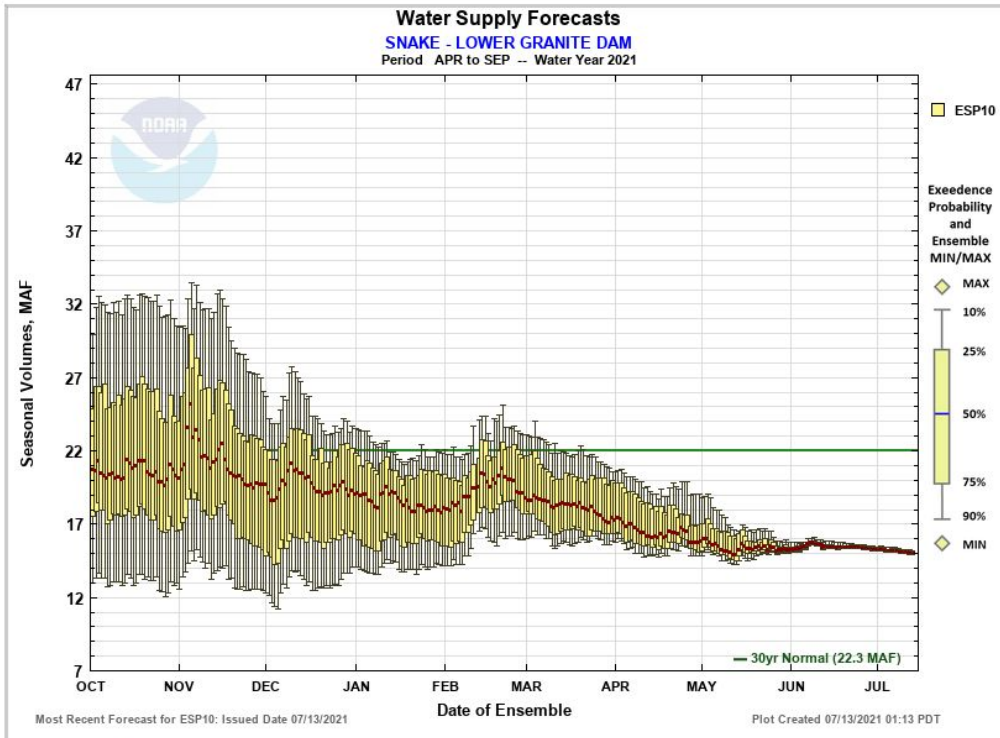
APR-SEP	15153	15230	68	15450	22279
APR-JUL	13168	13176	66	13185	19848
APR-AUG	14141	14180	67	14261	21091
JAN-SEP	20430	20508	69	20727	29872
JAN-JUL	18445	18453	67	18462	27440
OCT-SEP	24527	24605	71	24824	34667

Reference

ESP with 0 Days QPF Ensemble: 2021-07-13 Issued: 2021-07-13

APR-SEP	15160	15240	68	15456	22279
APR-JUL	13172	13184	66	13204	19848
APR-AUG	14148	14194	67	14281	21091
JAN-SEP	20438	20517	69	20734	29872
JAN-JUL	18450	18461	67	18482	27440
OCT-SEP	24535	24614	71	24831	34667

Move the mouse over the desired "Forecast Period" to display a graph.



Max Scale
 Scale To Data
 Scale To Last 45 Days
 Show Min/Max Ensemble Volume
 Show Tooltips Help



ESP10 Apr-Sep Water Supply Forecasts

Choose Date: 07/13/2021 Archive: Water Year

COLUMBIA - THE DALLES DAM (TDAO3) Forecasts for Water Year 2021

Official Water Supply

ESP with 10 Days QPF Ensemble: 2021-07-13 Issued: 2021-07-13

Forecast Period	Forecasts Are in KAF				30 Year Average (1981-2010)
	90 %	50 %	% Average	10 %	
APR-SEP	76354	76975	83	78337	92704
APR-JUL	66542	66658	83	66772	79855
APR-AUG	72259	72512	83	73099	87532
JAN-SEP	92587	93207	82	94570	114216
JAN-JUL	82775	82890	82	83004	101368
OCT-SEP	107757	108377	83	109740	130518

Experimental Water Supply

HEFS with 15 days EQPF Ensemble: 2021-07-13 Issued: 2021-07-13

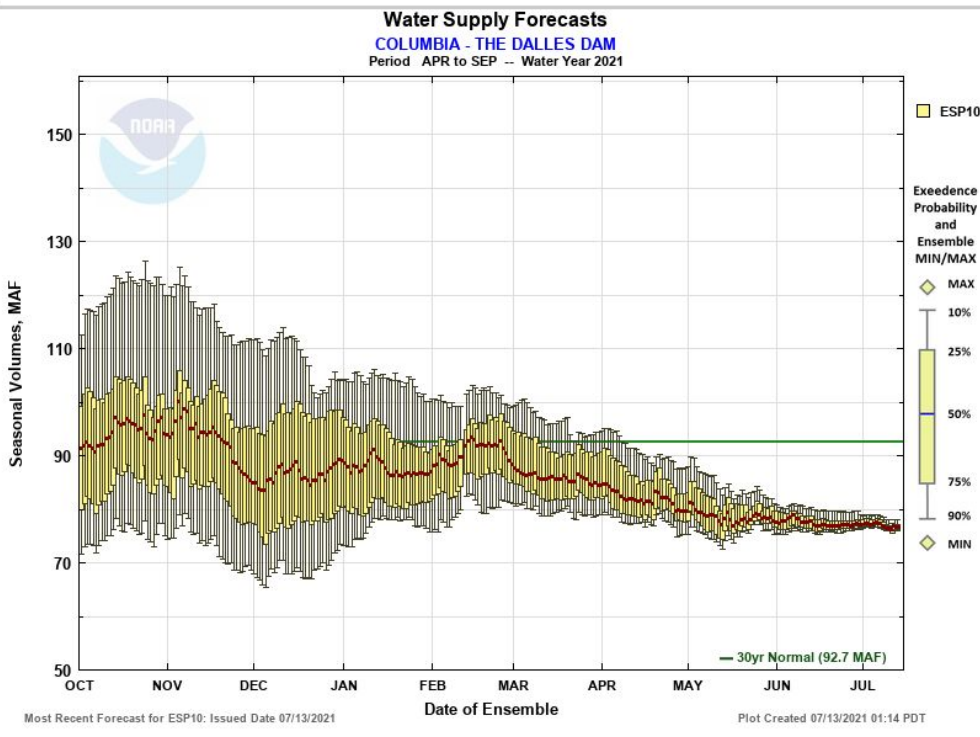
APR-SEP	76434	76888	83	78403	92704
APR-JUL	66475	66654	83	66829	79855
APR-AUG	72230	72565	83	73114	87532
JAN-SEP	92667	93121	82	94636	114216
JAN-JUL	82708	82886	82	83062	101368
OCT-SEP	107837	108291	83	109806	130518

Reference

ESP with 0 Days QPF Ensemble: 2021-07-13 Issued: 2021-07-13

APR-SEP	76380	77162	83	78726	92704
APR-JUL	66382	66696	84	67146	79855
APR-AUG	72205	72782	83	73507	87532
JAN-SEP	92613	93395	82	94959	114216
JAN-JUL	82615	82929	82	83378	101368
OCT-SEP	107783	108565	83	110129	130518

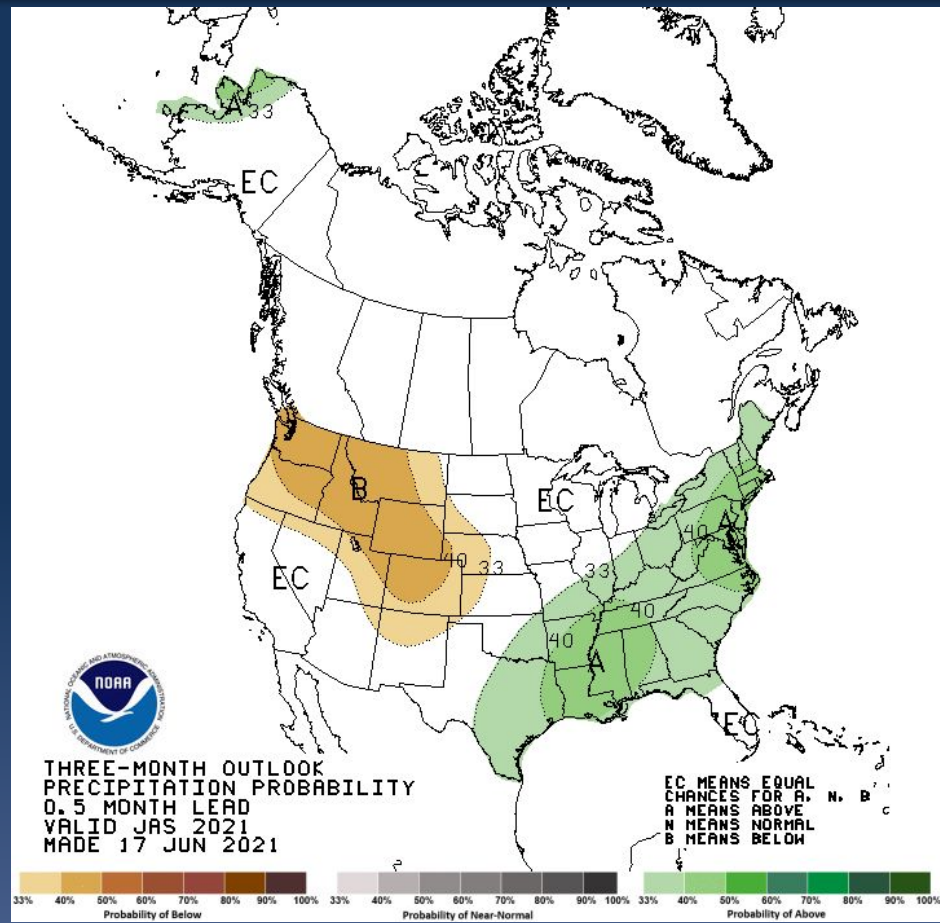
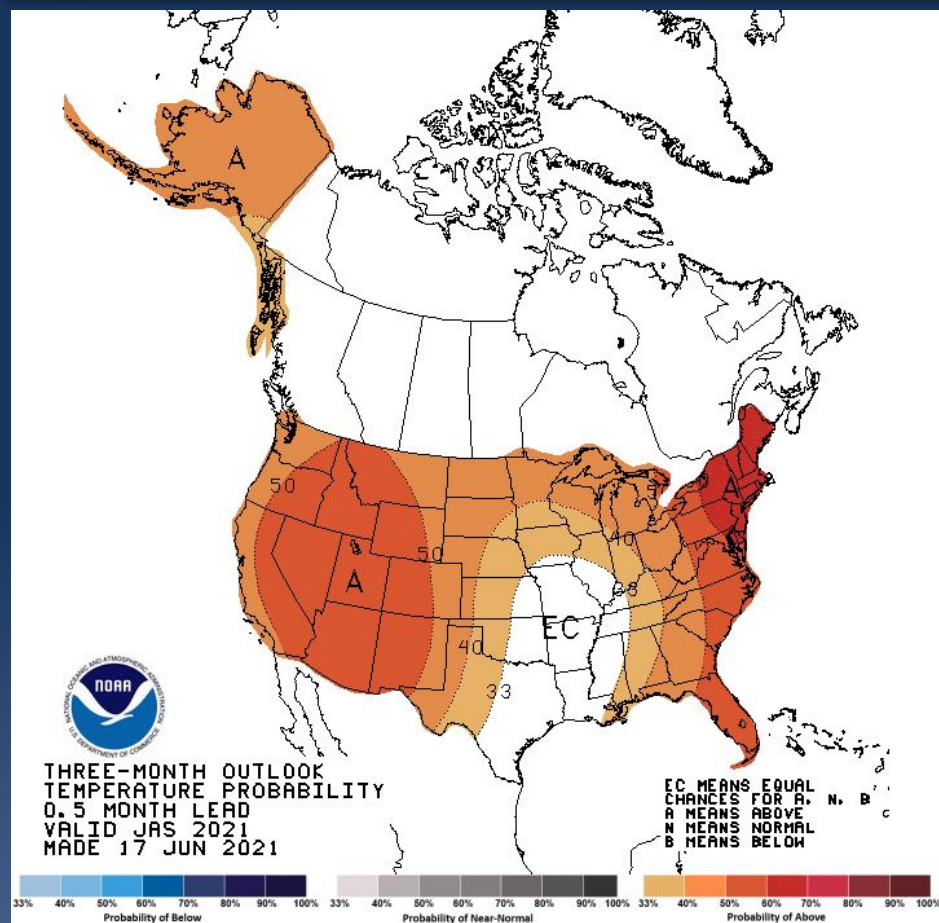
Move the mouse over the desired "Forecast Period" to display a graph.



Max Scale
 Scale To Data
 Scale To Last 45 Days
 Show Min/Max Ensemble Volume
 Show Tooltips Help



CPC Three-Month Outlook





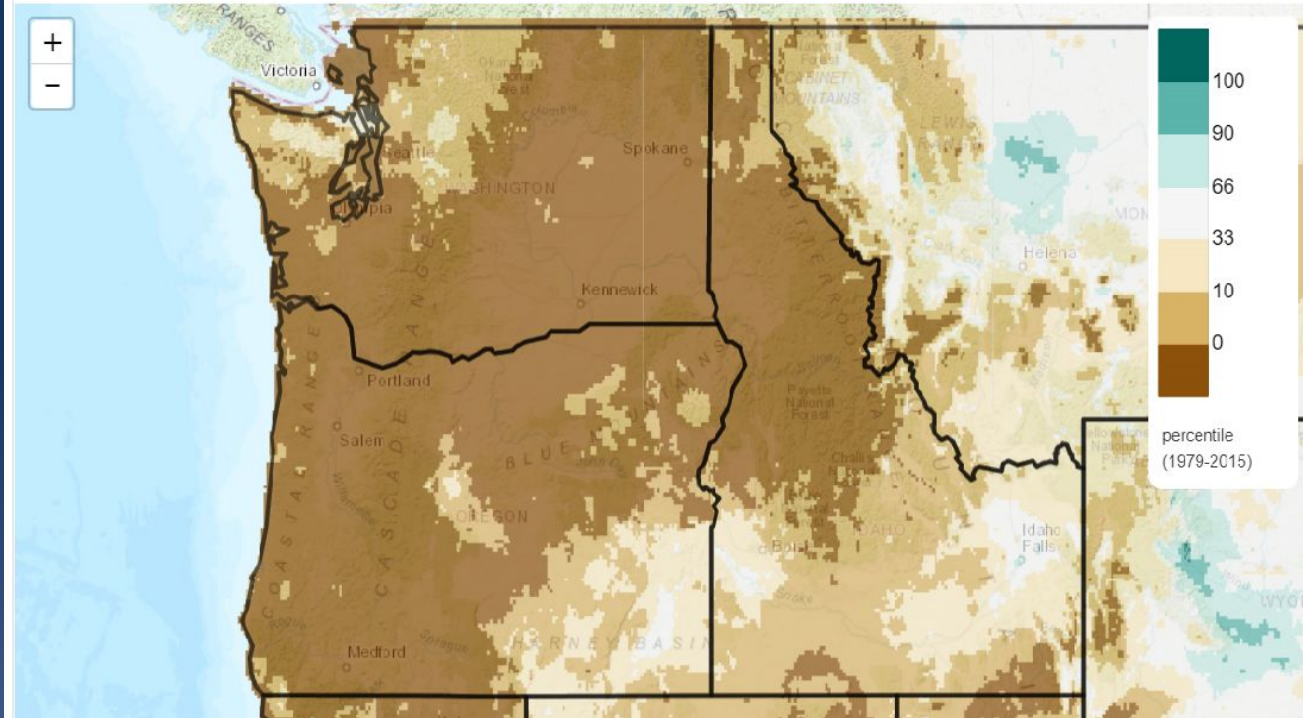
Take Home Messages

- At the end of February much of the Columbia basin had near to above normal WS forecasts. Snake basin had largely below normal volume forecasts; Middle Snake tributaries exhibited especially low volume forecasts.
- With few exceptions, WY precipitation to date was below normal across the RFC domain—good snow building in the northern Cascades and in the Upper Columbia basins helped keep WS volume forecasts up. The WA and northern OR cascades, Blue and Wallowa ranges all benefited from a healthy snow building in February.
- Very dry conditions since the beginning of March have reduced water supply forecasts domain wide. Currently the only basins with normal to above normal Apr-Sept forecasts are found in the Clark Fork and in the snow-fed portions of the WA cascades.
- Many Natural volume forecasts on the west side of the OR cascades, in the Middle and Lower Snake, and MC lower tribs have Apr-Sep volume forecasts that rank in the single digits for driest volumes in the historical record; many of these forecasts--should they verify--would be the driest Apr-Sep volume on record.

Precip Percentile March-May

Total Precipitation Percentile, Last 3 Full Months

2021/03/01 - 2021/05/31



<https://climatetoolbox.org/tool/climate-mapper>
Preset Link to: Precip Percentile Last 90 Days

COLUMBIA BASIN RESERVOIR OPERATIONS

Aaron Marshall

Reservoir Control Center

Columbia Basin Water Management

Northwestern Division

14 July 2021



"The views, opinions and findings contained in this report are those of the authors(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other official documentation."



**US Army Corps
of Engineers®**



@NWDUSACE



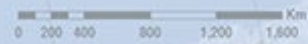
WHERE WE ARE - USACE WORLDWIDE



9 Divisions
45 Districts

- USACE DIVISIONS**
- Northwestern NWD
 - South Pacific SPD
 - Southwestern SWD
 - Mississippi Valley MVD
 - Great Lakes & Ohio River LRD
 - South Atlantic SAD
 - North Atlantic NAD
 - Pacific Ocean POD
 - Trans Atlantic TAD

- Other USACE Organizations**
- 249th Engineer Battalion (Fort Belvoir, VA)
 - Army Geospatial Center (Alexandria, VA)
 - Engineer Research & Development Center (Vicksburg, MS)
 - Engineering and Support Center (Huntsville, AL)
 - Finance Center (Millington, TN)
 - Humphreys Engineer Center Support Activity (Alexandria, VA)
 - Institute for Water Resources (Alexandria, VA)
 - Logistics Activity (Millington, TN)
 - Marine Design Center (Philadelphia, PA)





REGIONAL WATER MANAGEMENT STRUCTURE



Federal Coordination

Federal dams are owned and operated by the U.S. Army Corps of Engineers and the Bureau of Reclamation

Bonneville Power Administration is responsible for marketing and transmitting the power generated by the federal facilities

Operations are coordinated between the three agencies in real-time and on a planning basis

Key Relationships

Successful water management depends on close working relationships with our partner agencies

Federal

Bureau of Reclamation
Bonneville Power Administration
NOAA Fisheries
U.S. Fish & Wildlife Service

States

Oregon
Washington
Idaho
Montana

International

BC Hydro

Pacific Northwest Tribes



COLUMBIA RIVER BASIN

The Columbia River Basin drains parts of 7 states and southeast British Columbia

- 259,000 square miles (France)
- Over 1,200 miles long
- 4th largest river in U.S. (runoff volume)

Headwaters in Rocky Mountains

- British Columbia (15% area, 35% runoff)
- Montana
- Idaho
- Wyoming

Main Tributaries

- Snake River (Clearwater & Salmon)
- Willamette River
- Pend Oreille River (Clark Fork & Flathead)
- Kootenai/Kootenay River





COLUMBIA RIVER BASIN

Corps of Engineers Dams:

- Libby (Kootenai River)
- Albeni Falls (Pend Oreille River)
- Chief Joseph (Columbia River)
- Lucky Peak (Boise River)
- Dworshak (N. Fork Clearwater River)

- Lower Granite (lower Snake River)
- Little Goose (lower Snake River)
- Lower Monumental (lower Snake River)
- Ice Harbor (lower Snake River)

- McNary (lower Columbia River)
- John Day (lower Columbia River)
- The Dalles (lower Columbia River)
- Bonneville (lower Columbia River)





MULTI-PURPOSE RESERVOIR SYSTEM



Dams operated as part of a coordinated, multiple-purpose reservoir system

The Corps works with regional partners to operate the Columbia River System to serve 8 Congressionally authorized purposes:

- Flood risk management
- Hydropower
- Navigation
- Irrigation
- Water Supply
- Fish and Wildlife
- Recreation
- Water Quality



STORAGE & RUN-OF-RIVER DAMS



Main Storage Projects

- Mica, Arrow, Duncan (BC Hydro)
- Grand Coulee, Hungry Horse (USBR)
- Libby, Albeni Falls, Dworshak (Corps)
- SKQ Dam/Flathead Lake (Energy Keepers Inc.)
- Brownlee (Idaho Power)

Dworshak



John Day

Main Run-of-River Projects (Corps)

- Chief Joseph
- Lower Granite
- Little Goose
- Lower Monumental
- Ice Harbor
- McNary
- John Day
- The Dalles
- Bonneville



COLUMBIA RIVER BASIN

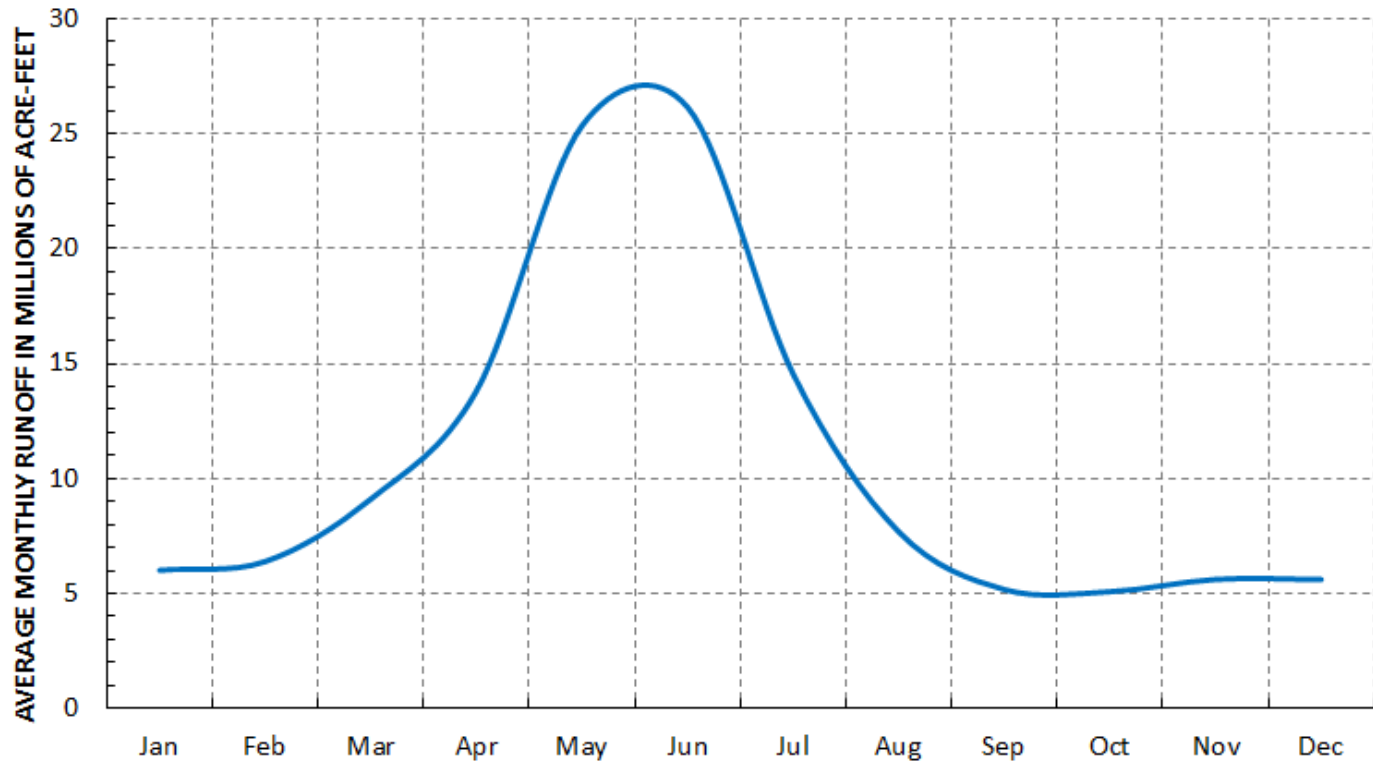
Annual runoff primarily driven by snowmelt

- Average annual runoff at The Dalles 130 MAF
- Enough water to cover Oregon in about 2 feet of water

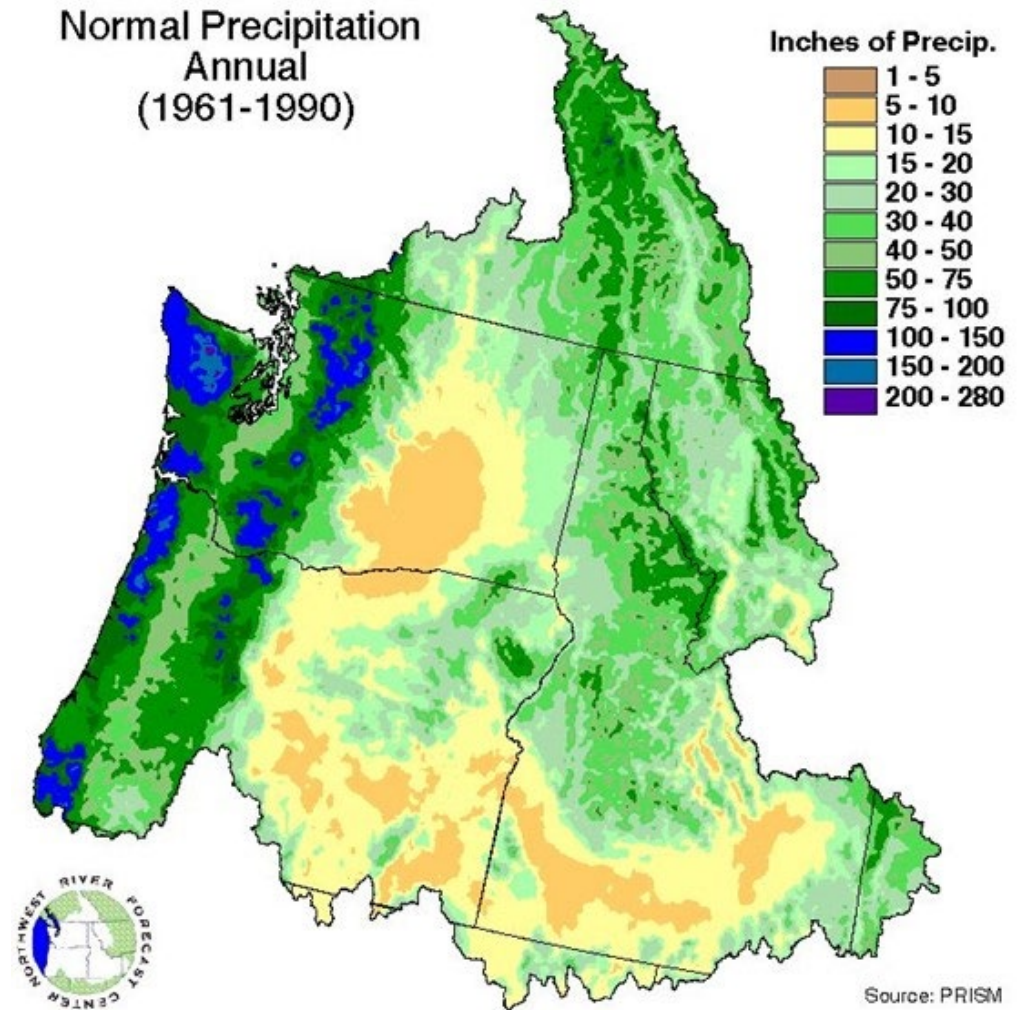
COLUMBIA RIVER AT THE DALLES DAM

AVERAGE MONTHLY RUNOFF

Period of Record: 1981-2010



Normal Precipitation
Annual
(1961-1990)



Climate

- West of Cascades: temperate
- East of Cascades: semi-arid

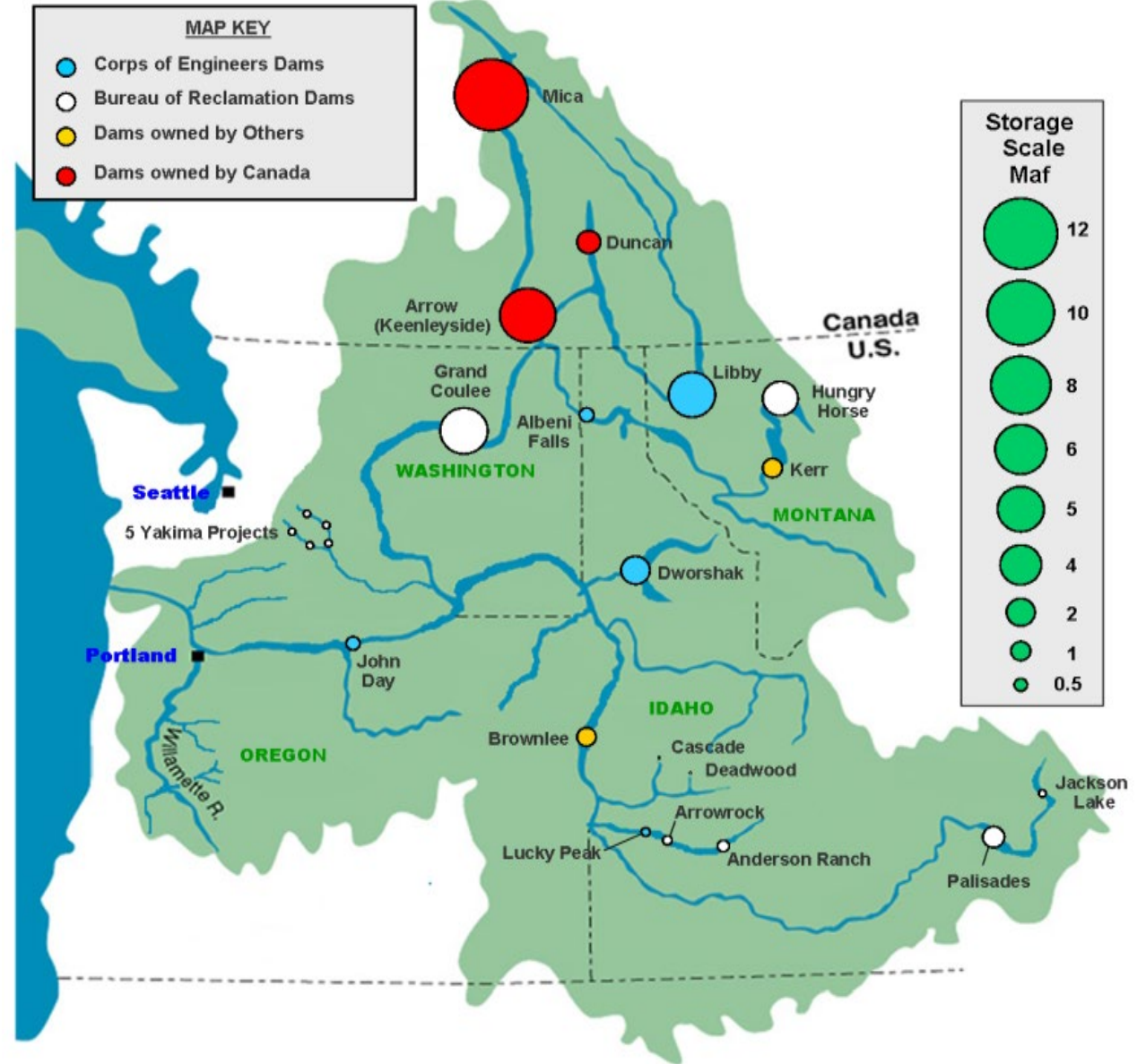
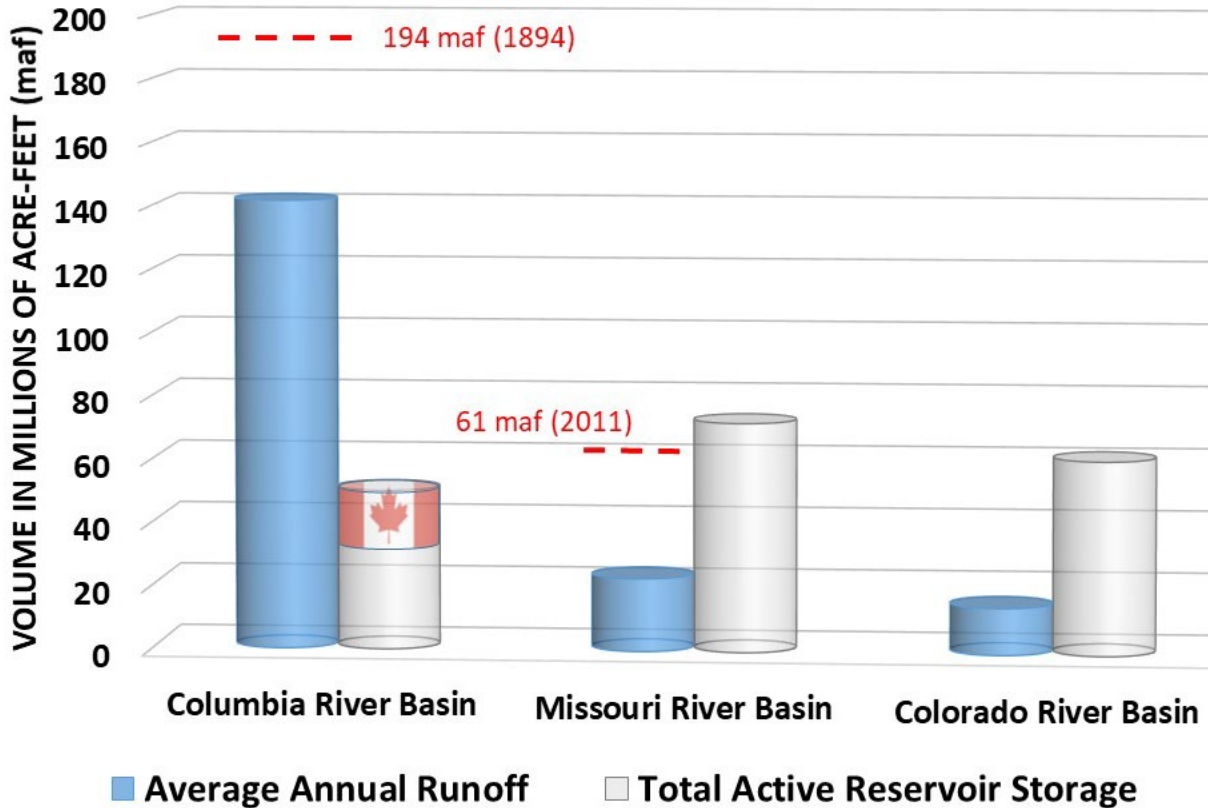


FLOOD RISK MANAGEMENT



Space is needed in storage reservoirs to manage flows in lower Columbia and lower Snake Rivers

- Limited space available for flood risk management
- Usable reservoir storage ~1/3 of annual runoff



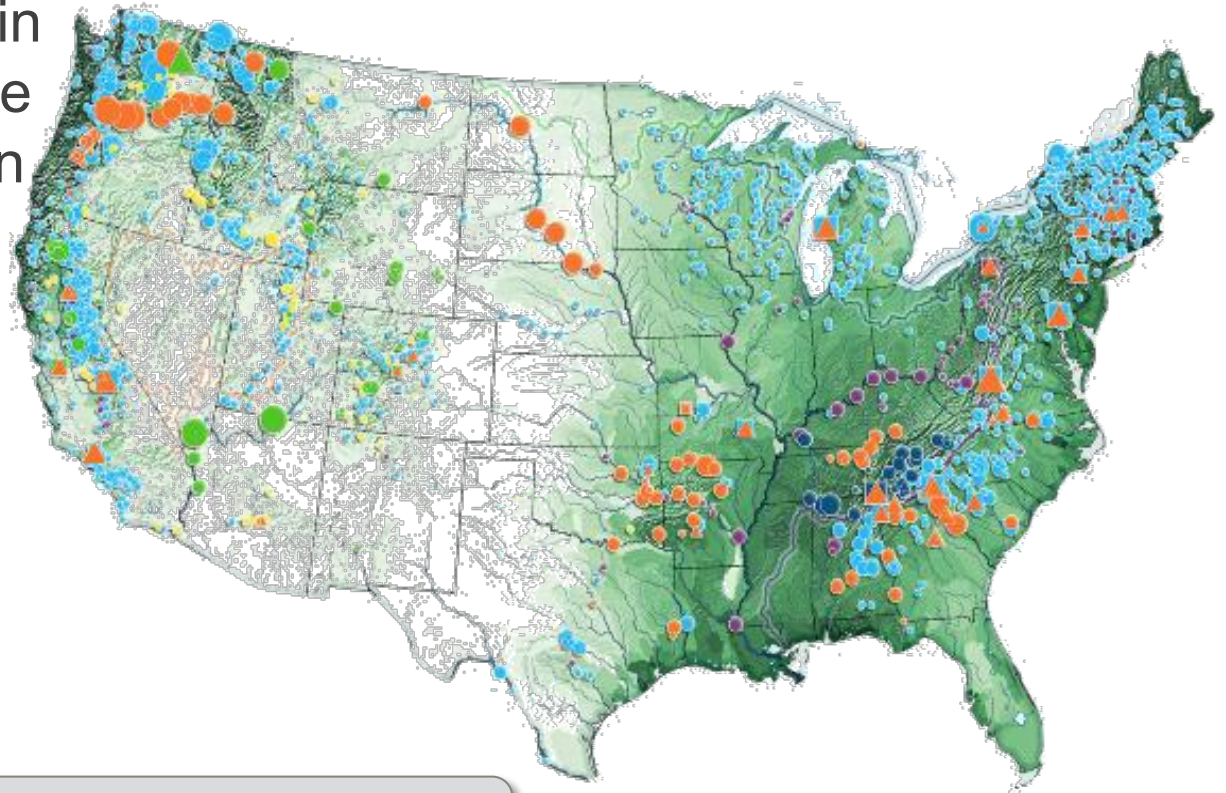


HYDROPOWER

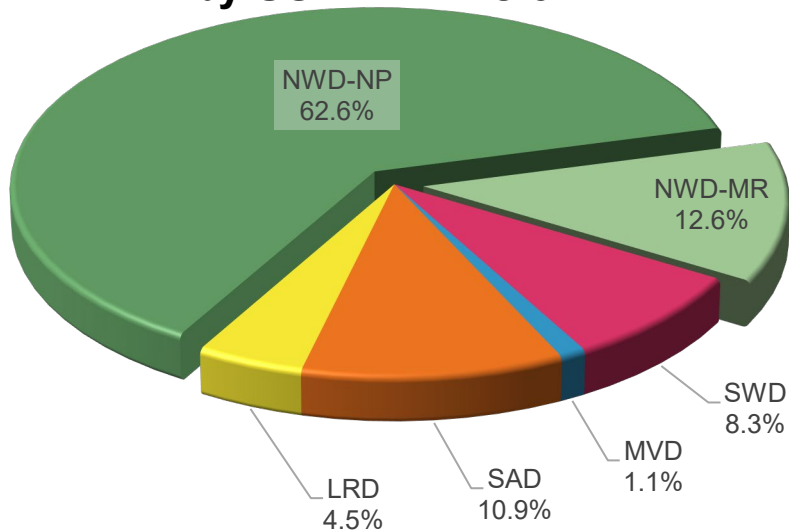


There are 31 federal hydropower facilities within the Columbia Basin owned and operated by the Corps of Engineers and Bureau of Reclamation

Power is largely a byproduct of managing the reservoir system for all other purposes

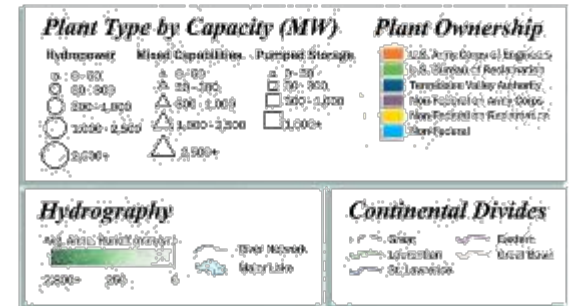


Hydropower Generation Capacity by USACE Division



Columbia Basin Hydropower (Corps)

- 21 hydroelectric dams, 156 units
- 14,600 MW Capacity
- 5600 aMW generation (powers 6 million homes annually)



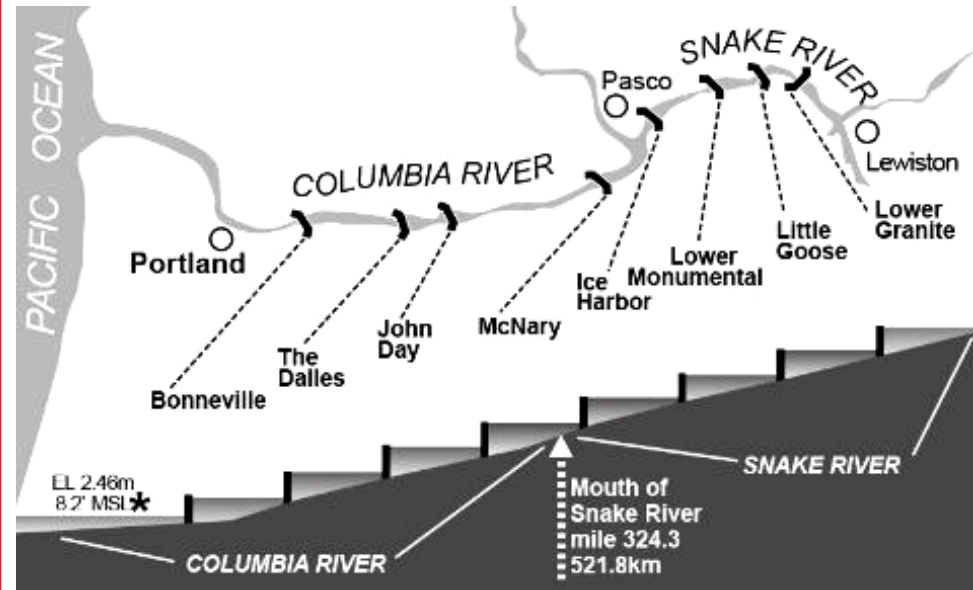


NAVIGATION



Adequate depth and velocity limits allow vessels to navigate the river channel.

- 8 locks on the lower Columbia and lower Snake River dams
- 485 miles (780 km) of navigable waterways from the mouth to Lewiston, ID
- Approximately 61 million tons of cargo worth \$24B* annually



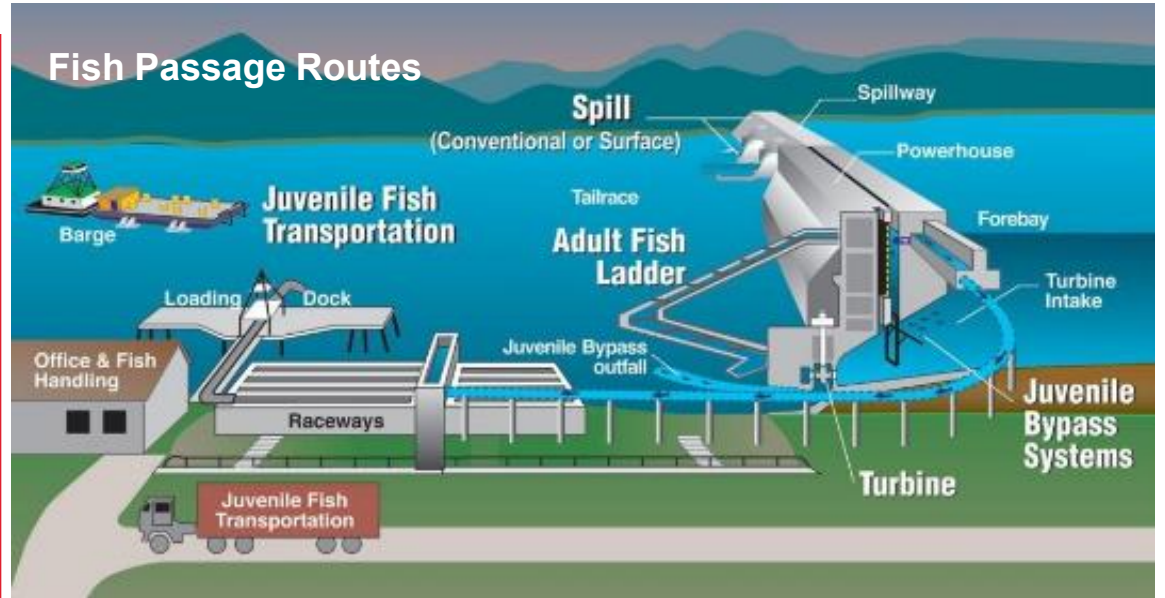
* 2015-2017 Average - Data derived from Waterborne Commerce statistics and Compiled by Channel Portfolio Tool



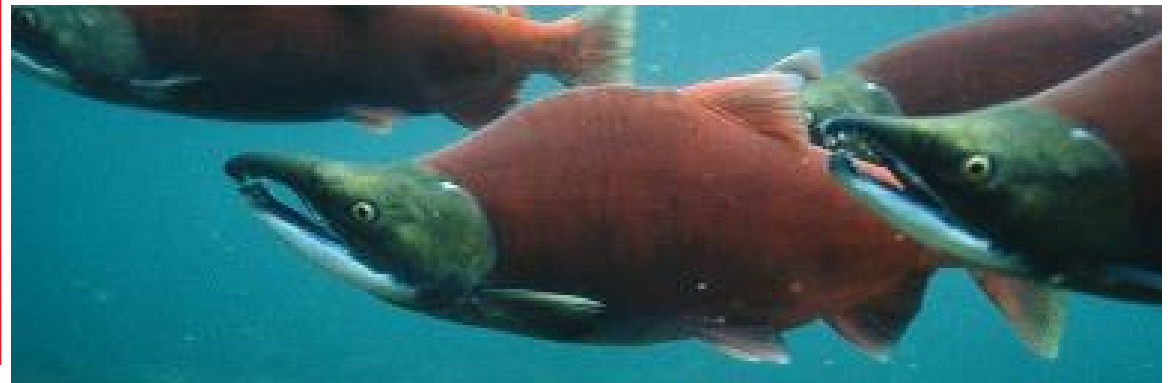
FISH AND WILDLIFE

Dams are operated in accordance with current USFWS and NOAA Fisheries Biological Opinions

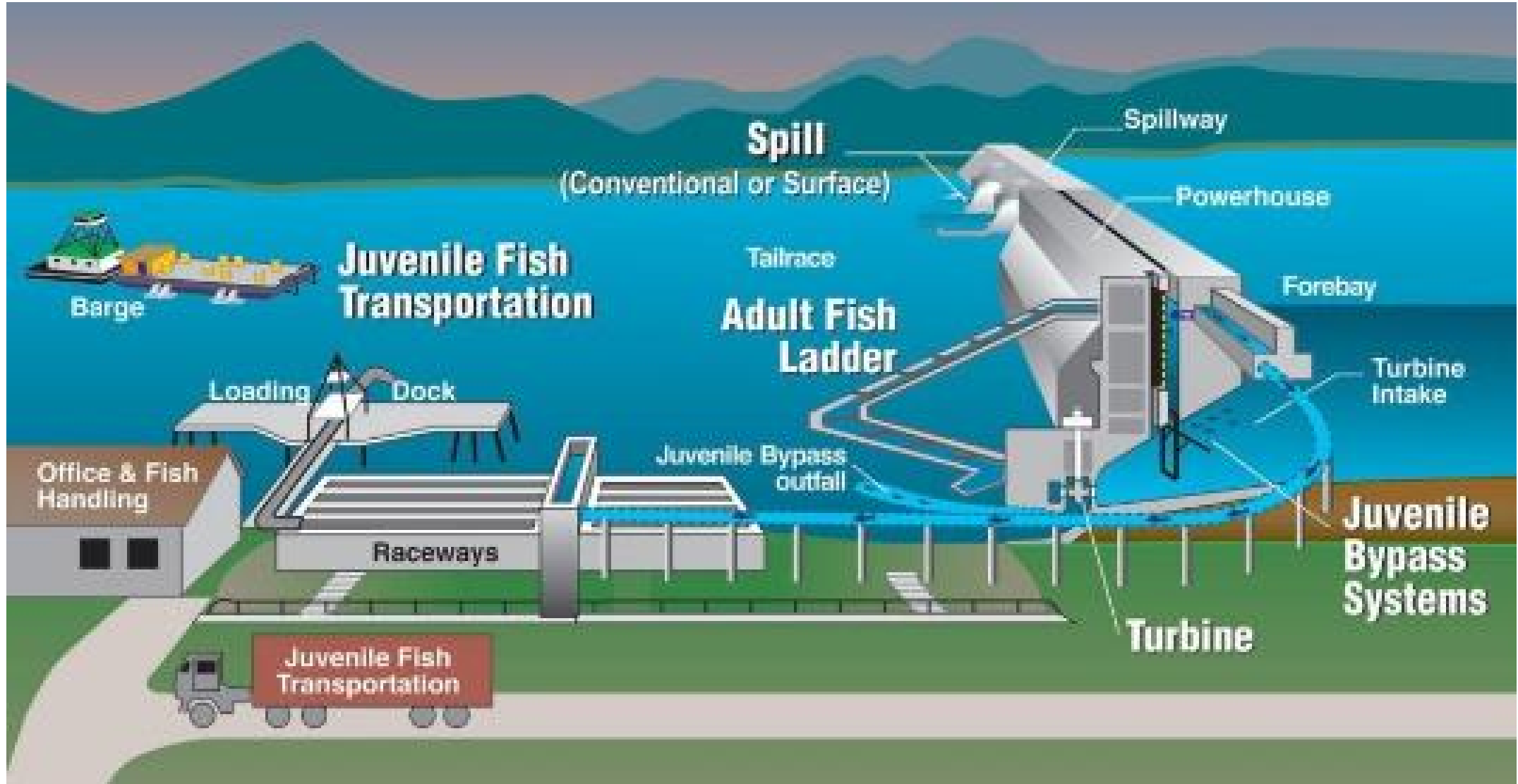
Operations manifest as flow targets, reservoir elevation targets, and hydropower generation limits



Project-specific spill requirements are managed to aid fish passage within water quality standards



FISH AND WILDLIFE

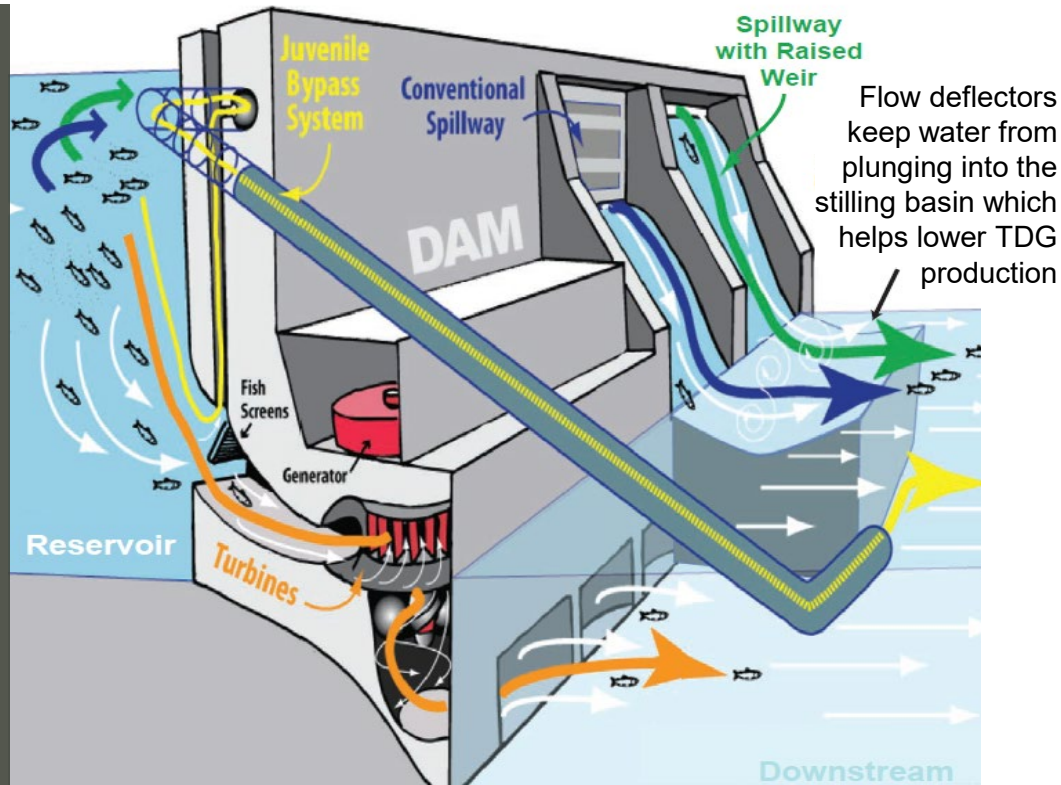


Spill over the spillway can aid migrating juvenile salmon heading to the ocean but can also produce total dissolved gas (TDG)

Some projects (Dworshak, Libby and Hungry Horse) are operated to provide temperature benefits downstream

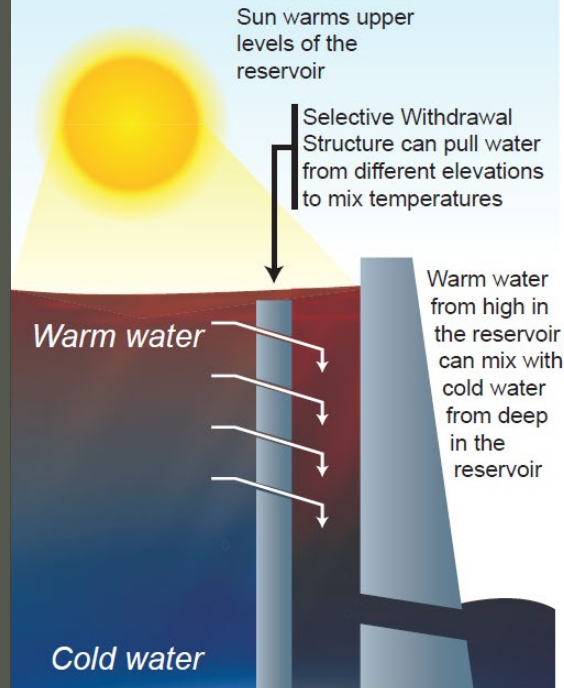
Spill is managed to balance fish passage benefits with TDG production

TOTAL DISSOLVED GAS

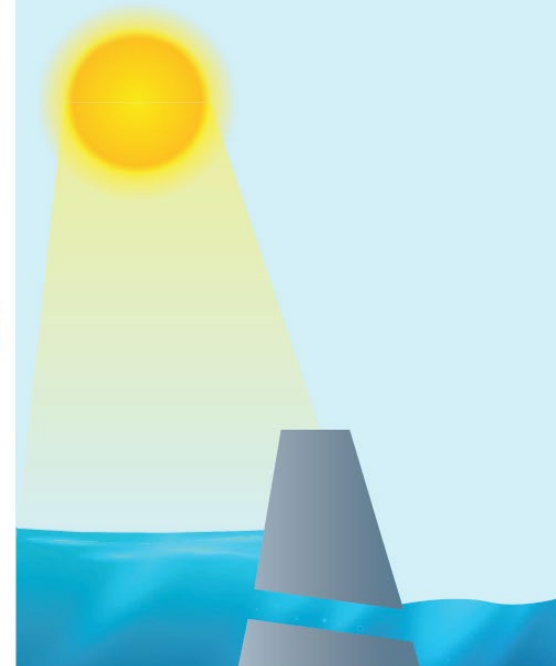


TEMPERATURE

Stratified Reservoir with Selective Withdrawal Structure



Isothermal Reservoir



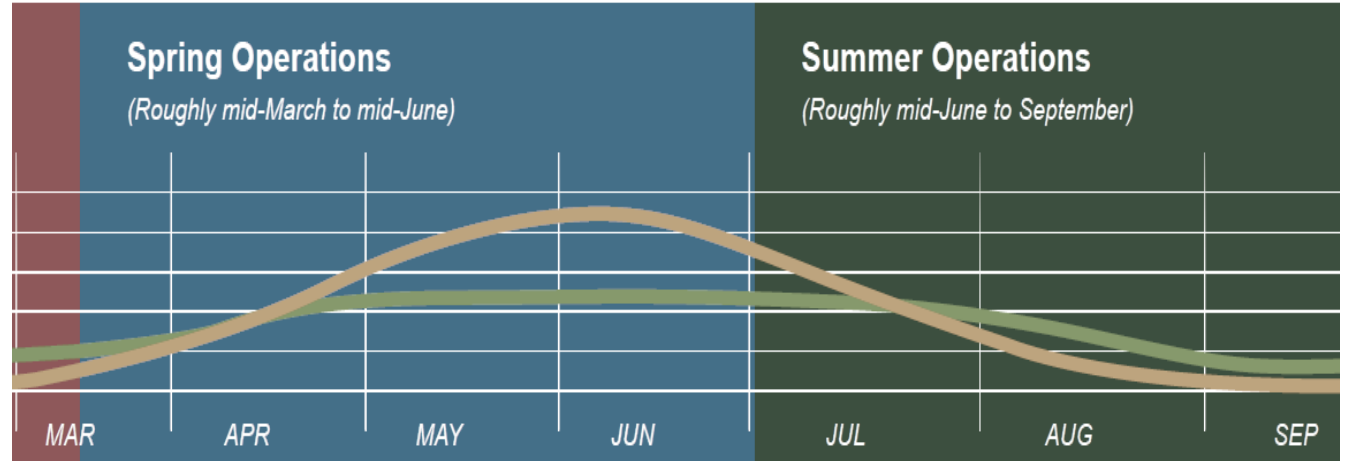


JUVENILE FISH PASSAGE SPILL

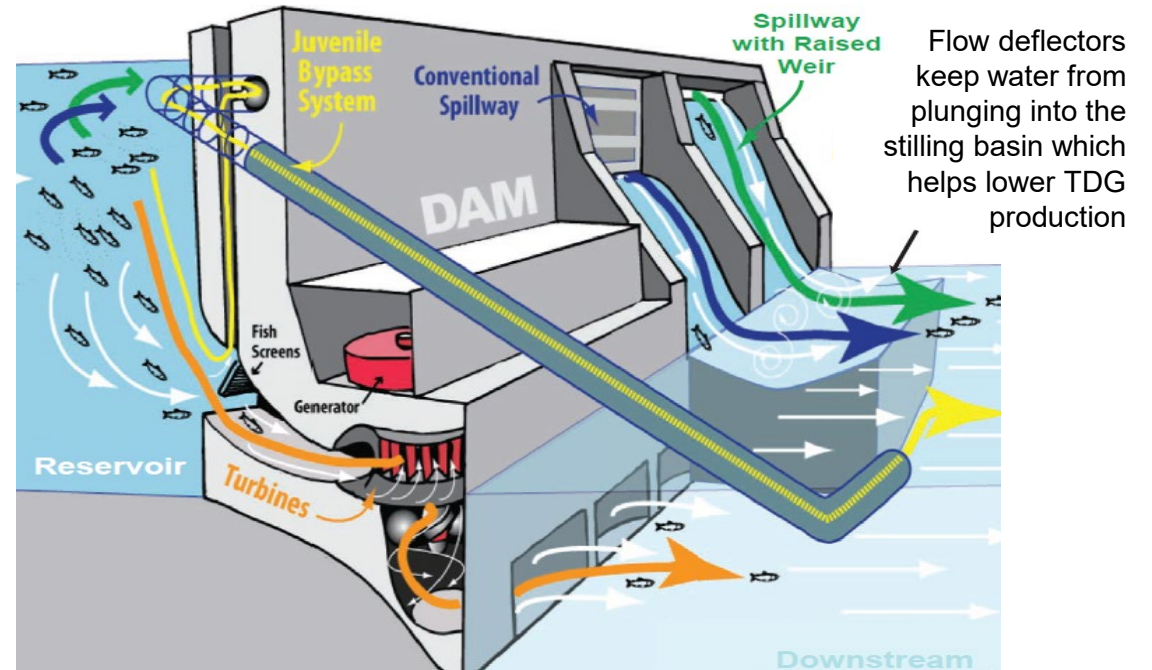
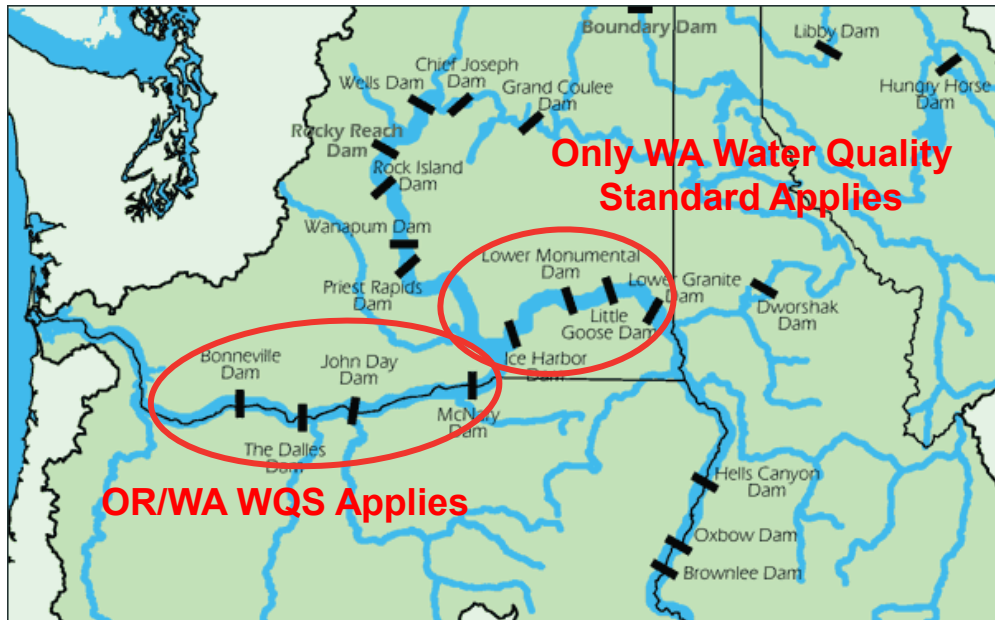


The Corps provides spill to aid juvenile fish passage across 3 periods:

- Spring Spill (Flexible Spill Operations) -
 - 3 Apr – 20 Jun on Lower Snake
 - 10 Apr – 15 Jun on Lower Columbia
- Summer Spill -
 - 21 Jun – 14 Aug on Lower Snake
 - 16 Jun – 14 Aug on Lower Columbia
- Late Summer Spill -
 - 15 - 31 Aug on Lower Snake and Lower Columbia



— Streamflow without dams (unregulated) — Streamflow with dams (regulated)





WATER SUPPLY & IRRIGATION



Reservoir levels are managed to allow pumping for irrigation and M&I water supply
– 6.5 million acres irrigated





RECREATION & CONSTRUCTION



Recreation and construction activities often need specific reservoir levels or flows

- Boat races
- Swim events
- Windsurfing & kiteboarding
- Underwater bridge inspections
- Bridge construction





MULTI-PURPOSE RESERVOIR SYSTEM

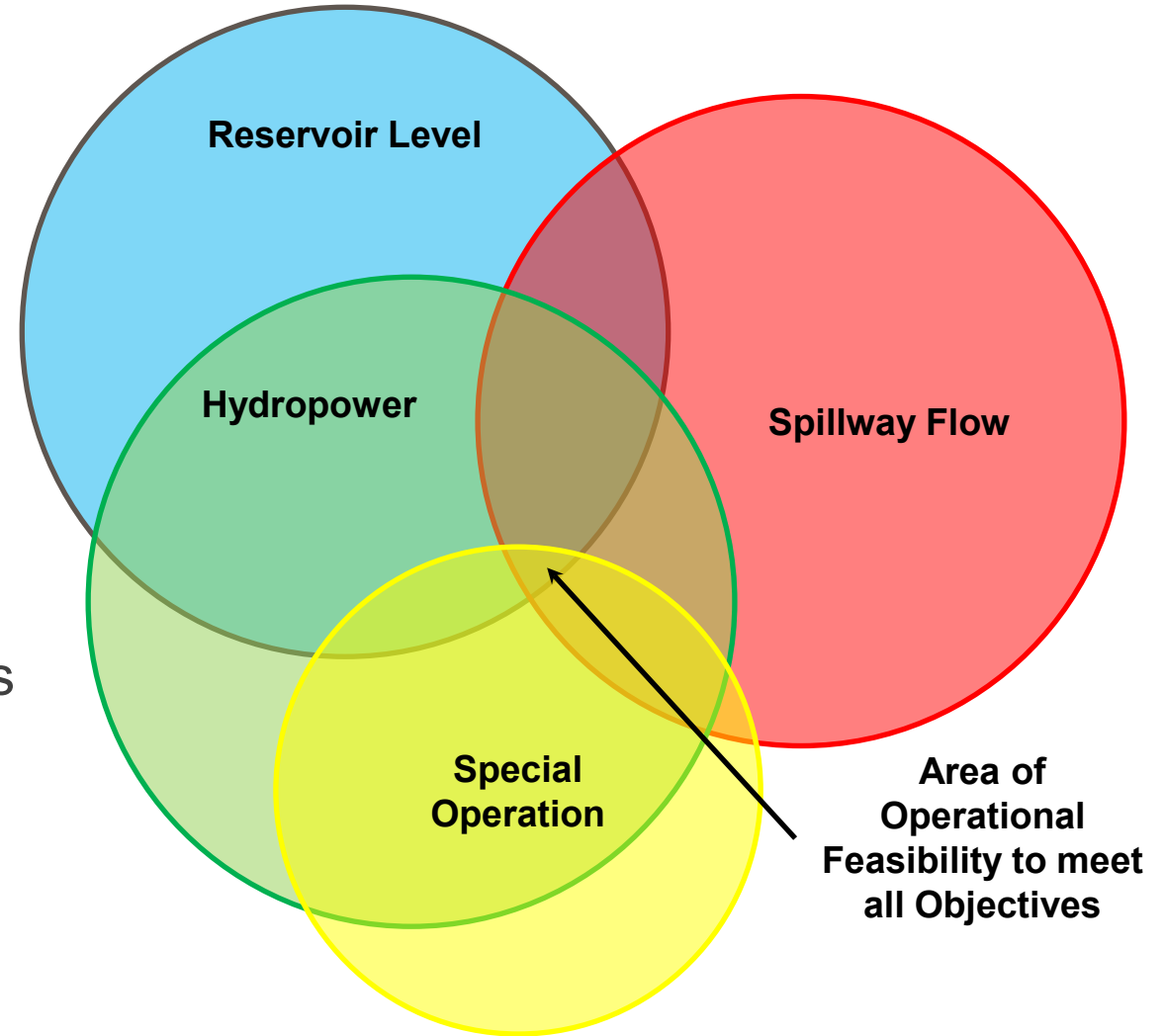


Many of the multiple purposes can be successfully implemented at the same time

Each objective has its own set of needs

There is often only a small space where all objectives can be fully met

When all objectives cannot be fully met, the federal agencies work with regional stakeholders to discuss adaptive management and tradeoffs





COLUMBIA RIVER TREATY OVERVIEW



- The 1964 Treaty required Canada to construct and operate three storage dams (Mica, Arrow, and Duncan) with 15.5 Maf of storage for flood control and power generation
- The Treaty allowed the U.S. to construct and operate Libby Dam with 5 Maf of storage on the Kootenai River in Montana for “flood control and other purposes”
- Nonpower Uses Agreement is developed annually to provide benefits in Canada and the United States
- Provides 1 Maf of flow augmentation storage in Canada for U.S. fish objectives in exchange for improved whitefish and trout spawning flows downstream of Arrow in Canada
- 1 Maf of flow augmentation was stored in January 2021
- Released 8 May through 9 July 2021





2021 OPERATIONS

Dworshak:

- Release of cold water to keep Lower Granite tailwater temperature at or below 68°F
- Began on 22 June, 2-3 weeks earlier than normal due to record heatwave
- Dworshak filled to about 3 feet below full pool before drafting for temp. augmentation

Grand Coulee:

- Release of water for flow augmentation during spring for juvenile salmon out-migration
- Spring target of 220 kcfs at McNary Dam
- Refilled on 12 July (typical)
- Additional 2-foot draft by 31 August due to low water supply to support salmon flow objectives



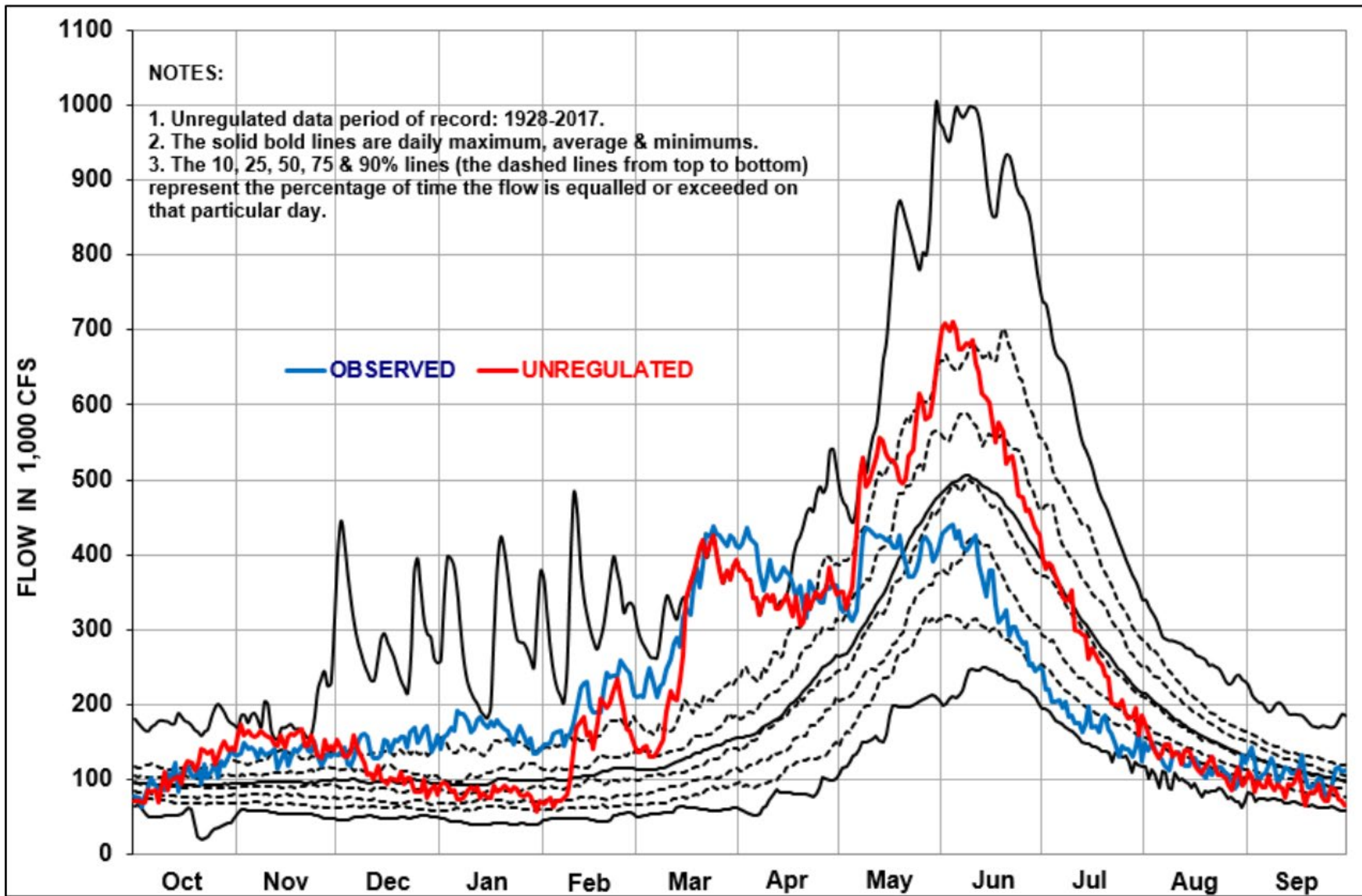


BONUS SLIDES





WY2017

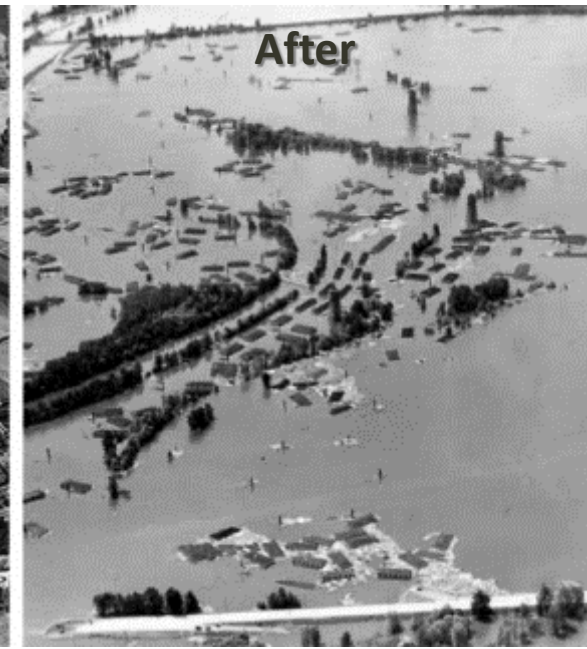




U.S. ARMY

1948 VANPORT FLOOD

- Town of Vanport destroyed, at least 15 dead
- Basin-wide flooding, damage est. \$102,725,000
- At least 51 dead, more than 46,000 lose homes
- Columbia River flows peaked at ~1000 kcfs, remained above 900 kcfs for 3 weeks

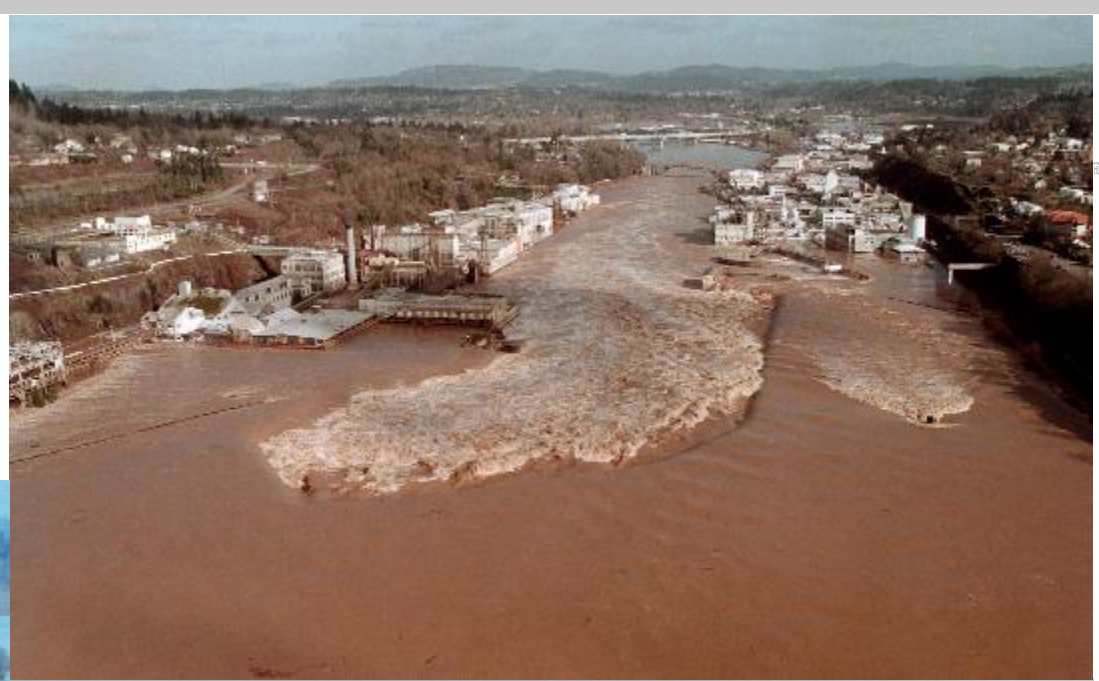




U.S. ARMY

1996 WILLAMETTE FLOOD

- 8 dead in Oregon, more than \$500 million in property damage throughout the Pacific Northwest
- 3,000 people displaced from their homes
- Peak stage 28.6 feet, 10.6 feet above flood stage





FLOOD RISK MANAGEMENT



Flood Categories (in feet)

Major Flood Stage:	25
Moderate Flood Stage:	20
Flood Stage:	16
Action Stage:	15
Low Stage (in feet):	1

Historic Crests

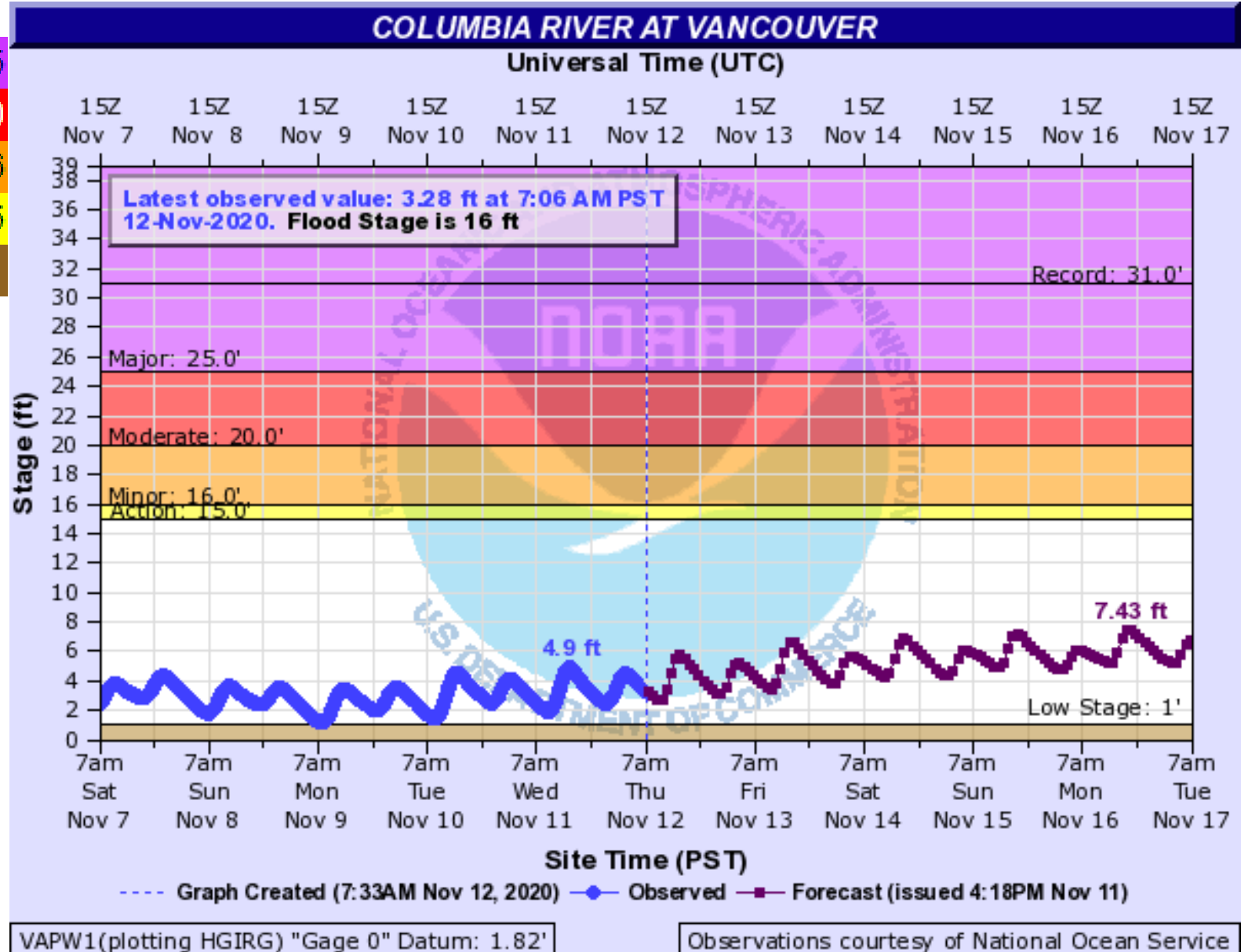
- (1) 33.60 ft on 06/07/1894
- (2) 31.00 ft on 06/13/1948
- (3) 30.80 ft on 06/01/1948
- (4) 27.70 ft on 12/25/1964
- (5) 27.60 ft on 06/04/1956

[Show More Historic Crests](#)

(P): Preliminary values subject to further review.

Recent Crests

- (1) 15.60 ft on 04/12/2019
- (2) 17.60 ft on 03/30/2017
- (3) 17.43 ft on 06/02/2011
- (4) 12.32 ft on 11/26/1999
- (5) 15.00 ft on 12/30/1998

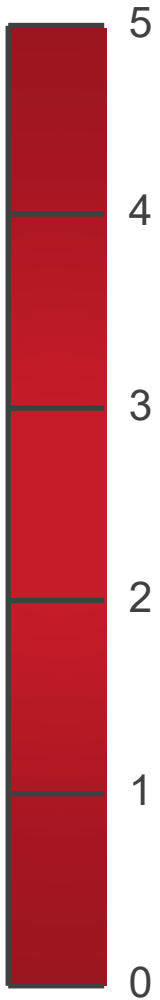




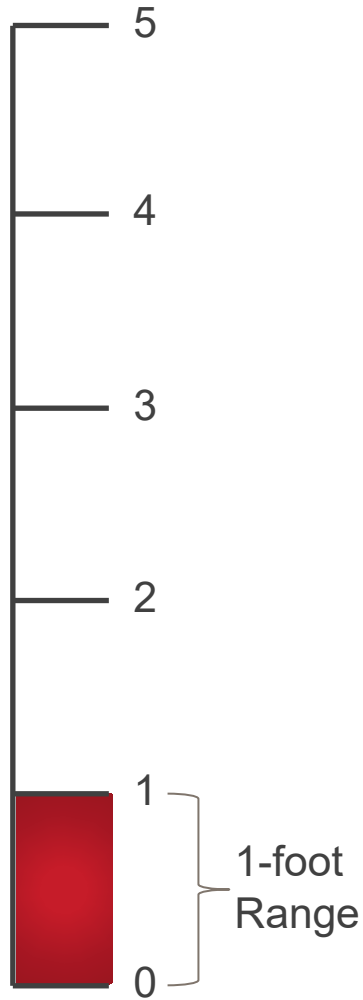
SNAKE RIVER MOP OPERATIONS



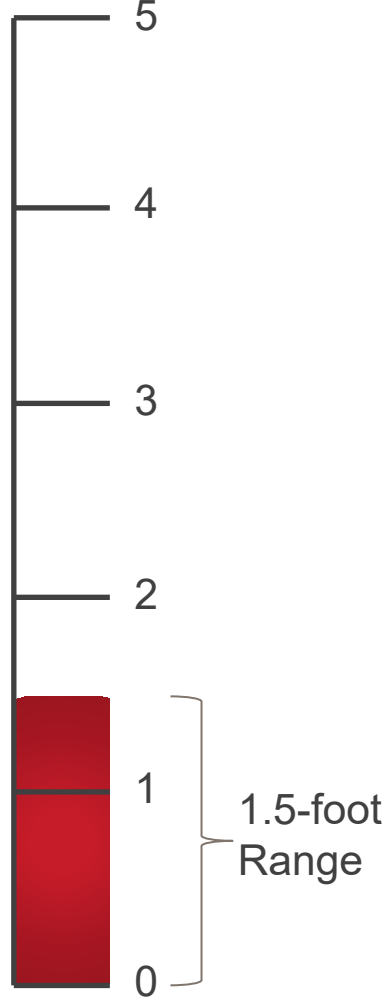
Normal Pool Range



2008 BiOp MOP (3 APR – 31 AUG)

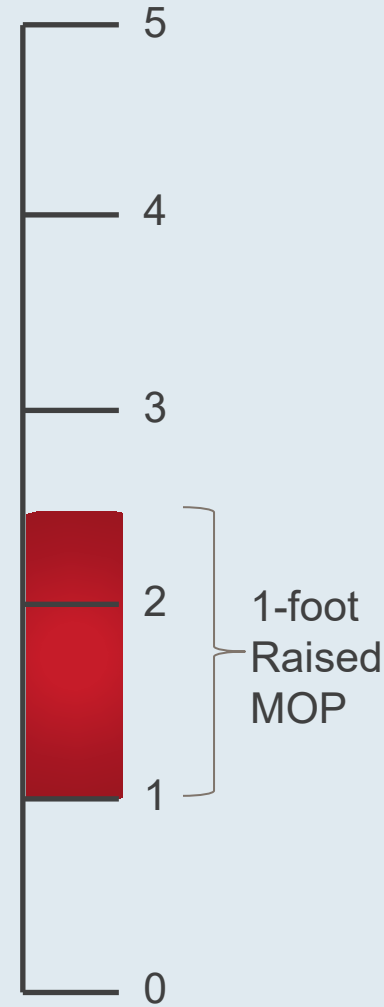


2020 BiOp MOP (3 APR – 14 AUG)

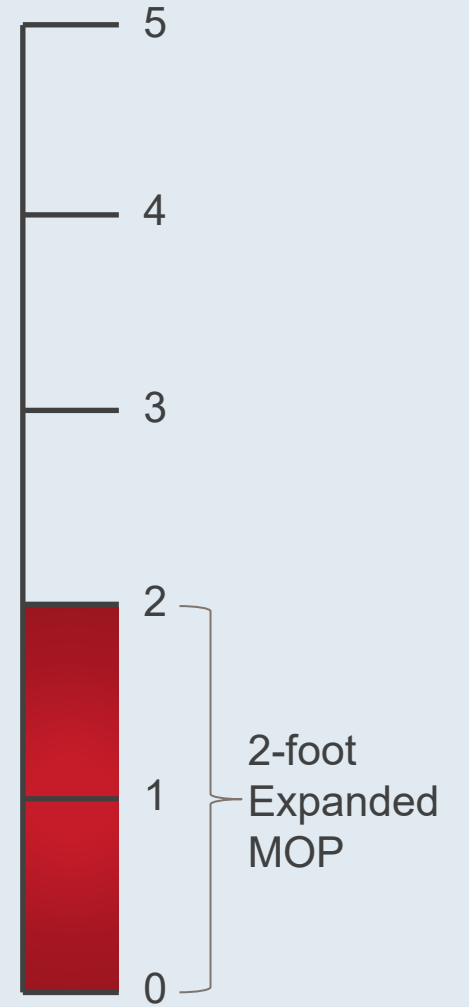


MOP In-Season Adjustments

Raised MOP



Expanded MOP

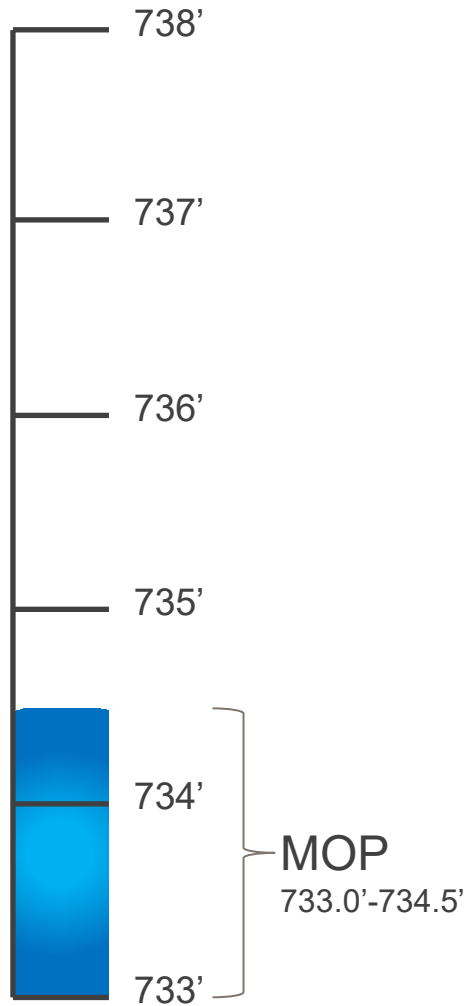




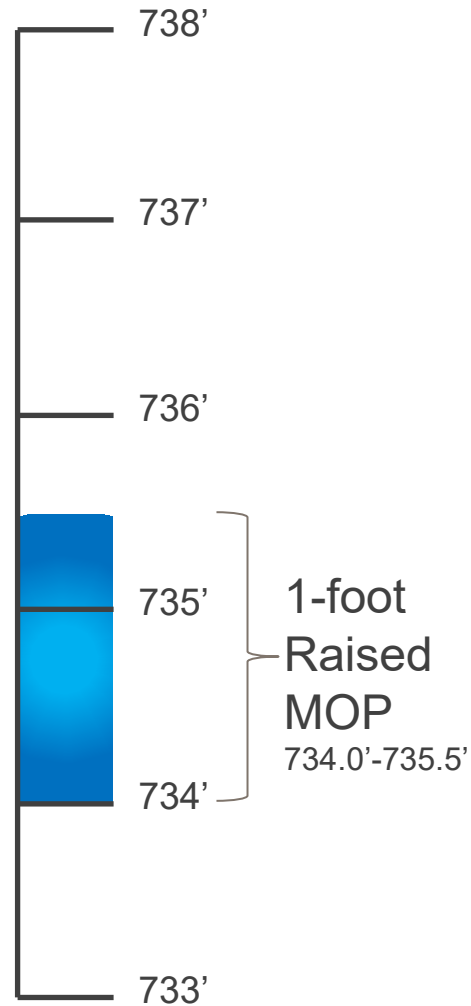
2021 LOWER GRANITE VARIABLE MOP (3 APR – 14 AUG)



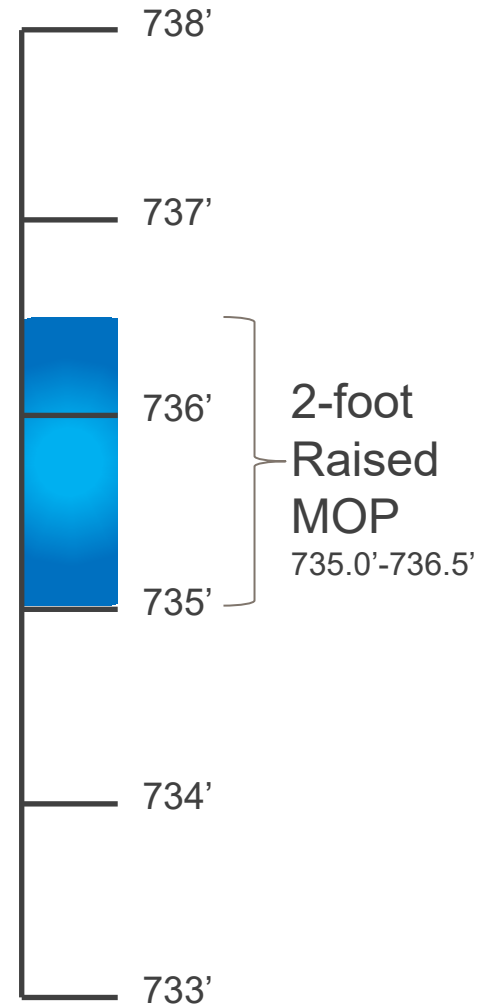
Q ≥ 120 kcfs



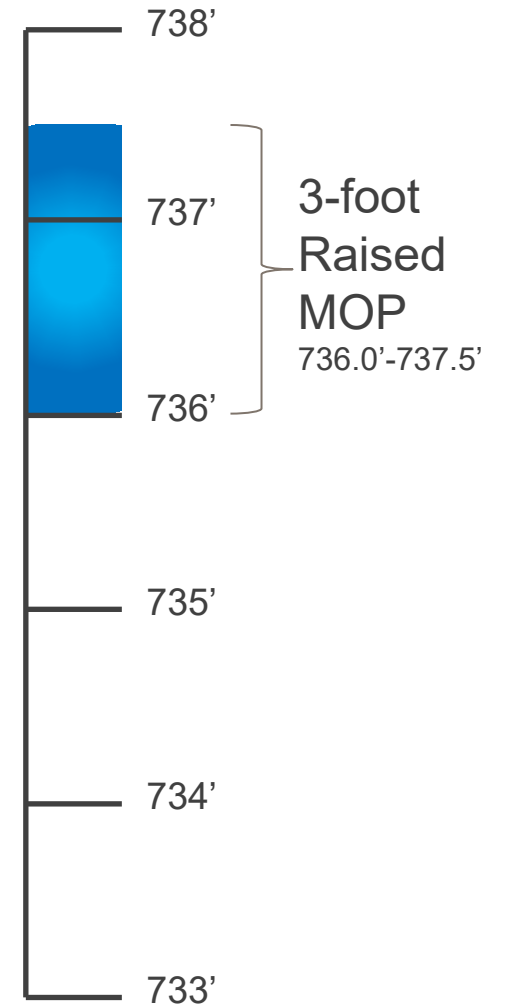
Q = 80-119 kcfs



Q = 50-79 kcfs

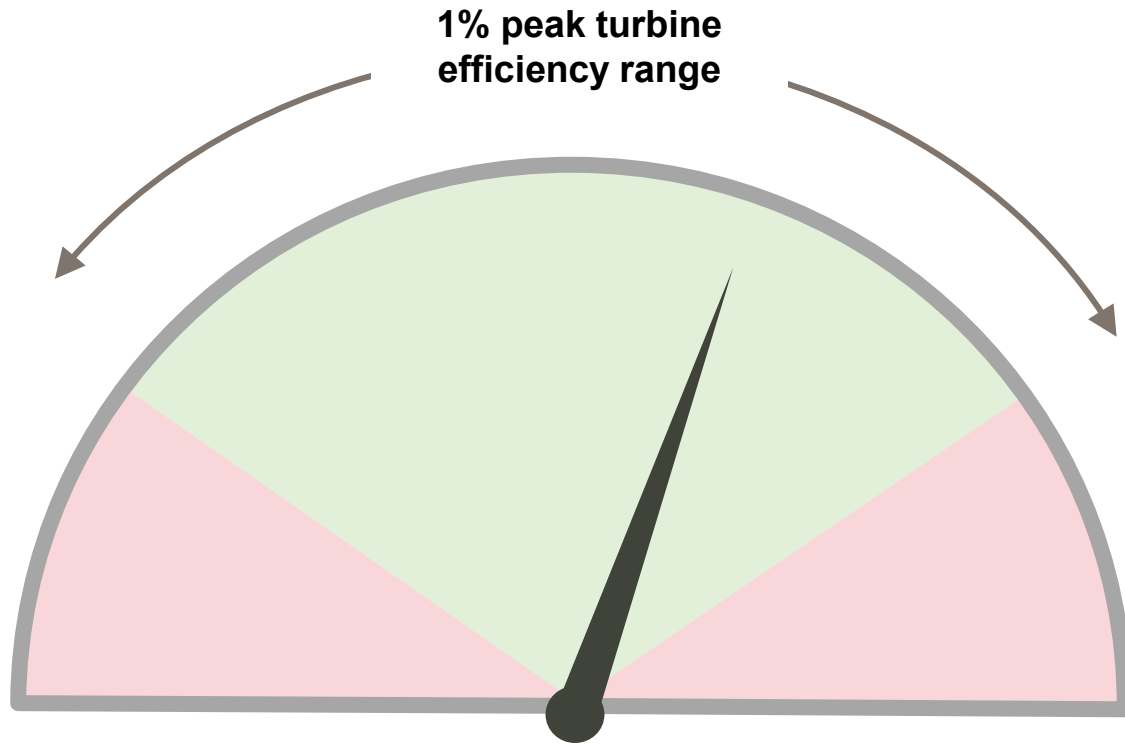


Q < 50 kcfs





OPERATING TURBINES ABOVE 1%



- At fish passage projects, turbines are generally operated within 1% of peak efficiency, which is also good for fish that pass through a turbine
- Turbines can generate more MW if they operate above 1%
- 2020 ROD allows turbines to operate above 1% in certain conditions:
 - Contingency Reserves
 - TDG Management
 - Balancing Reserves
- Operating above 1% should occur infrequently, Corps tracks occurrences & sends to NOAA yearly