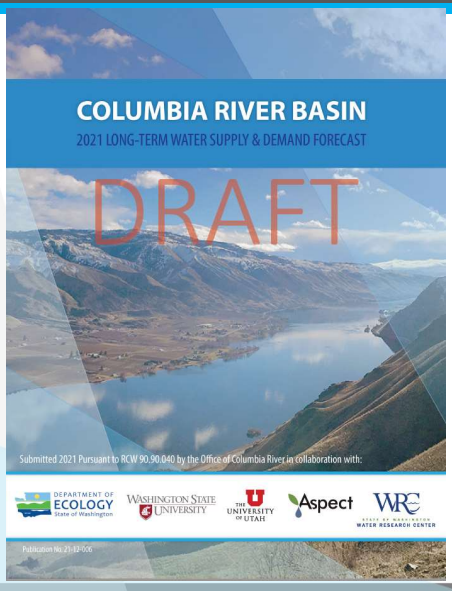
COLUMBIA RIVER BASIN
2021 LONG-TERM WATER SUPPLY & DEMAND FORECAST

Melissa Downes
Office of Columbia River
Washington State Department of Ecology

Jennifer Adam
Berry Distinguished Professor, Civil and Environmental Engineering, Washington State University

Background



- Every 5 years, the Washington State Department of Ecology's Office of the Columbia River (OCR) is required to submit a long-term (20-year) water supply and demand forecast to the State Legislature
- Washington State University (WSU) was assigned to develop the forecast for water supply and out-of-stream demand
- The forecast helps improve understanding of where additional water supply is most critically needed, now and in the future

Team Members

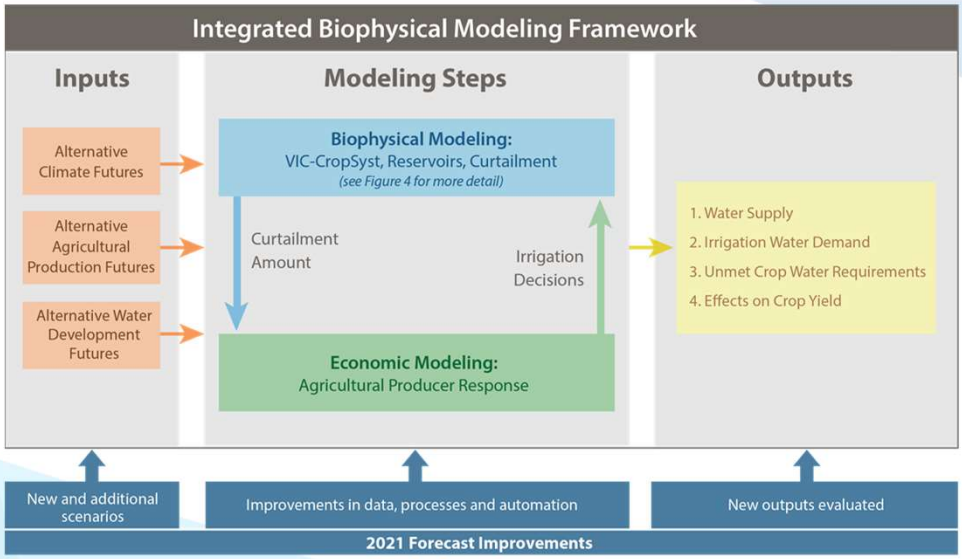
- **Washington State University: Jenny Adam, Collins Asante-Sasu, Michael Brady, Rojina Desar, Sonia Hall, Hannah Goodspeed, Becca Gustine, Chad Kruger, Mingliang Liu, Julie Padowski, Kirti Rajagopalan, Ashish Kondal, Sasha McLarty, Fabio Scarpare, Claudio Stockle, Aaron Whittemore, Jon Yoder, Georgine Yorgey, Matt Yourek**
- **Aspect Consulting: Dan Haller, Seann McClure, Jon Turk, Wendy Valdez**
- **University of Utah: Michael Barber, Ry Weber**
- **Washington Ecology: Michael Callahan, Melissa Downes, Tyler Roberts, Jennifer Stephens, Scott Tarbutton, Tom Tebb**

Forecast Components

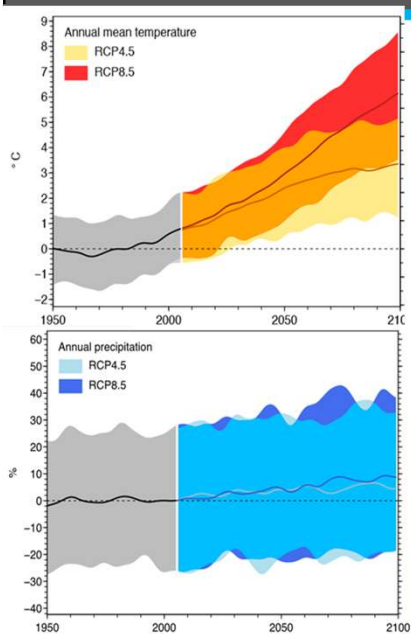
			Methods	Geographic Scopes
SUPPLIES	Surface water		Integrated modeling of historical (1986-2015) and multiple future scenarios (2026-2055). Climate change impacts also modeled through 2070.	Columbia River Basin (including focus on eastern Washington) Washington's Watersheds Columbia River Mainstem
	Groundwater		Trends analysis using existing well depth data	Washington's Aquifers
DEMANDS	Out of Stream	Agricultural	Integrated modeling of historical (1986-2015) and multiple future scenarios (2026-2055). Climate change impacts also modeled through 2070.	Columbia River Basin (including focus on eastern Washington) Washington's Watersheds
		Residential	Data-based estimates of per capita use and population growth projections	Eastern Washington Washington's Watersheds
	Instream	Flows for Fish	Independent simulation modeling study (Mauger 2019)	Washington's Watersheds
			Compared integrated modeling results to flow regulations	Columbia River Mainstem
		Hydropower	Review existing data and information from power entities	Columbia River Basin

COLUMBIA RIVER BASIN 2021 LONG-TERM WATER SUPPLY & DEMAND FORECAST

Overview of Integrated Modeling: Biophysical and Economic Models



Future Climate Scenarios



Temperature

- Annual temperature increase
- Summer increases are greater than other seasons

Precipitation

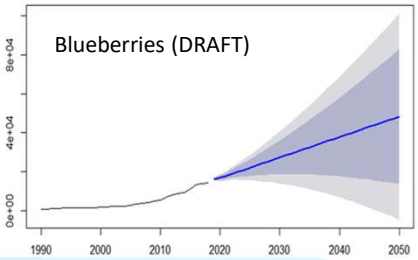
- Annual precipitation: highly uncertain, but possibly a slight increase
- Summer precipitation decreases; other seasons increase

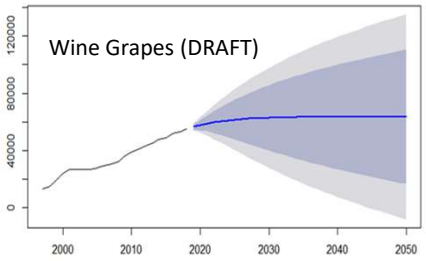
17 (previously 5) scenarios for each greenhouse gas increase

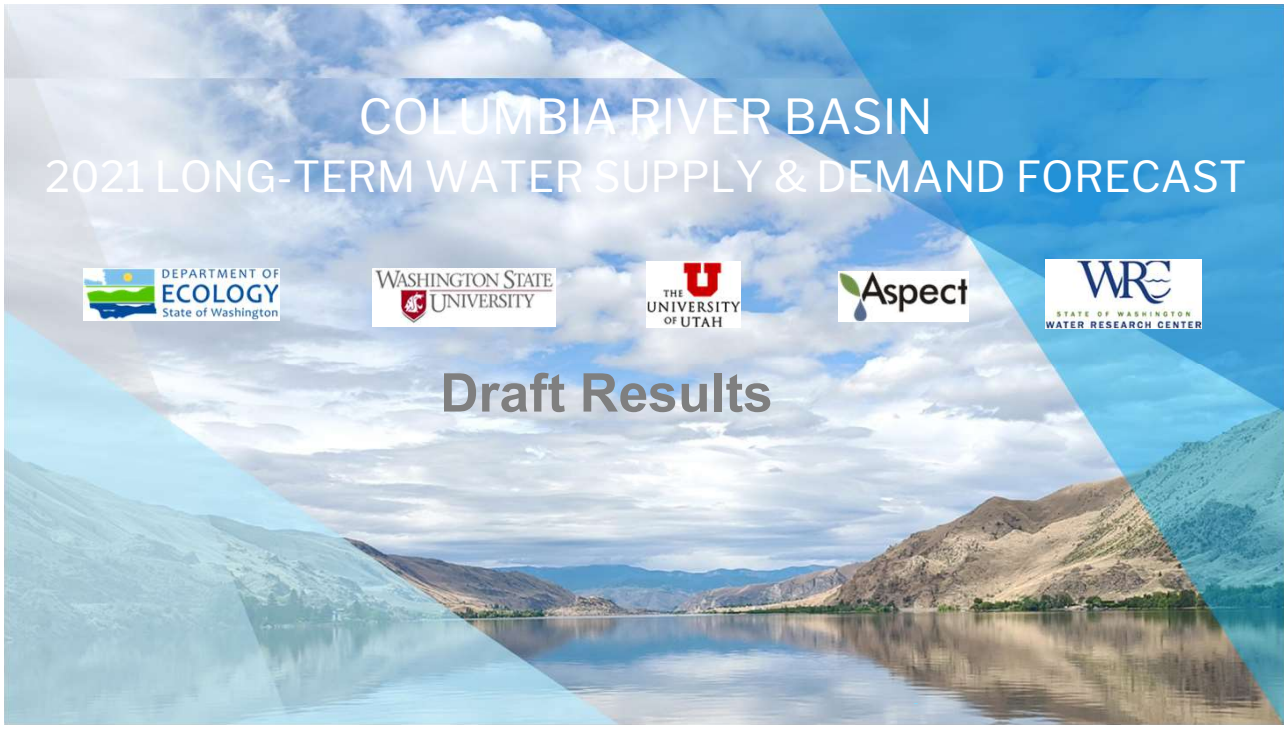
Full set of scenarios due to increased compute power; this helps in capturing future low and high flows

Future Crop Mix

- Estimate statistical models that identify relationships between crop mix and crop prices, and interactions between crop types. When one crop increases acreage, which crops lose acreage?
- Different statistical modeling approaches for two different groups of crops.
  - Crops that account for a lot of acreage: hay, grains, tree fruit.
  - Crops that are smaller in acreage but economically important: blueberries, wine grapes, hops.

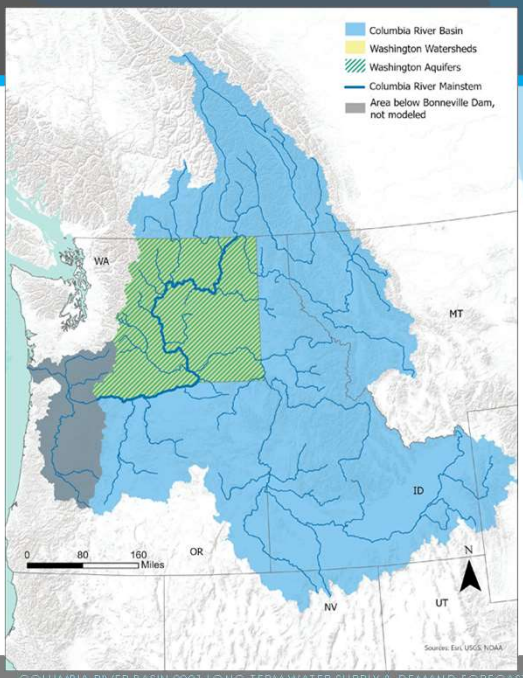






Spatial Layers

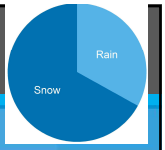
- Columbia River Basin
- WA Watersheds
- Columbia Mainstem
- Aquifer Subareas



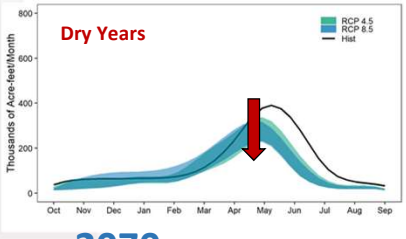
Water Supply: Washington Portion of Columbia River Basin

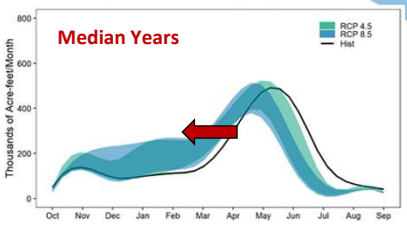
Changes Between Years			
	Historical (million ac-ft)	2040 Forecast (million ac-ft)	% change by 2040
Low supply year (20th percentile)	11.1	10.9 (± 0.25)	-1.2% (± 2.3%)
Median year (50th percentile)	15.7	15.8 (± 0.34)	0.5% (± 2.2%)
High supply year (80th percentile)	23.0	**23.5 (± 0.46)**	**2.3% (± 2.0%)**
Shifts Within A Year			
	Historical (million ac-ft)	2040 Forecast (million ac-ft)	% change by 2040
Wet Season (November - May)	11.1	**12.6 (± 0.28)**	**14.2% (± 2.5%)**
Dry Season (June - October)	4.6	**3.1 (± 0.14)**	**-32.2% (± 3.1%)**

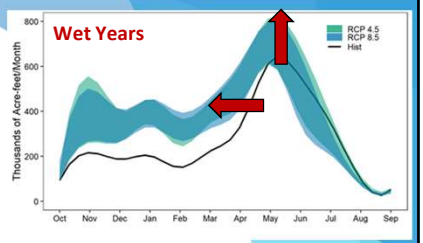
WRIA 45 – Wenatchee: Water Supply



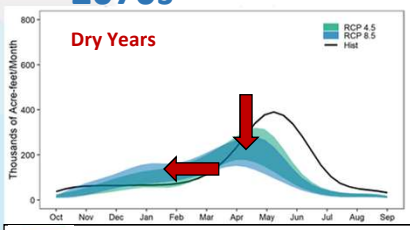
2040s

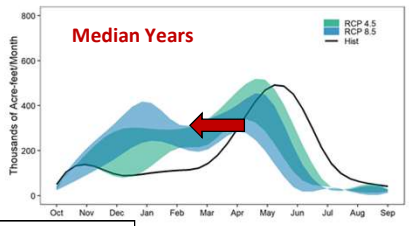


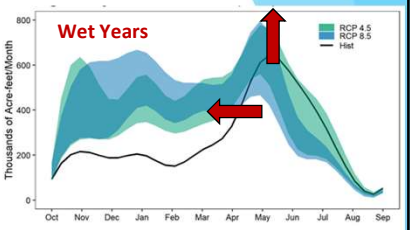




2070s

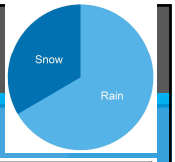




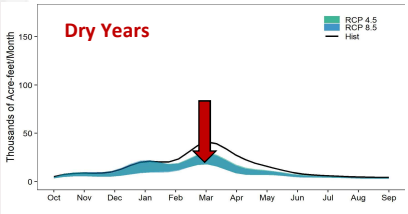


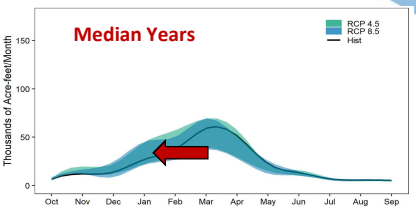
Future: High Greenhouse Gas Concentrations
Future: Low Greenhouse Gas Concentrations
Historical

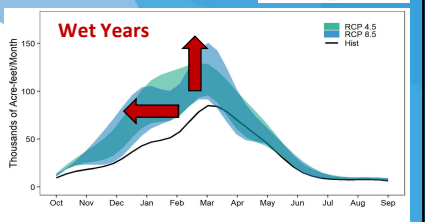
WRIA 32 – Walla Walla: Water Supply



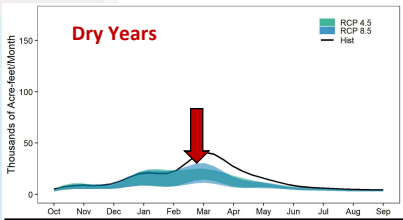
2040s

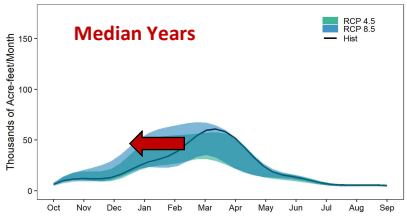


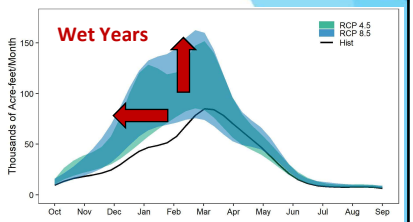




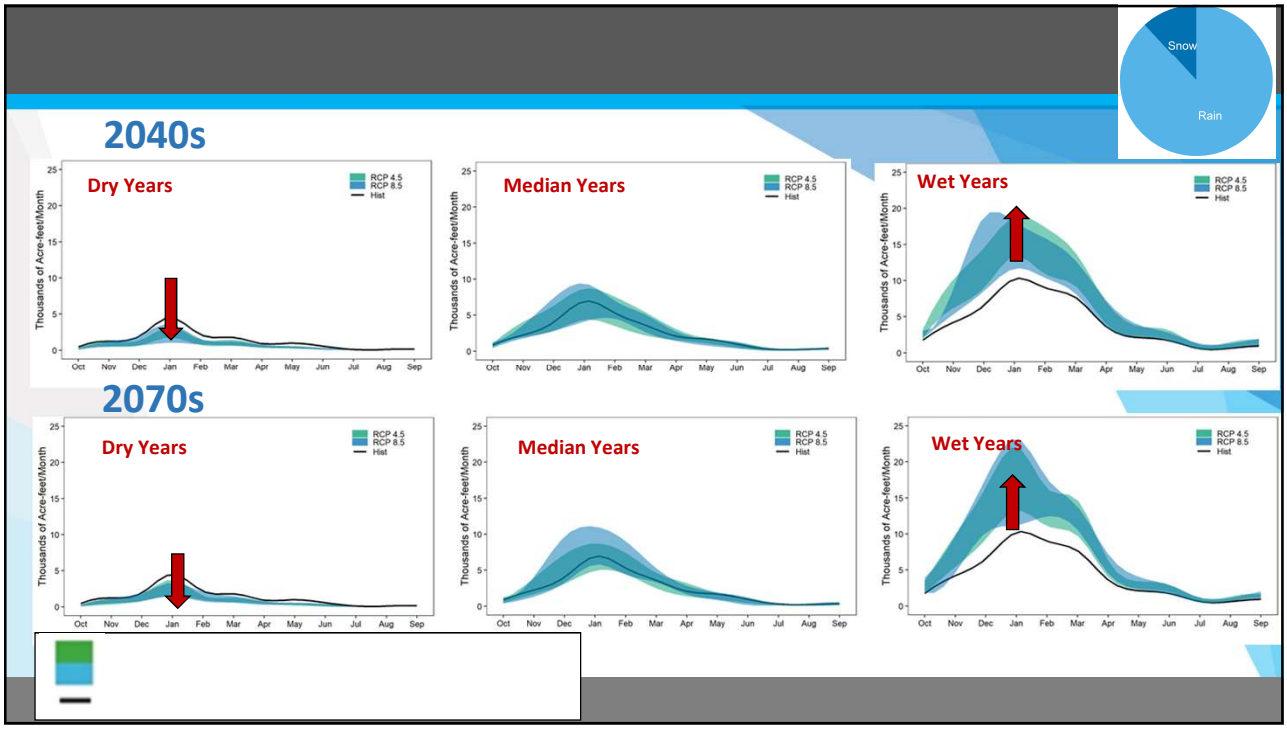
2070s



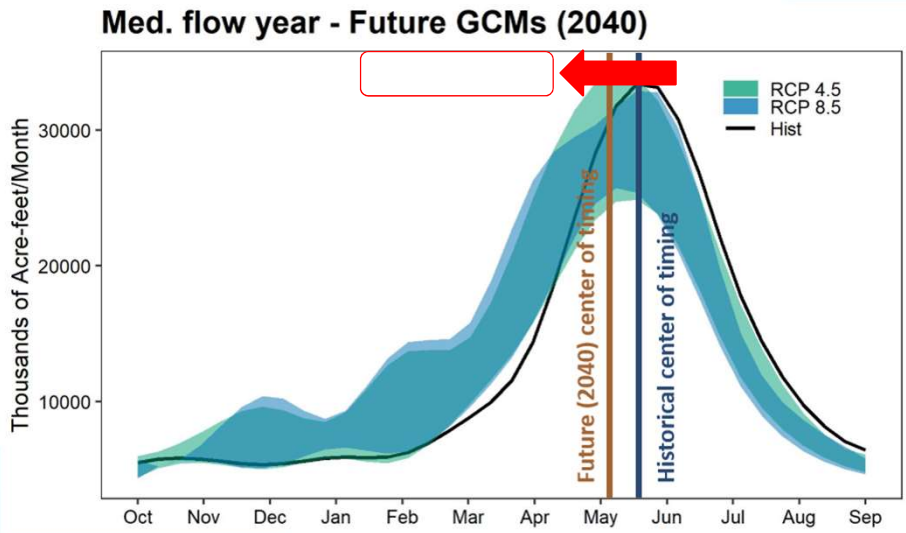




Future: High Greenhouse Gas Concentrations
Future: Low Greenhouse Gas Concentrations
Historical

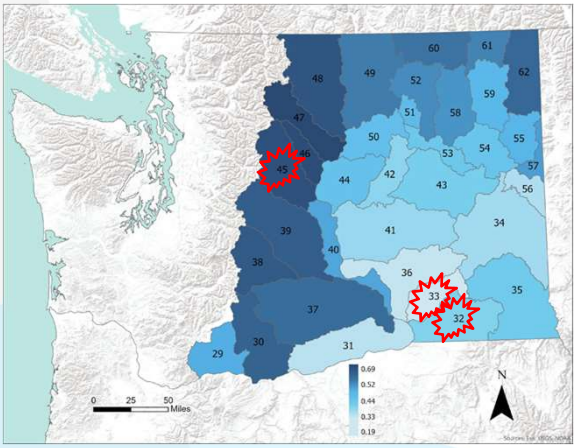


Change in Center of Timing: Example for Bonneville

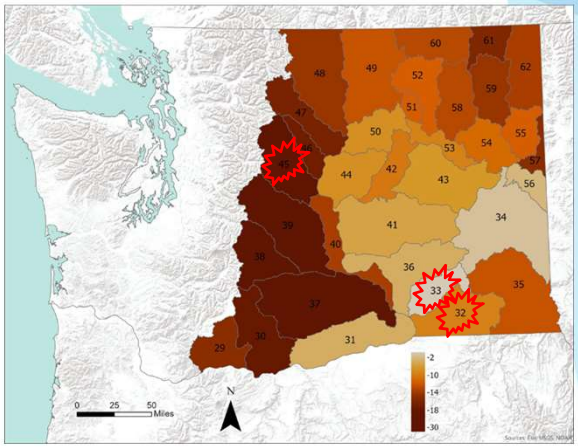


Vulnerability due to Snowmelt Changes (Shift to the Left)

Historical Snowmelt Fraction (% runoff derived from snowmelt)

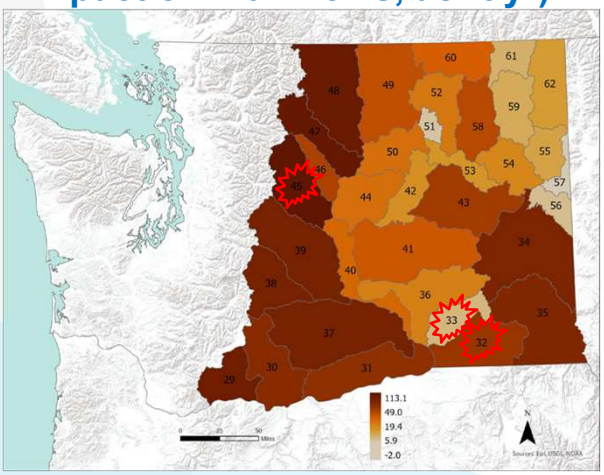


Change of timing of snowmelt peak (# days)

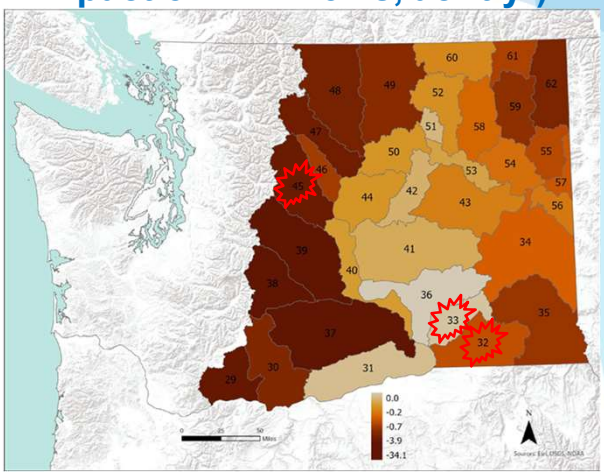


High and Low Flow Vulnerability by WRIA

High Flow Vulnerability (climate impact on max flows, ac-ft/yr)



Low Flow Vulnerability (climate impact on min flows, ac-ft/yr)



Irrigation Demand: Effects of Climate (Low, Medium, High)

Washington Portion of Columbia River Basin	Historical (million ac-ft)	% change by 2040	% change by 2070
Low demand year (20th percentile)	2.45	-1.3% (± 1.1%)	-3.8% (± 1.3%)
Median demand year (50th percentile)	3.01	-2.2% (± 0.6%)	-5.5% (± 0.9%)
High demand year (80th percentile)	3.56	-3.0% (± 0.7%)	-6.8% (± 0.9%)

Irrigation Demand: Effects of Management (Changes by Season)

Washington Portion of Columbia River Basin	Historical (million ac-ft)	Future (2040) Climate, Historical Planting Date, Historical Crop Mix	Future (2040) Climate, Future Planting Date, Historical Crop Mix	Future (2040) Climate, Future Planting Date, Future Crop Mix
Median year (50th percentile)	3.01	-2.2% (± 0.6%)	-3.1% (± 0.6%)	-2.1% (± 0.6%)
Early Season (March -- June)	1.27	8.3% (± 1.7%)	10.2% (± 1.7%)	10.8% (± 1.7%)
Late Season (July -- October)	1.74	-9.9% (± 1.2%)	-12.8% (± 1.1%)	-11.5% (± 1.2%)

Causes of Projected Changes in Irrigation Demand

Factors contributing to a decrease

- Springs getting wetter (small role)
- Higher water-use efficiencies due to increases in CO_2
- Shifting of irrigation requirements earlier in the season due to
  - Faster/greater canopy development early in the season
  - Shorter irrigation season for most crops
  - Earlier planting

Factors contributing to an increase

- Increased potential evapotranspiration
- Crop mix: shift towards less water-use efficient crops
- *Expanded irrigated acreage (**250,000 acre-ft/yr projected**)
- *Double cropping: **3%-6%** of irrigated lands are currently double-cropped, but insignificant impact in future

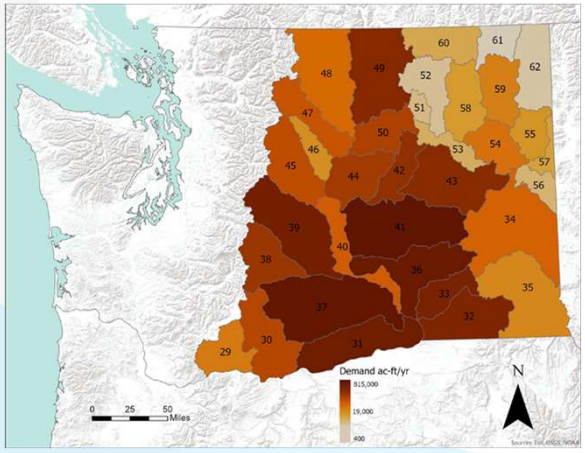
*not included in demand tables just shown

Total Out-of-Stream Water Demand

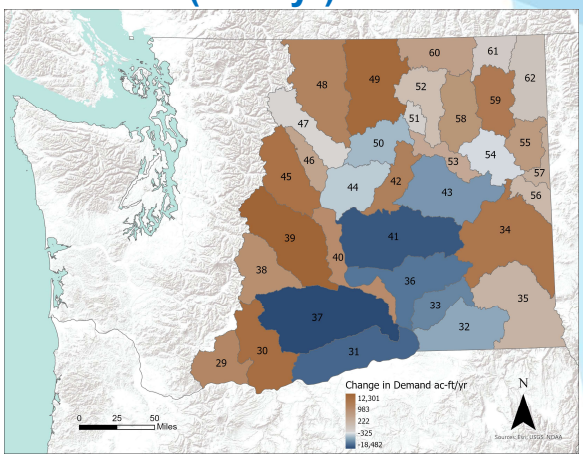
Washington Portion of the Columbia River Basin	Historical (million ac-ft)	% change by 2040
Median agricultural demand (50th percentile)	3.0	-2.2% (± 0.6%)
Residential water demand	0.2	24%
Median agricultural demand + planned water supply projects	3.0	+6.0% (± 0.6%)
Median agricultural demand + planned water supply projects + residential water demand	3.2	+6.9% (± 0.6%)

Irrigation Demand by WRIA

Historical Irrigation Demand (ac-ft/yr)

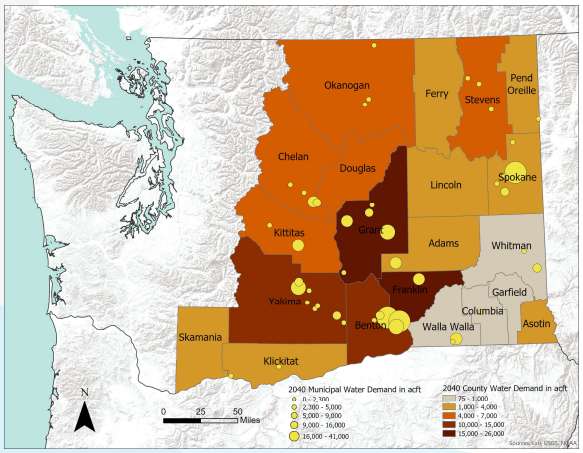


2040s Change in Irrigation Demand (ac-ft/yr)

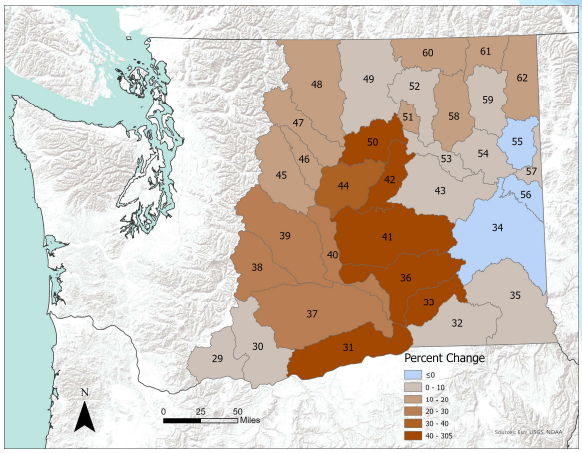


Residential Demand by WRIA

2040s Residential Demand (ac-ft/yr)

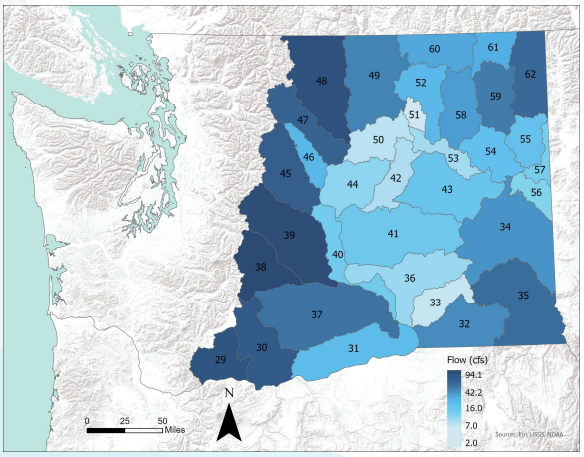


2040s Change in Summer Residential Demand (ac-ft/yr)

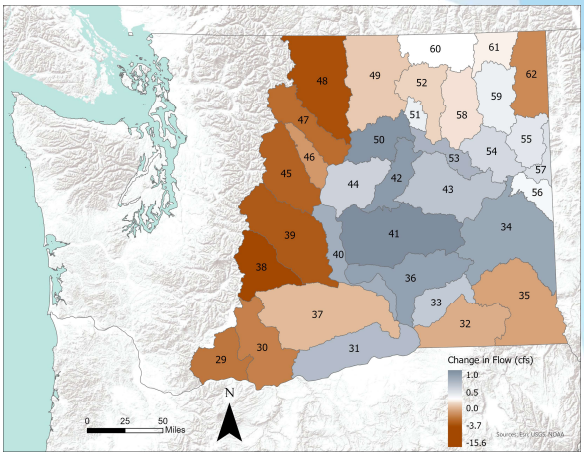


Fish-Relevant Metrics*: Lowest seven-day average flow in ten years (7Q10)

Historical (cfs)



2040s Change (cfs)



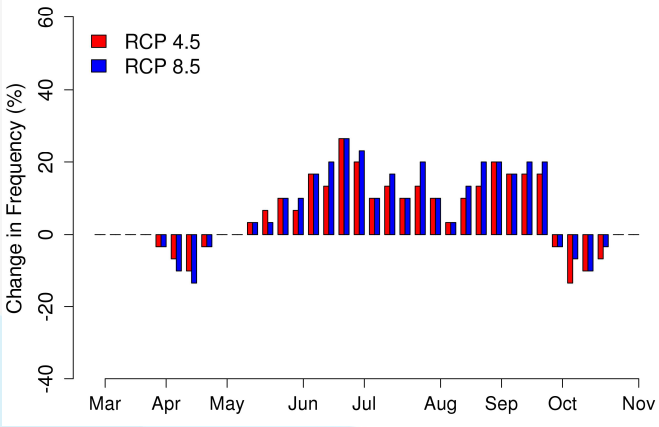
*in partnership with Guillaume Mauger, UW Climate Impacts Group

Scenarios for Hydropower Generation Demand

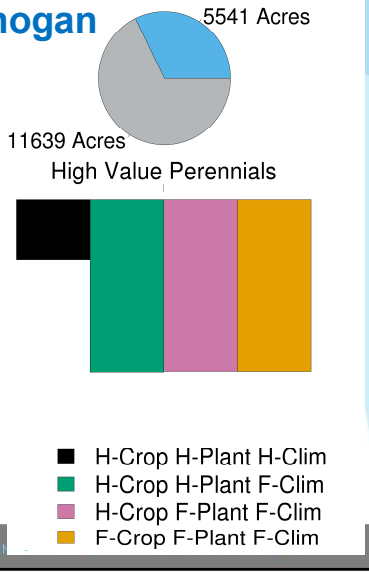
		Generation Demand (KWh)			Percent Change	
		2019	2040 - Low	2040 - High	2040 - Low	2040 - High
Scenario 1 Population Growth	Total electricity demand	106,463,608	117,410,322	137,592,463	10	29
	Hydroelectric	66,026,861	69,175,073	75,468,376	5	14
Scenario 2 Population Growth + Electric Vehicles	Total electricity demand	106,463,608	118,697,840	140,746,676	11	32
	Hydroelectric	66,026,861	72,329,286	76,755,894	10	16
Scenario 3 Population Growth + Electric Vehicles + Data Centers	Total electricity demand	106,463,608	130,523,840	156,514,676	23	47
	Hydroelectric	66,026,861	88,097,286	88,581,894	33	34

Water Rights Interruption

Methow



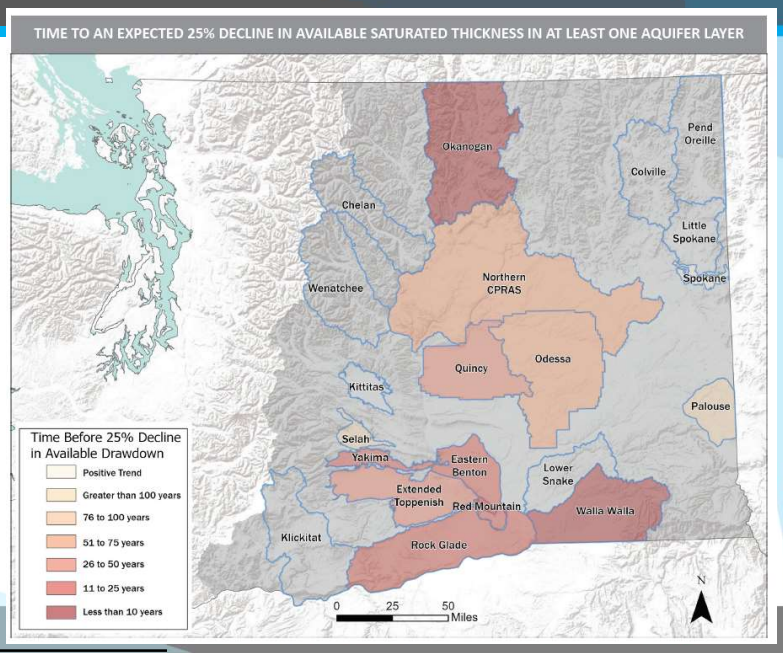
Okanogan



COLUMBIA RIVER BASIN 2021 LOW

Groundwater Module

- Trend analysis on existing monitoring wells (ECY, DNR, USGS, WWBWC)
- Separate trends by aquifer layers
- Interpolate trends within subareas
- Predict future vulnerabilities
- Pilot monitoring



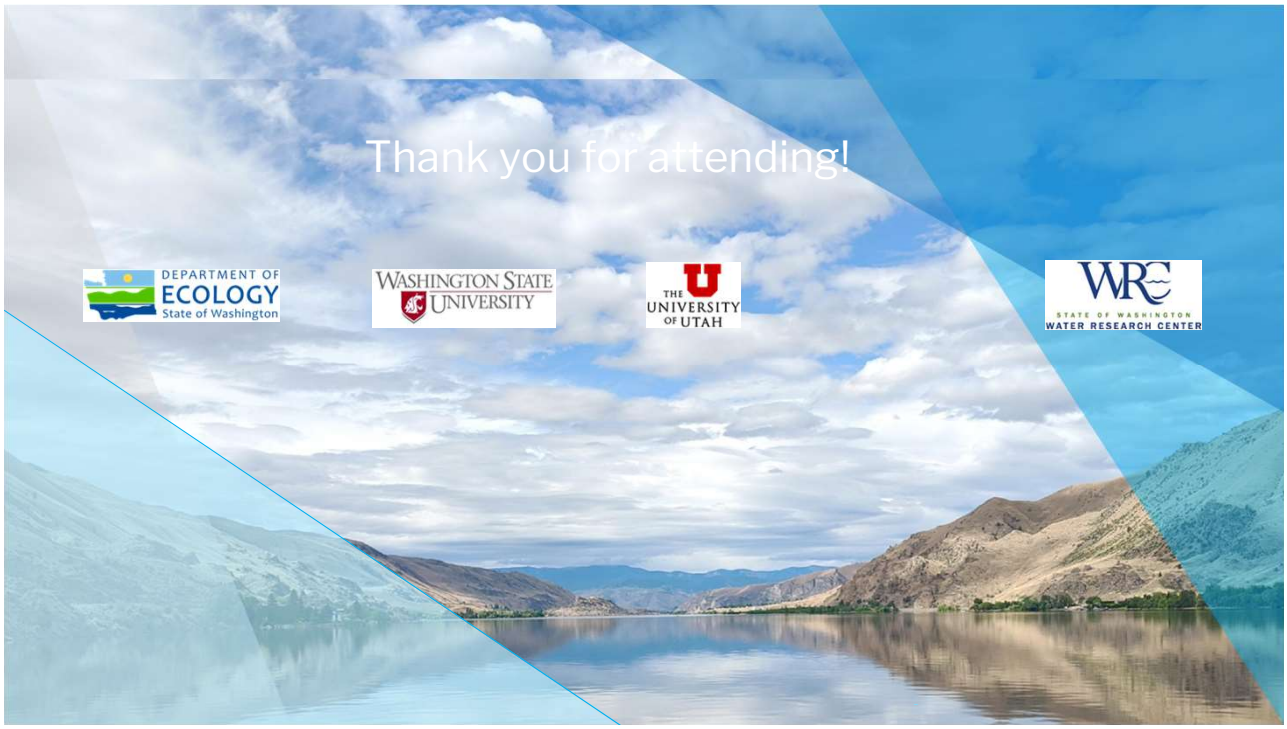
Key Takeaways

- The timing of surface water supplies is shifting, especially in the snowmelt-dominated Cascades watersheds.
- Groundwater levels generally are declining in all aquifer layers across most of eastern Washington.
- Locally increasing agricultural and residential water demands are combining with lower water supplies at critical times, leading to increasing frequency of instream flow deficits and resulting curtailments.

Reports & Communication

- Public Meetings
  - June 8 (2:30-5:30pm) and June 17 (8:30-11:30am)
- Public Comment Period
  - June 2 through July 2
- Deliverables
  - legislative report
  - technical report
  - 2-page high-level summary
  - (new) web interface for data

Report Available at: https://ecology.wa.gov/2021Forecast


Thank you for attending!
DEPARTMENT OF ECOLOGY State of Washington
WASHINGTON STATE UNIVERSITY
THE UNIVERSITY OF UTAH
WRC
STATE OF WASHINGTON WATER RESEARCH CENTER