Water Resources Research

Supporting Information for

Where and When Does Streamflow Regulation Significantly Affect Climate Change Outcomes in the Columbia River Basin?

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Text S1. High Flow Frequency Methods

The Log Pearson Type III (LP3) distribution with the Expected Moments Algorithm (Stedinger and Griffis, 2008) method was used to fit distribution curves to maximum time series. Distributions were computed using PeakfqSA (England and Cohn, 2019), a stand-alone version of the Unites States Geological Survey (USGS) Peakfq flood frequency software (Veilleux, et al. 2014). PeakfqSA configuration file options were set to use the station (at-site) skew, the Multiple Grubbs Beck test (Cohn et al., 2013) to detect and adjust for low outliers, and the plotting position

$$p_{i:n} = \frac{i-\alpha}{n+1-2\alpha} \tag{1}$$

where $\alpha = 0.4$ and n is the sample size of the data.

Text S2. Low Flow Frequency Methods

The LP3 distribution with the method of moments was used to describe annual July-October 7-day average minimums. Calculation of the distribution and confidence intervals followed methods presented by Chowdhury and Stedinger (1991) and Stedinger et al. (1993). If X_p is the p^{th} quantile of the LP3 distribution, then

$$X_p = 10^{(\mu_y - K_p\sigma_y)}, \tag{2}$$

where μ_y and σ_y are the mean and standard deviation of the log-transformed sample y, respectively. K_p is approximated by the Wilson-Hilferty transformation.

$$K_p \approx \frac{2}{\gamma_m}\left(1 + \frac{\gamma_y z_p}{6} - \frac{\gamma_y^2}{36}\right)^3 - \frac{2}{\gamma}, \tag{3}$$

where γ_y is the skew of the log-transformed sample and z_p is the p^{th} quantile of the standard normal distribution.

For each LP3 fit, we calculated the 90% confidence bounds CI_{90},

$$CI_{90} = X_p \pm \eta\left(\zeta_{\alpha,p} - z_p\right)\sigma, \tag{4}$$

where σ is the standard deviation of the sample, and z_p is the p^{th} quantile of the standard normal distribution. $\zeta_{0.5,p}$ is the 5th percentile of the noncentral t-distribution.

$$\zeta_{0.5,p} \approx \frac{z_p + z_{0.5}\sqrt{\frac{1}{n} + \frac{z_p^2}{2(n-1)} - \frac{z_{0.5}^2}{2n(n-1)}}}{1 - \frac{z_{0.5}^2}{2(n-1)}}, \tag{5}$$

where n is the sample size of the data and $z_{0.5}$ is the 5th quantile of the standard normal distribution. z values were determined using the Python's `scipy.stats.norm.ppf` module. η is a scaling factor to extend confidence intervals for normal quantiles to the LP3 distribution.

$$\eta \cong \sqrt{\frac{1 + \gamma K_p + \frac{1}{2}\left(1 + \frac{3}{4}\gamma^2\right)K_p^2}{1 + \frac{1}{2}z_p^2}}. \tag{6}$$

Time series of low flows may exhibit autocorrelation due to groundwater dependence. Autocorrelation violates the assumption that our data are independent and, therefore, our goodness of fit. We tested for autocorrelation using Pearson's lag-1 correlation coefficient

$$r = \frac{\sum_{i=1}^{n-1}(x_i - \bar{x})(x_{i+1} - \bar{x})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}, \tag{7}$$

where n is the sample size. The sample was considered autocorrelated if $r > 0.3$. r was calculated using Python's `scipy.stats.pearsonr` module. If autocorrelation was detected, we used the effective sample size (Dingman, 2015) to calculate confidence intervals by replacing n in equation (6) with

$$n_{eff} = n\left(\frac{1-r}{1+r}\right). \tag{8}$$

Samples with zero-flows required truncation before log-transformation. We fit the LP3 curve to truncated samples and adjusted the probabilities to account for zero-flows using methods described by Salas et al. (2019). The probability q that a given 7 day-minimum X is less than or equal to x_q is

$$P\left(X \leq x_q\right) = F\left(x_q\right) = q. \tag{9}$$

If a truncated sample has some number n_o of zero values, an estimator of the probability of zero flow is

$$\hat{q}_0 = P(X = 0) = \frac{n_o}{n} \tag{10}$$

which can be used to adjust the probability q,

$$q_T = \frac{q - \hat{q}_0}{1 - \hat{q}_0}. \tag{11}$$

If after truncation and probability adjustments, the distribution did not contain the probability of interest (in our case, the 0.1 percentile corresponding to a 10-year return period), we fit the low flow frequency curve non-parametrically. Non-parametric confidence intervals were computed using the binomial distribution as described by Helsel et al. (2020). We also used non-parametric methods to fit the distribution if more than 10% of the sample fell outside of the LP3 confidence bounds.

Text S3. Log Pearson Type III Goodness of Fit Tests

The Kolmogorov-Smirnov (KS) and probability plot correlation coefficient (PPCC) goodness of fit tests (Stedinger et al., 1993) were performed to test the suitability of the LP3 analytical curves for fitting the unregulated and regulated high and low flow extreme time series. The KS tests evaluates whether the analytical estimates are drawn from the same population distribution as the empirical sample at the 90% confidence level by measuring the maximum difference between the analytical and empirical cumulative frequency curves. If the maximum difference is less than the KS test statistic D (equation (12)) then we accept the null hypothesis that the two samples come from the same population distribution at the 90% confidence level. The test statistic D is calculated as

$$D = 1.358\sqrt{\frac{n+m}{nm}} \tag{12}$$

where n is the sample size of the empirical sample and m is the sample size of the analytical sample. In our case, n is 30 and m is 41. We accept the null hypothesis if the maximum difference is less than the KS test statistic D value of 0.326.

The PPCC measures the linearity of the probability plot. If the empirical sample is drawn from the analytical distribution, the probability plot of ordered empirical data x_i versus the corresponding estimated probability w_i should appear linear and the correlation coefficient r (equation (13)) should be near 1.

$$r = \frac{\sum(x_i - \bar{x})(w_i - \bar{w})}{[\sum(x_i - \bar{x})^2 \sum(w_i - \bar{w})^2]^{0.5}} \tag{13}$$

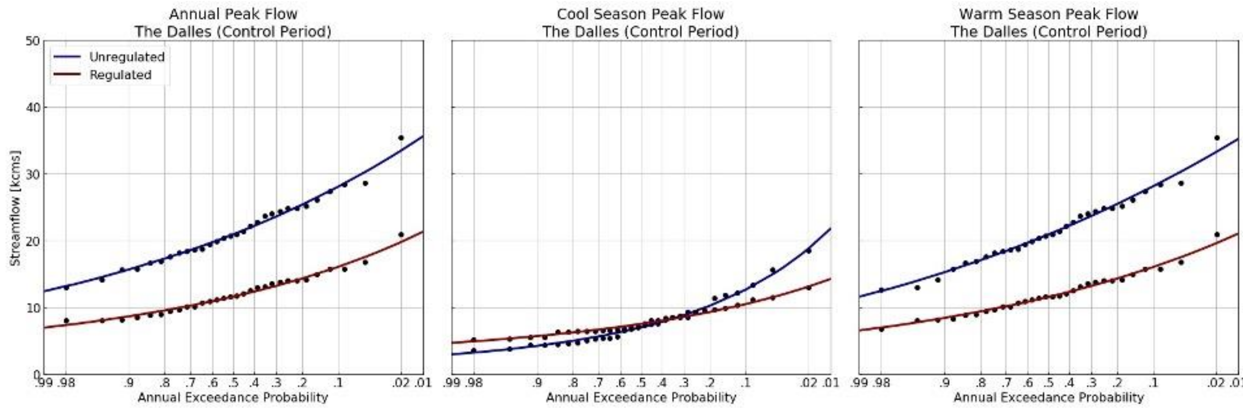

Figure S1. LP3 analytical fits for annual, cool season (October-March), and warm season (April-September) peak flows at The Dalles for a single ensemble member for the control period (1976-2005). Unregulated curves are shown in blue. Regulated curves are shown in red.

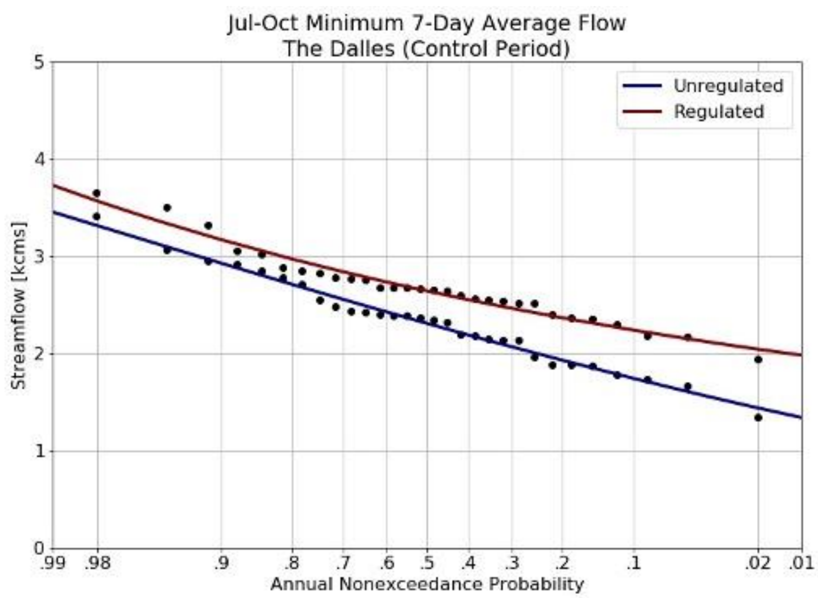

Figure S2. LP3 analytical fits annual minimum July-October 7-day average flows at The Dalles (TDA) for a single ensemble member for the control period (1976-2005). Unregulated curves are shown in blue. Regulated curves are shown in red.

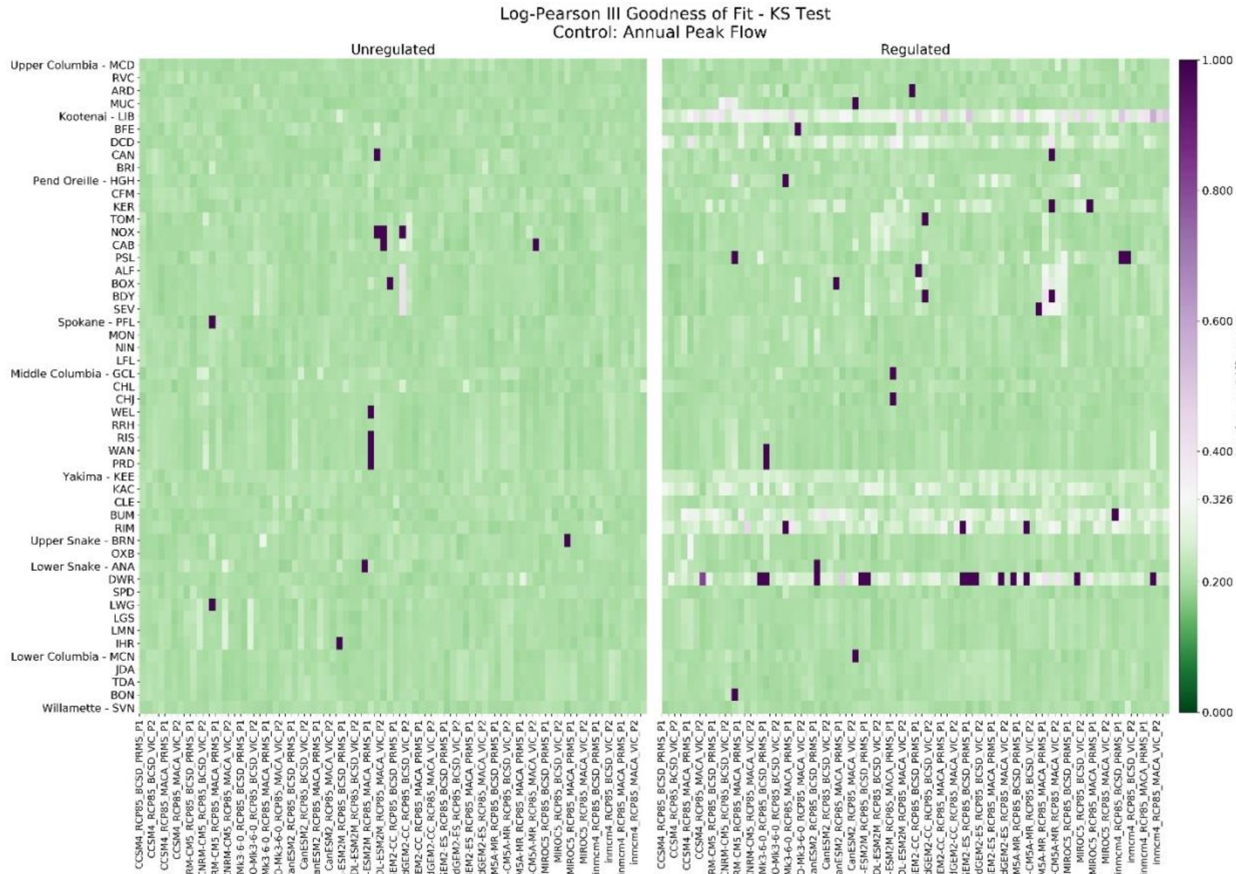

Figure S3. KS LP3 goodness of fit test results for control period annual peak flows for each ensemble member and each site included in the daily analysis. Test results are shown for unregulated analytical estimates (left) and regulated analytical estimates (right) and all 80 ensemble members (x-axis); however, only every other ensemble member is labelled. We accept the null hypothesis that the empirical and analytical populations are drawn from the same distributions if the maximum difference is less than the KS test statistic 0.326.

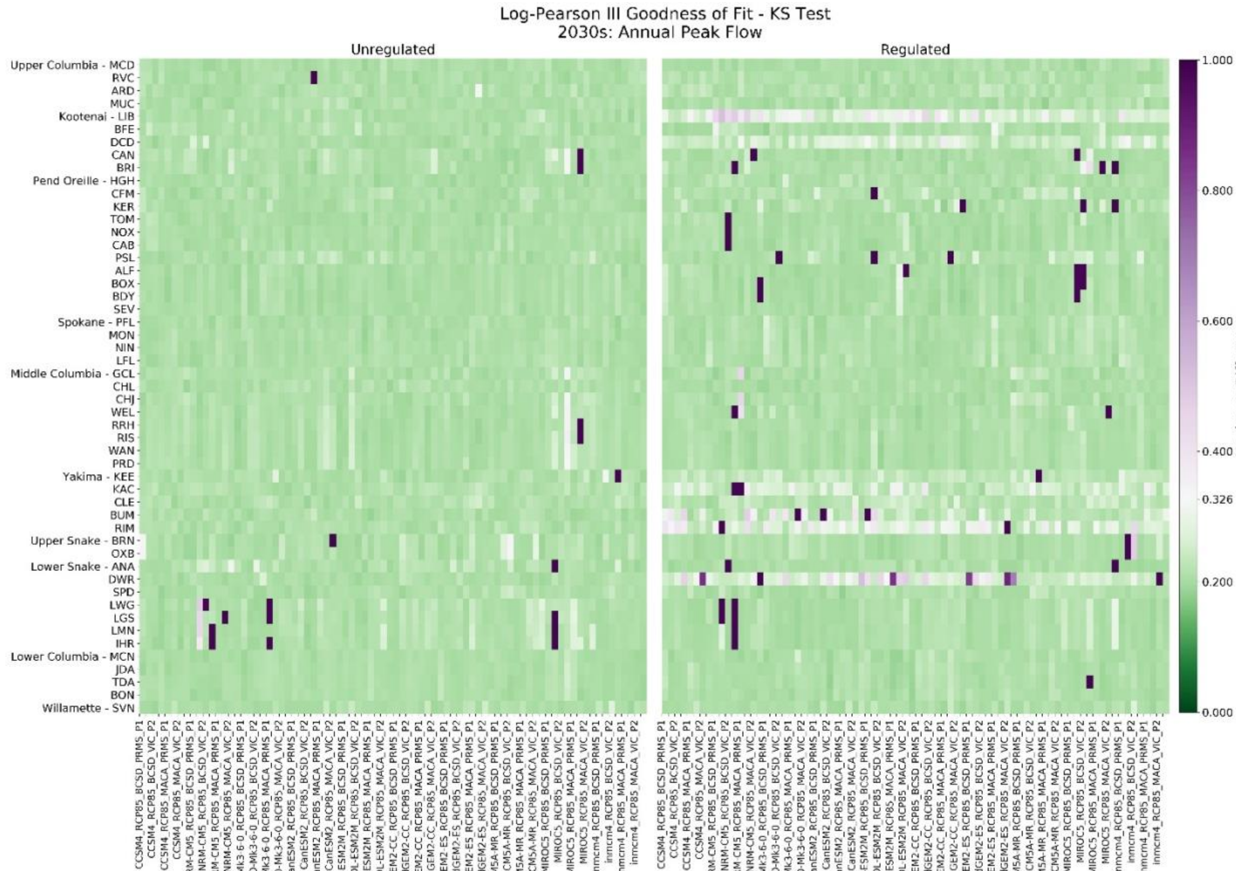

Figure S4. KS LP3 goodness of fit test results for 2030s annual peak flows for each ensemble member and each site included in the daily analysis. Test results are shown for unregulated analytical estimates (left) and regulated analytical estimates (right) and all 80 ensemble members (x-axis); however, only every other ensemble member is labelled. We accept the null hypothesis that the empirical and analytical populations are drawn from the same distributions if the maximum difference is less than the KS test statistic 0.326.

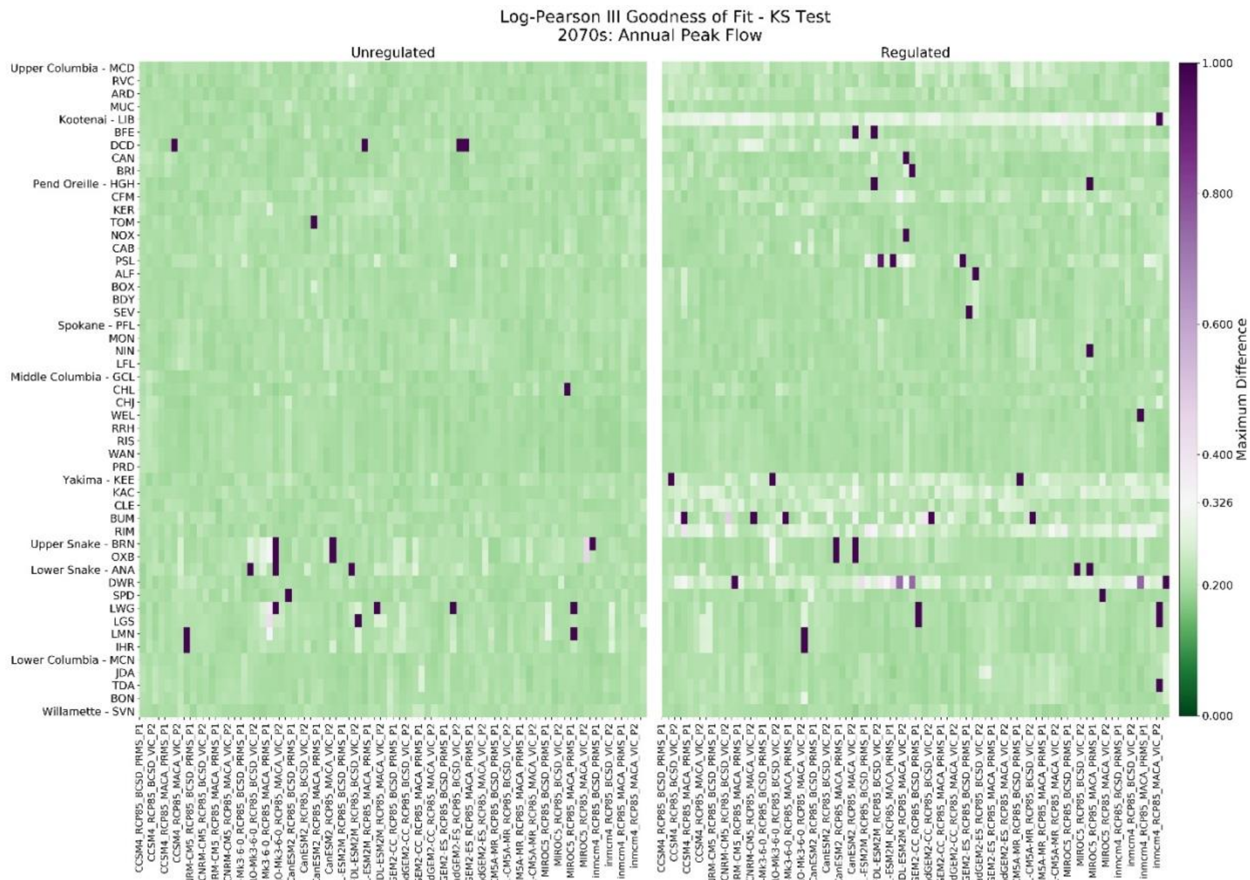

Figure S5. KS LP3 goodness of fit test results for 2070s annual peak flows for each ensemble member and each site included in the daily analysis. Test results are shown for unregulated analytical estimates (left) and regulated analytical estimates (right) and all 80 ensemble members (x-axis); however, only every other ensemble member is labelled. We accept the null hypothesis that the empirical and analytical populations are drawn from the same distributions if the maximum difference is less than the KS test statistic 0.326.

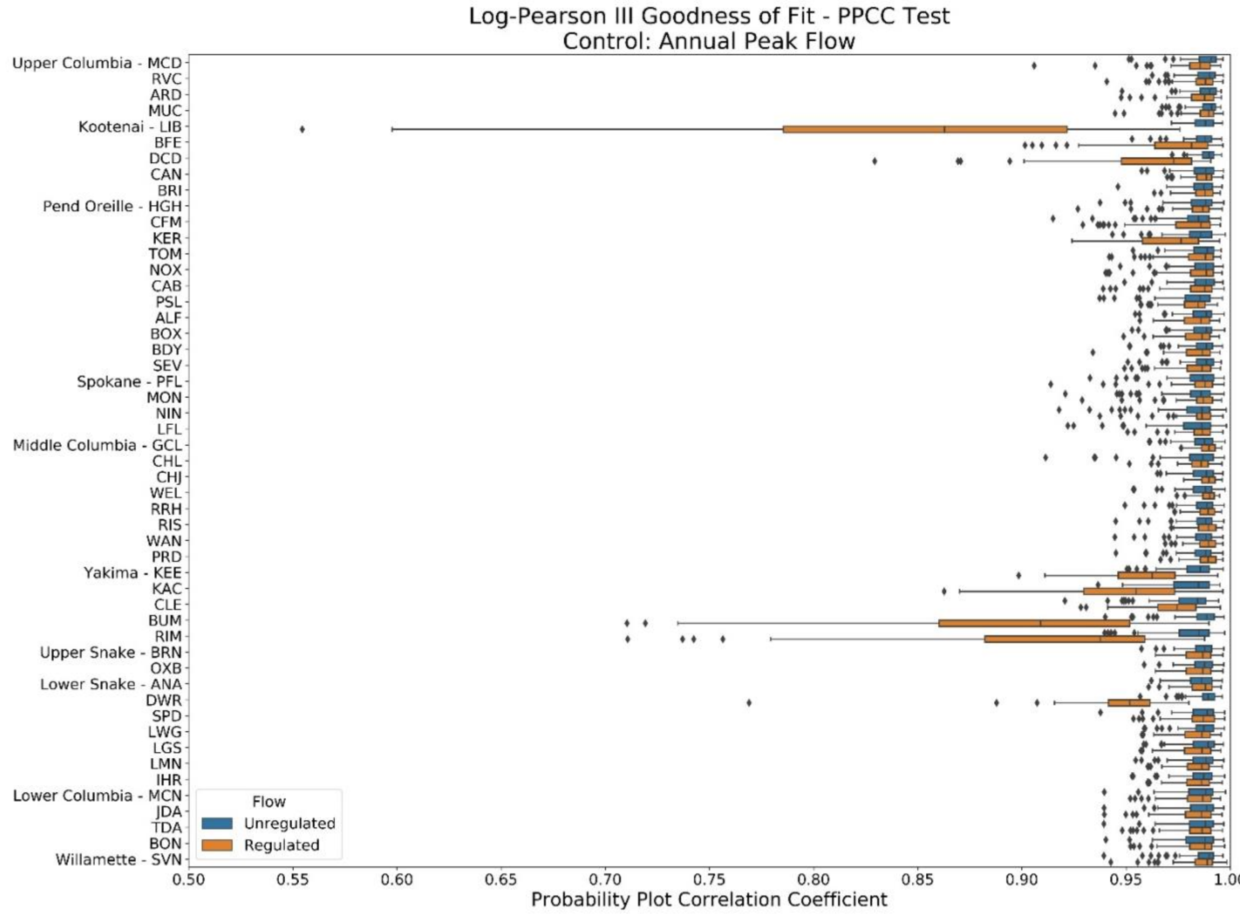

Figure S6. PPCC LP3 goodness of fit test results for control period annual peak flows for each site included in the daily analysis. Boxplots represent the distribution of test results for the 80-member ensemble for unregulated analytical estimates (orange) and regulated analytical estimates (blue). The analytical curve is a strong predictor of the empirical data if the probability plot correlation coefficient is near 1.

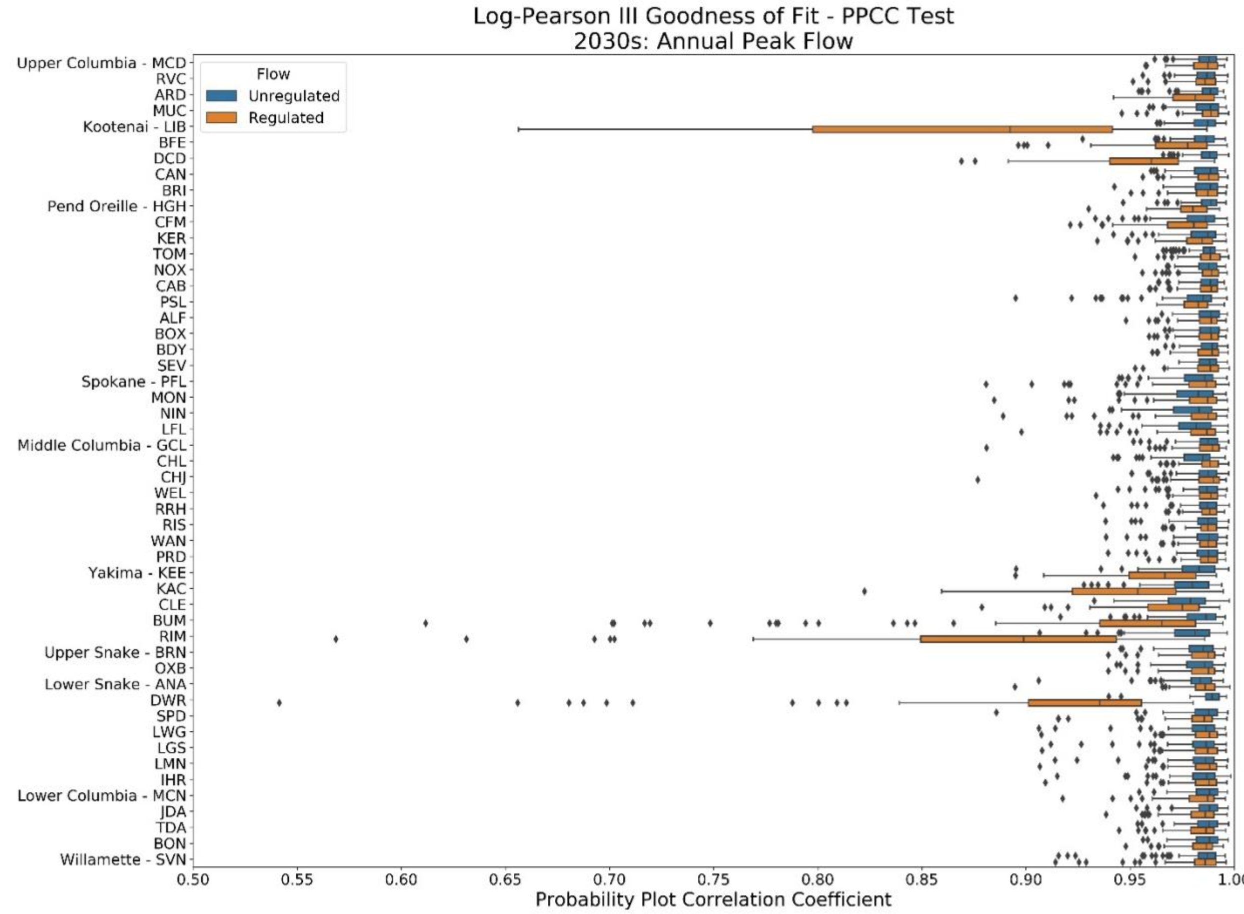

Figure S7. PPCC LP3 goodness of fit test results for 2030s annual peak flows for each site included in the daily analysis. Boxplots represent the distribution of test results for the 80-member ensemble for unregulated analytical estimates (orange) and regulated analytical estimates (blue). The analytical curve is a strong predictor of the empirical data if the probability plot correlation coefficient is near 1.

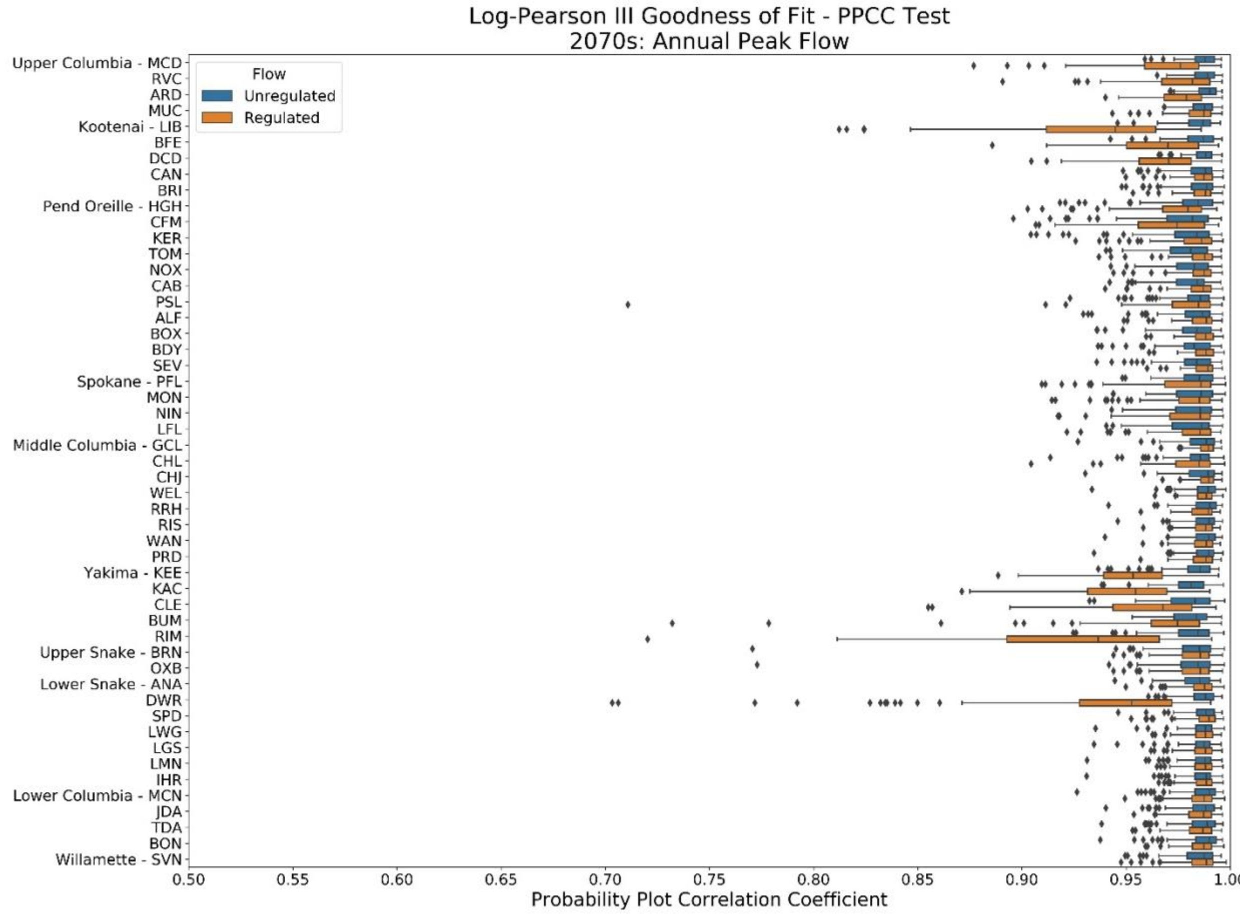

Figure S8. PPCC LP3 goodness of fit test results for 2070s annual peak flows for each site included in the daily analysis. Boxplots represent the distribution of test results for the 80-member ensemble for unregulated analytical estimates (orange) and regulated analytical estimates (blue). The analytical curve is a strong predictor of the empirical data if the probability plot correlation coefficient is near 1.

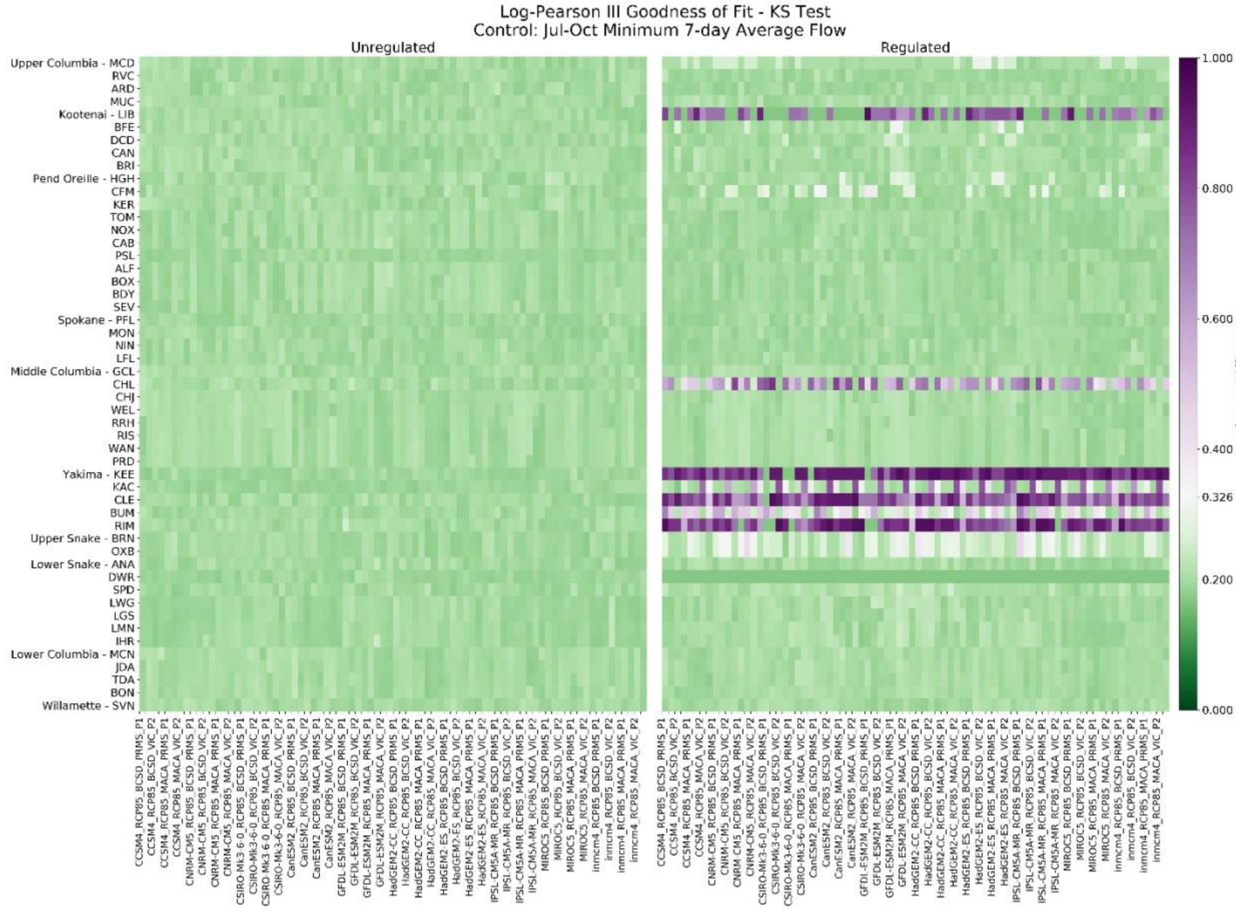

Figure S9. KS LP3 goodness of fit test results for control period annual minimum July-October 7-day average flows for each ensemble member and each site included in the daily analysis. Test results are shown for unregulated analytical estimates (left) and regulated analytical estimates (right) and all 80 ensemble members (x-axis); however, only every other ensemble member is labelled. We accept the null hypothesis that the empirical and analytical populations are drawn from the same distributions if the maximum difference is less than the KS test statistic 0.326.

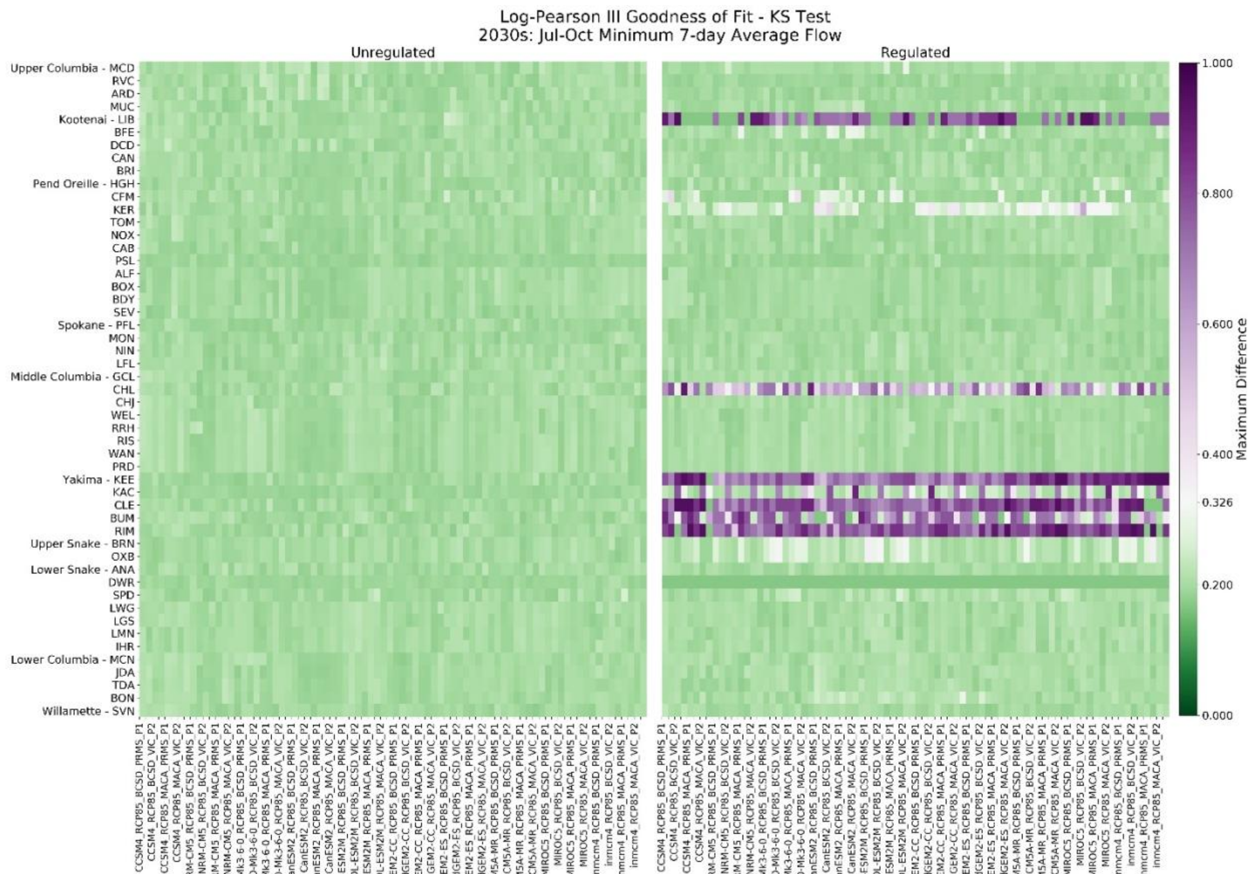

Figure S10. KS LP3 goodness of fit test results for 2030s annual minimum July-October 7-day average flows for each ensemble member and each site included in the daily analysis. Test results are shown for unregulated analytical estimates (left) and regulated analytical estimates (right) and all 80 ensemble members (x-axis); however, only every other ensemble member is labelled. We accept the null hypothesis that the empirical and analytical populations are drawn from the same distributions if the maximum difference is less than the KS test statistic 0.326.

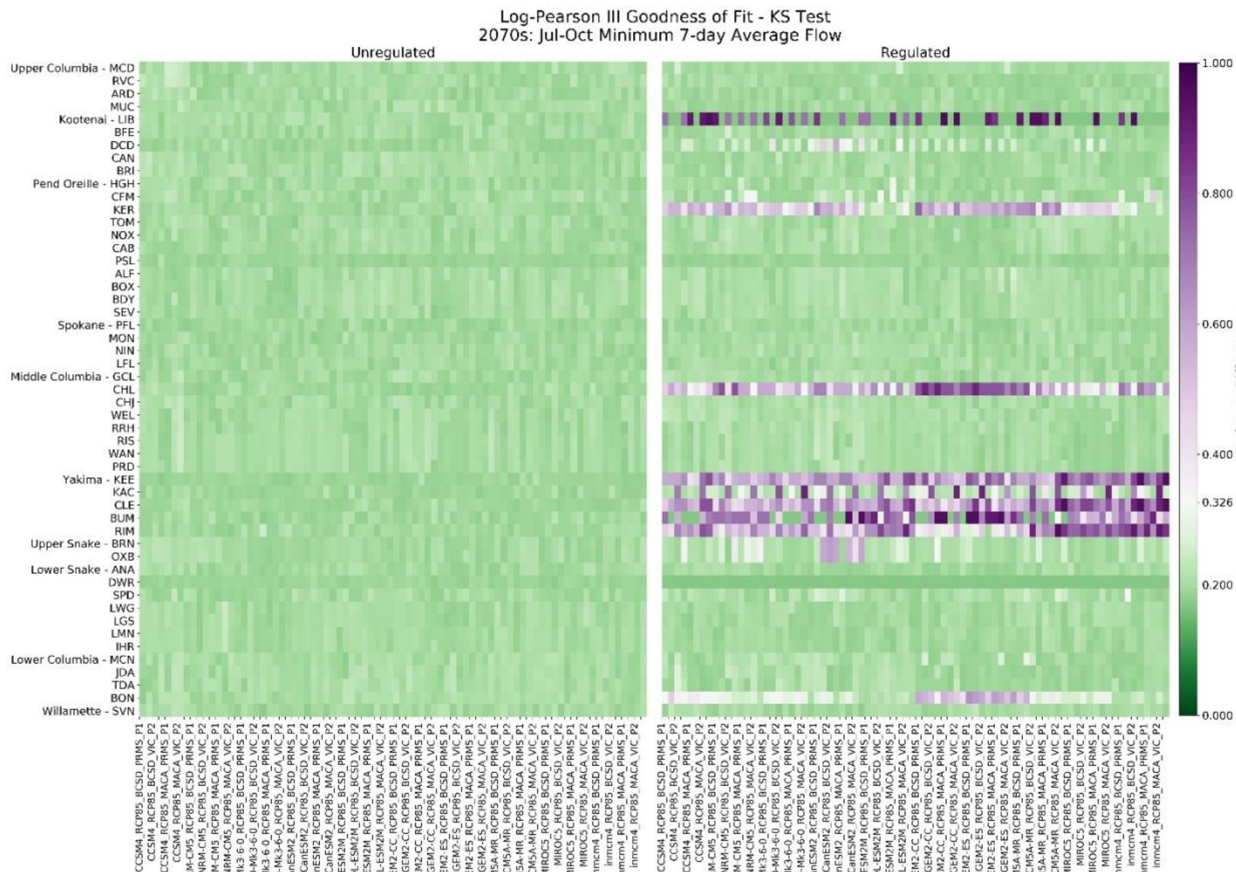

Figure S11. KS LP3 goodness of fit test results for 2070s annual minimum July-October 7-day average flows for each ensemble member and each site included in the daily analysis. Test results are shown for unregulated analytical estimates (left) and regulated analytical estimates (right) and all 80 ensemble members (x-axis); however, only every other ensemble member is labelled. We accept the null hypothesis that the empirical and analytical populations are drawn from the same distributions if the maximum difference is less than the KS test statistic 0.326.

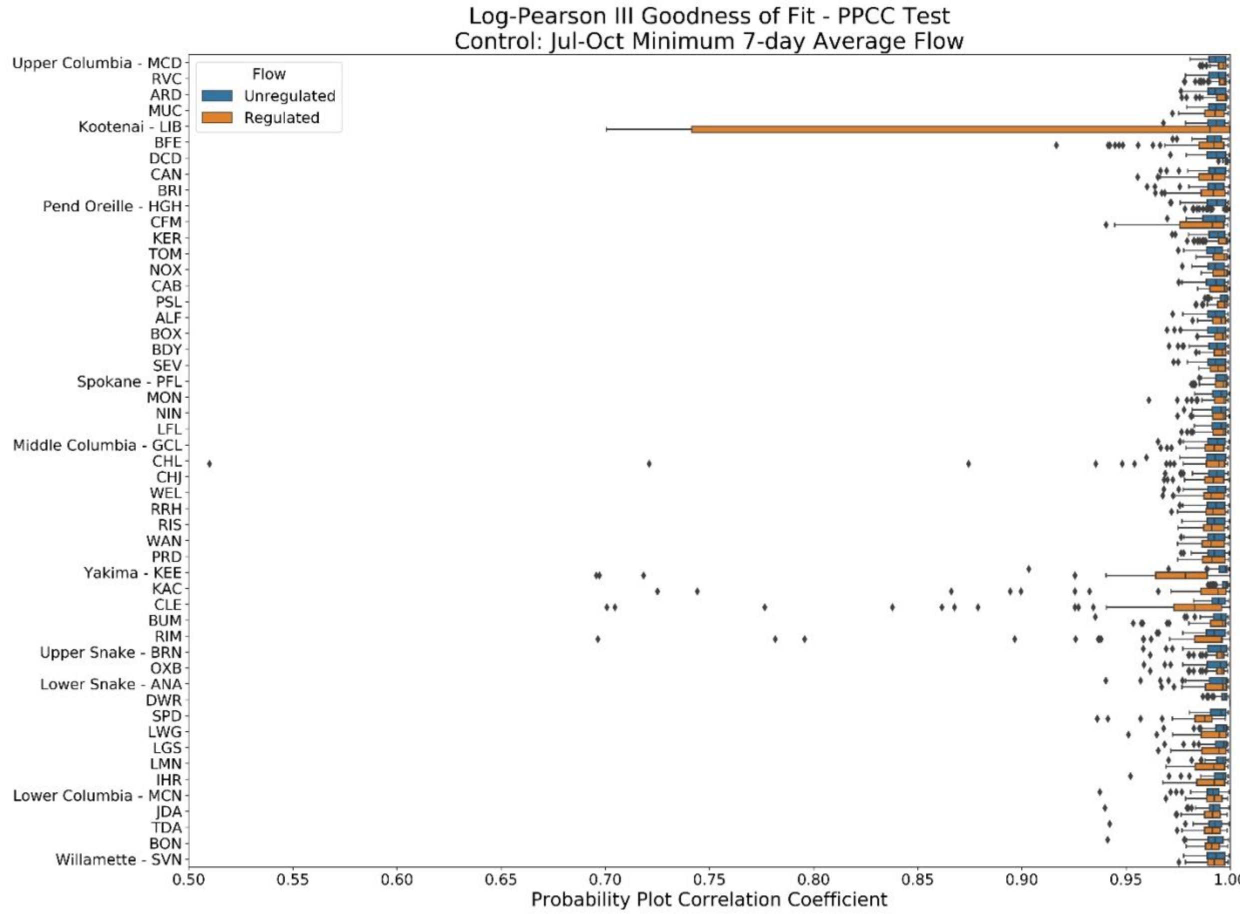

Figure S12. PPCC LP3 goodness of fit test results for control period annual minimum July-October 7-day average flows for each site included in the daily analysis. Boxplots represent the distribution of test results for the 80-member ensemble for unregulated analytical estimates (orange) and regulated analytical estimates (blue). The analytical curve is a strong predictor of the empirical data if the probability plot correlation coefficient is near 1.

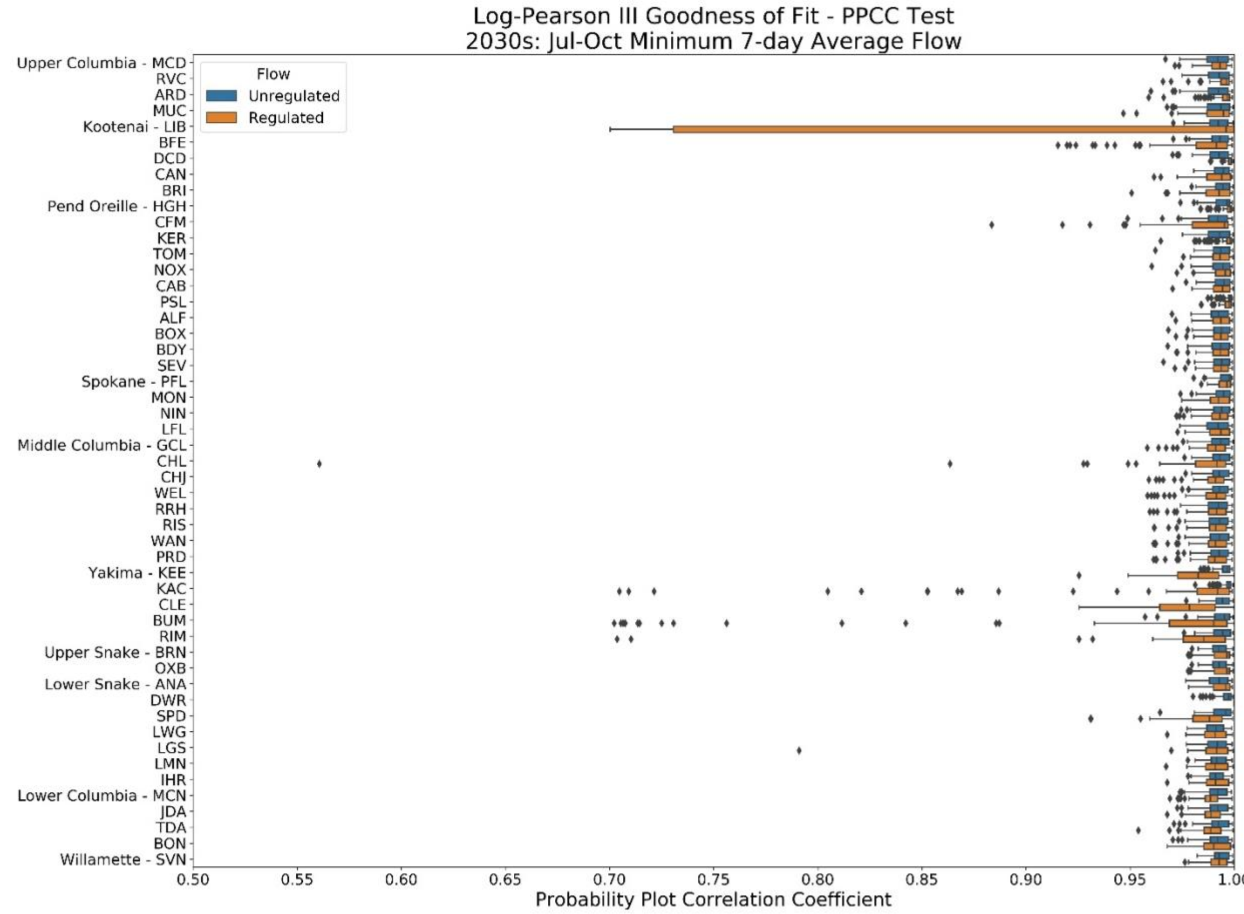

Figure S13. PPCC LP3 goodness of fit test results for 2030s annual minimum July-October 7-day average flows for each site included in the daily analysis. Boxplots represent the distribution of test results for the 80-member ensemble for unregulated analytical estimates (orange) and regulated analytical estimates (blue). The analytical curve is a strong predictor of the empirical data if the probability plot correlation coefficient is near 1.

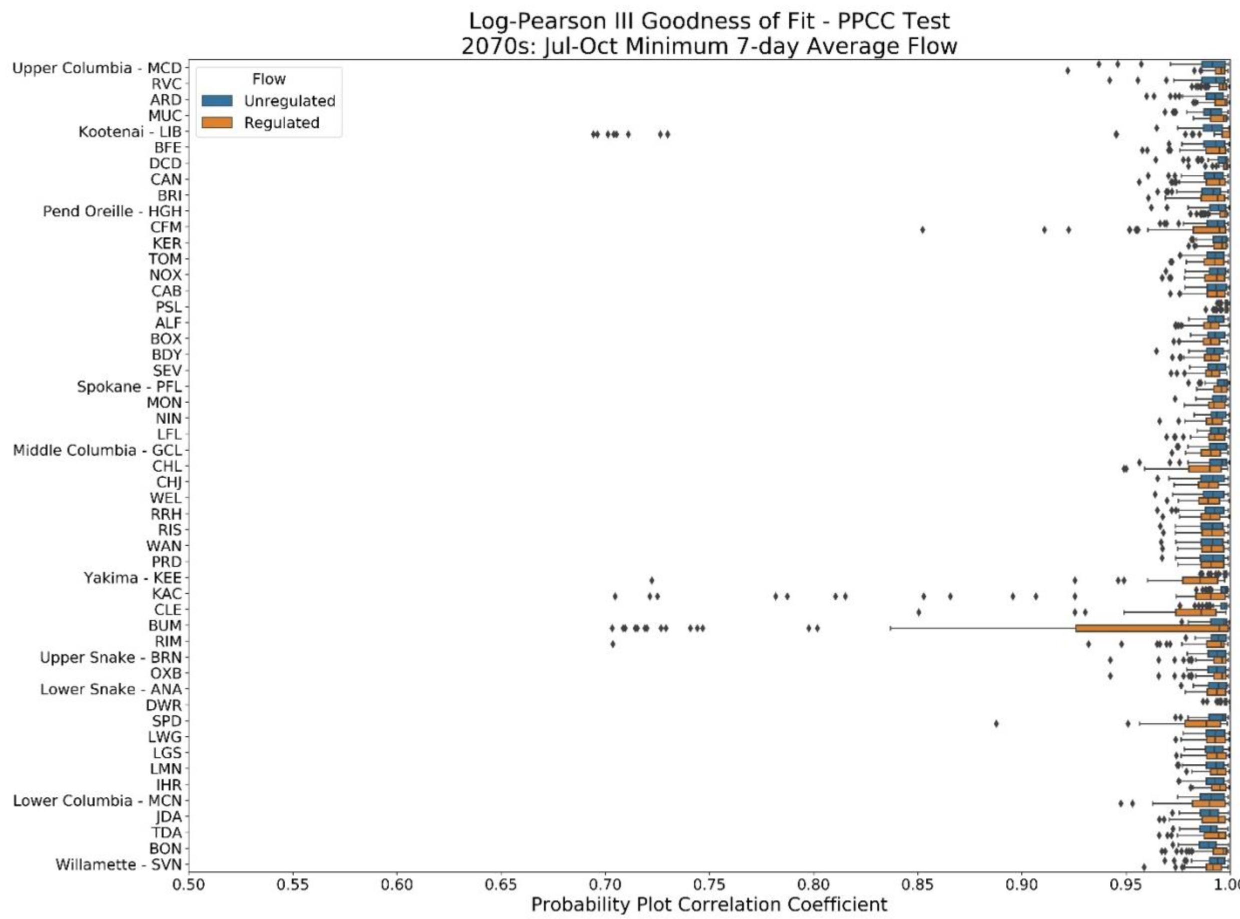

Figure S14. PPCC LP3 goodness of fit test results for 2070s annual minimum July-October 7-day average flows for each site included in the daily analysis. Boxplots represent the distribution of test results for the 80-member ensemble for unregulated analytical estimates (orange) and regulated analytical estimates (blue). The analytical curve is a strong predictor of the empirical data if the probability plot correlation coefficient is near 1.

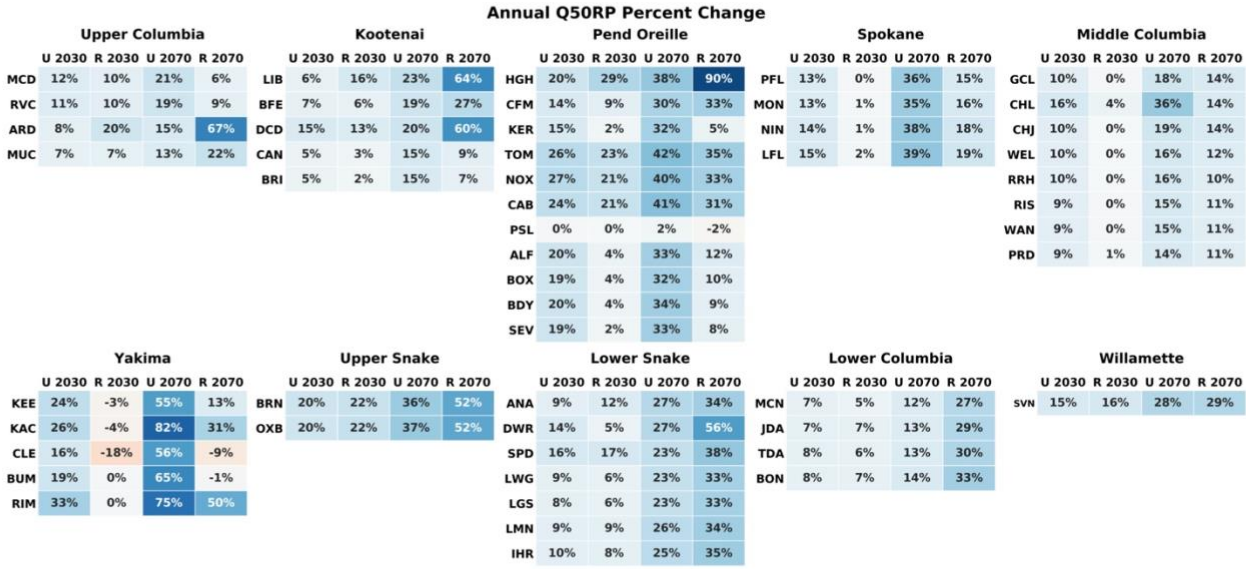

Figure S15. Median percent change of annual Q50RP flow for unregulated conditions (U) and regulated conditions (R). For each region, locations are sorted from upstream (top) to downstream (bottom) based on position of confluence with the next lowest order stream using a top-down stream order approach (e.g., a headwater tributary has a higher stream order than the mainstem).

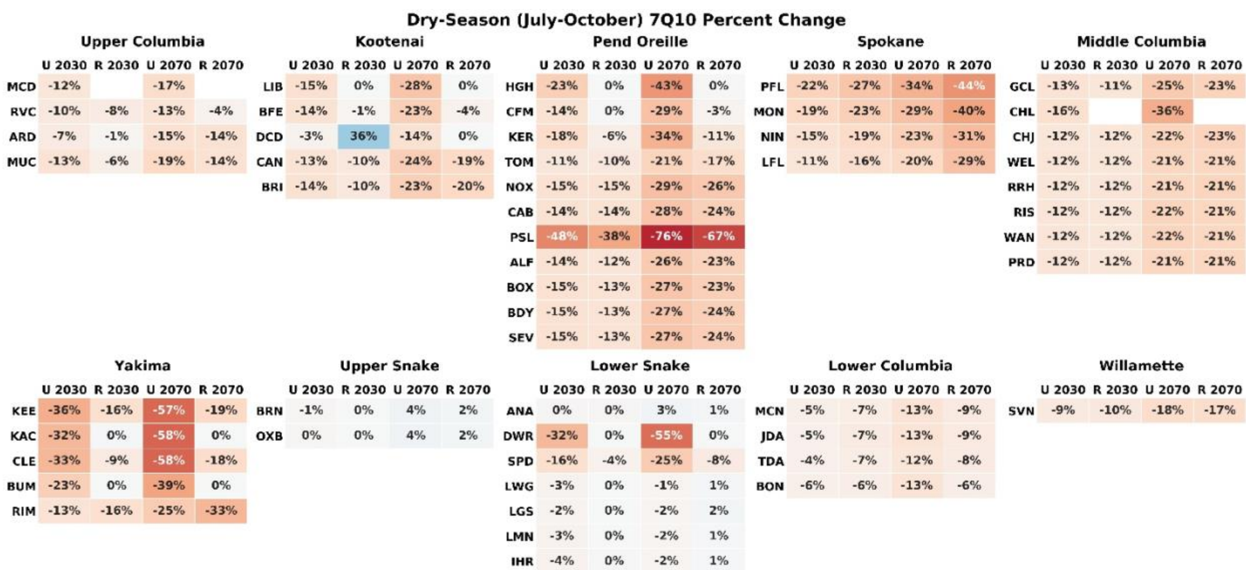

Figure S16. Median percent change of annual 7Q10 flow for unregulated conditions (U) and regulated conditions (R). For each region, locations are sorted from upstream (top) to downstream (bottom) based on position of confluence with the next lowest order stream using a top-down stream order approach (e.g., a headwater tributary has a higher stream order than the mainstem). Locations where the heatmap is blank exhibited infinite or invalid values as a result of near-zero or zero 7Q10 flows in the numerator or the denominator.

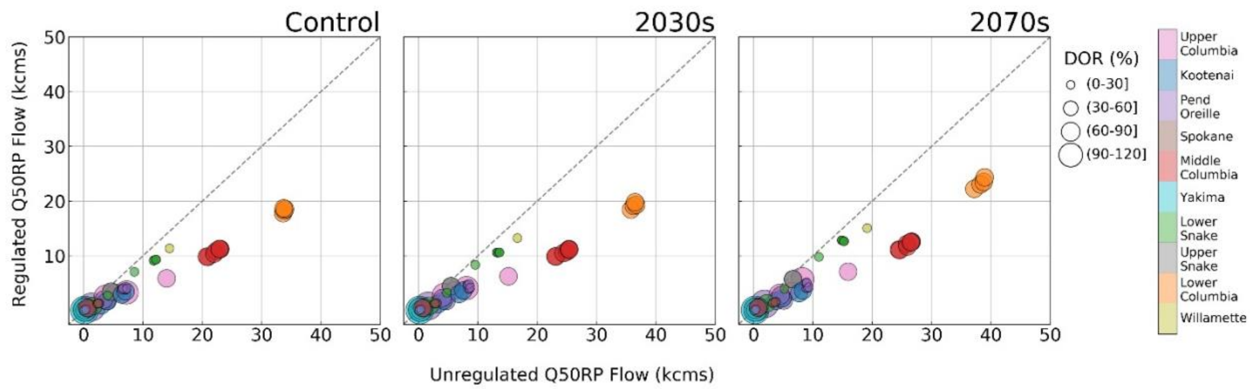

Figure S17. Annual 50-year return period peak flows (Q50RP) for unregulated conditions (x-axis) and regulated conditions (y-axis). Figure shows the median Q50RP flows across the 80-member ensemble. Points are colored by region and sized by the degree of upstream regulation (DOR). In the absence of regulation, points would fall on the dashed 1:1 line.

Table S1. Details about the 75 locations cited in the main text including drainage area and control period (1976-2005) regime. For each region, locations are sorted from upstream (top) to downstream (bottom) based on position of tributary confluence with the next lowest order stream using a top-down stream order approach (e.g., a headwater tributary has a higher stream order than the mainstem).

Region	Site ID	Location	River	Drainage Area (km^2)	Control Regime
Upper Columbia	MCD	Mica	Columbia River	21471	snow
	RVC	Revelstoke	Columbia River	26418	snow
	ARD	Arrow Lakes	Columbia River	36519	snow
	MUC	Birchbank	Columbia River	88099	snow
Kootenai	LIB	Libby	Kootenai River	23271	snow
	BFE	Bonners Ferry	Kootenai River	32867	snow
	DCD	Duncan	Duncan River	1331	snow
	CAN	Corra Linn	Kootenai River	45584	snow
	BRI	Brilliant	Kootenai River	49987	snow
Pend Oreille	HGH	Hungry Horse	South Fork Flathead River	4284	snow
	CFM	Columbia Falls	Flathead River	11562	snow
	KER	Kerr	Flathead River	18353	snow
	TOM	Thompson Falls	Clark Fork	54682	snow
	NOX	Noxon Rapids	Clark Fork	56547	snow
	CAB	Cabinet Gorge	Clark Fork	57169	snow
	PSL	Priest Lake	Priest River	1481	snow
	ALF	Albeni Falls	Pend Oreille River	62678	snow
	BOX	Box Canyon	Pend Oreille River	64491	snow
	BDY	Boundary	Pend Oreille River	65268	snow
	SEV	Waneta	Pend Oreille River	66822	snow
Spokane	PFL	Post Falls	Spokane River	9946	snow

	MON	Monroe Street	Spokane River	11111	snow
	NIN	Nine Mile	Spokane River	13468	transient
	LFL	Long Lake	Spokane River	15592	transient
Middle Columbia	GCL	Grand Coulee	Columbia River	193472	snow
	CHL	Chelan	Chelan River	2393	snow
	CHJ	Chief Joseph	Columbia River	195285	snow
	WEL	Wells	Columbia River	222998	snow
	RRH	Rocky Reach	Columbia River	227401	snow
	RIS	Rock Island	Columbia River	231545	snow
	WAN	Wanapum	Columbia River	234912	snow
	PRD	Priest Rapids	Columbia River	248639	snow
Yakima	KEE	Keechelus	Yakima River	142	transient
	KAC	Kachess	Kachess River	166	transient
	CLE	Cle Elum	Cle Elum River	526	snow
	BUM	Bumping Lake	Bumping River	184	snow
	RIM	Rimrock - Tieton	Tieton River	484	snow
Upper Snake	JCKY	Jackson Lake	Snake River	2090	snow
	PALI	Snake nr Irwin Palisades	Snake River	13533	snow
	HEII	Snake nr Heise	Snake River	14898	snow
	LORI	Lorenzo	Snake River	15048	snow
	REXI	Henry's Fork nr Rexburg	Henrys Fork	7563	rain
	SHYI	Snake nr Shelley	Snake River	25356	snow
	BFTI	Snake nr Blackfoot	Snake River	29293	snow
	AMFI	American Falls	Snake River	35224	snow
	MILI	Milner	Snake River	44496	snow
	KIMI	Snake nr Kimberly	Snake River	57860	snow
	SKHI	King Hill	Snake River	92722	snow
	SWAI	Snake nr Murphy	Snake River	108521	transient
	ANDI	Anderson Ranch	South Fork Boise River	2533	snow
	ARKI	Arrowrock	Boise River	5739	snow
	LUCI	Lucky Peak	Boise River	6941	snow
	BIGI	Glenwood Bridge	Boise River	7182	snow
	OWY	Owyhee River nr Rome OR	Owyhee River	28904	rain
	SNYI	Nyssa	Snake River	152032	transient
	DEDI	Deadwood	Deadwood River	290	snow
	PABI	Payette NF+SF	Payette River	1181	snow
	HRSI	Horseshoe Bend	Payette River	5750	snow
	PRPI	Payette	Payette River	8392	snow
	WEII	Weiser	Weiser River	3755	transient
	BRN	Brownlee	Snake River	188007	transient

	OXB	Oxbow	Snake River	188551	transient
Lower Snake	ANA	Anatone	Snake River	240765	snow
	DWR	Dworshak	North Fork Clearwater River	6320	snow
	SPD	Spalding	Clearwater River	24786	snow
	LWG	Lower Granite	Snake River	267287	snow
	LGS	Little Goose	Snake River	269100	snow
	LMN	Lower Monumental	Snake River	281014	snow
	IHR	Ice Harbor	Snake River	281014	snow
	MCN	McNary	Columbia River	554258	snow
Lower Columbia	JDA	John Day	Columbia River	585338	snow
	TDA	The Dalles	Columbia River	613828	snow
	BON	Bonneville	Columbia River	621339	snow
Willamette	SVN	T.W. Sullivan	Willamette River	25900	transient

Table S2. September-November (SON) Volume Percent Change. U is unregulated, R is regulated. Table shows the (10th) 50th (90th) percentiles of the ensemble. For each region, locations are sorted from upstream (top) to downstream (bottom) based on position of tributary confluence with the next lowest order stream using a top-down stream order approach (e.g., a headwater tributary has a higher stream order than the mainstem).

SON

Region	Site ID	2030 U	2030 R	2070 U	2070 R
Upper Columbia	MCD	(-18) -11 (0)	(-5) 5 (15)	(-29) -14 (13)	(3) 20 (30)
	RVC	(-16) -9 (1)	(-6) 4 (12)	(-22) -8 (18)	(4) 17 (29)
	ARD	(-16) -7 (4)	(-11) -6 (-2)	(-20) -5 (20)	(-22) -11 (-4)
	MUC	(-17) -8 (5)	(-13) -8 (-2)	(-20) -8 (17)	(-23) -12 (-4)
Kootenai	LIB	(-21) -10 (6)	(-19) -11 (-2)	(-28) -12 (11)	(-31) -18 (-4)
	BFE	(-19) -8 (8)	(-16) -10 (0)	(-25) -12 (14)	(-30) -15 (0)
	DCD	(-19) -7 (13)	(-16) -9 (0)	(-32) 2 (34)	(-24) -13 (8)
	CAN	(-17) -8 (7)	(-17) -12 (0)	(-25) -12 (17)	(-28) -14 (2)
	BRI	(-18) -8 (8)	(-17) -11 (0)	(-24) -11 (17)	(-27) -15 (3)
Pend Oreille	HGH	(-27) -8 (14)	(-7) -1 (5)	(-39) -19 (20)	(-10) -1 (5)
	CFM	(-25) -5 (17)	(-10) -3 (8)	(-30) -13 (24)	(-14) -5 (13)
	KER	(-23) -6 (11)	(-14) -8 (0)	(-32) -15 (20)	(-36) -17 (-6)
	TOM	(-16) -3 (10)	(-13) -5 (2)	(-25) -9 (19)	(-29) -12 (1)
	NOX	(-17) -5 (9)	(-13) -6 (1)	(-26) -11 (16)	(-30) -13 (0)
	CAB	(-17) -4 (9)	(-14) -6 (2)	(-26) -10 (16)	(-30) -12 (0)
	PSL	(-17) -2 (20)	(-10) -4 (6)	(-15) 10 (43)	(-12) -1 (12)
	ALF	(-15) -3 (10)	(-9) -4 (1)	(-23) -8 (17)	(-20) -9 (0)
	BOX	(-15) -3 (10)	(-9) -4 (1)	(-23) -8 (17)	(-21) -9 (0)

	BDY	(-15) -3 (10)	(-9) -4 (1)	(-23) -8 (16)	(-21) -9 (0)
	SEV	(-15) -3 (10)	(-10) -4 (1)	(-23) -7 (16)	(-21) -9 (0)
Spokane	PFL	(-20) -2 (31)	(-13) -3 (12)	(-19) 2 (55)	(-15) -4 (19)
	MON	(-19) -3 (24)	(-13) -4 (11)	(-18) -1 (42)	(-15) -5 (15)
	NIN	(-18) -2 (24)	(-13) -3 (10)	(-17) 0 (35)	(-14) -4 (14)
	LFL	(-17) -2 (22)	(-13) -3 (10)	(-15) 1 (29)	(-14) -3 (12)
Middle Columbia	GCL	(-15) -5 (8)	(-11) -7 (0)	(-19) -6 (19)	(-21) -12 (-2)
	CHL	(-16) -3 (14)	(-12) -4 (8)	(-19) 5 (44)	(-21) -6 (20)
	CHJ	(-15) -5 (8)	(-11) -7 (0)	(-19) -7 (19)	(-21) -12 (-2)
	WEL	(-15) -4 (9)	(-11) -7 (0)	(-18) -5 (19)	(-20) -11 (-1)
	RRH	(-15) -5 (9)	(-11) -7 (0)	(-18) -5 (19)	(-20) -11 (0)
	RIS	(-15) -4 (9)	(-11) -6 (0)	(-17) -4 (19)	(-19) -10 (0)
	WAN	(-15) -4 (9)	(-11) -7 (0)	(-17) -4 (19)	(-20) -10 (0)
	PRD	(-15) -5 (9)	(-11) -7 (0)	(-17) -4 (19)	(-20) -10 (0)
Yakima	KEE	(-29) 0 (19)	(-31) -20 (-6)	(-39) 10 (34)	(-42) -30 (-20)
	KAC	(-26) 0 (25)	(-8) 0 (6)	(-39) 13 (39)	(-30) -12 (4)
	CLE	(-23) -2 (18)	(-39) -27 (-17)	(-34) 8 (35)	(-49) -38 (-25)
	BUM	(-18) -2 (21)	(-19) -6 (11)	(-20) 2 (49)	(-25) -4 (22)
	RIM	(-18) -3 (14)	(-5) -1 (5)	(-24) -4 (29)	(-21) -9 (1)
Upper Snake	JCKY	(-8) 0 (9)	(-5) 0 (3)	(-13) 1 (30)	(-19) -8 (2)
	PALI	(-5) 0 (13)	(-13) -7 (4)	(-7) 6 (28)	(-26) -12 (8)
	HEII	(-5) 0 (12)	(-12) -6 (5)	(-7) 6 (26)	(-24) -10 (9)
	LORI	(-5) 0 (12)	(-13) -5 (12)	(-7) 6 (26)	(-24) -7 (21)
	REXI	(-5) 0 (12)	(-3) 2 (10)	(-13) 0 (20)	(-6) 3 (16)
	SHYI	(-7) -1 (10)	(-11) -3 (10)	(-15) 0 (18)	(-23) -9 (13)
	BFTI	(-7) -1 (11)	(-12) -2 (13)	(-15) 0 (19)	(-26) -9 (17)
	AMFI	(-6) 0 (11)	(-15) -8 (1)	(-11) 2 (26)	(-31) -19 (-3)
	MILI	(-5) 0 (10)	(-36) -14 (14)	(-11) 2 (30)	(-56) -35 (14)
	KIMI	(-5) 0 (11)	(-27) -10 (13)	(-10) 3 (31)	(-42) -24 (15)
	SKHI	(-2) 3 (13)	(-4) 3 (11)	(-1) 8 (42)	(-1) 5 (30)
	SWAI	(-1) 5 (16)	(-2) 6 (14)	(0) 10 (44)	(0) 10 (37)
	ANDI	(-2) 11 (31)	(-9) 1 (9)	(5) 25 (60)	(-18) 0 (14)
	ARKI	(-2) 10 (29)	(-13) 2 (23)	(2) 20 (52)	(-19) 4 (33)
	LUCI	(-2) 9 (28)	(-14) -1 (9)	(1) 18 (52)	(-22) -3 (13)
	BIGI	(-2) 7 (24)	(-18) -1 (27)	(-2) 14 (46)	(-12) 12 (62)
	OWY	(0) 27 (65)	(-6) 2 (14)	(-2) 48 (143)	(-8) 5 (94)
	SNYI	(-1) 8 (20)	(-4) 4 (15)	(1) 14 (47)	(-1) 11 (39)
	DEDI	(-16) -4 (30)	(-15) 6 (30)	(-30) 1 (59)	(-14) 13 (38)
	PABI	(-13) 1 (26)	(-14) -4 (7)	(-27) 9 (54)	(-24) -13 (3)
	HRSI	(-10) 4 (27)	(-7) 1 (19)	(-17) 10 (47)	(-12) 4 (29)

	PRPI	(-16) 1 (23)	(-26) -12 (13)	(-29) 6 (43)	(-38) -15 (24)
	WEII	(-2) 8 (22)	(-5) 3 (14)	(1) 15 (44)	(-3) 9 (35)
	BRN	(-2) 7 (23)	(-5) 3 (14)	(1) 15 (43)	(-2) 9 (35)
	OXB	(-2) 7 (22)	(-5) 3 (14)	(1) 15 (43)	(-2) 9 (35)
Lower Snake	ANA	(-5) 4 (17)	(-6) 2 (15)	(-2) 9 (37)	(-4) 6 (31)
	DWR	(-15) -5 (17)	(-16) -8 (-2)	(-20) -4 (27)	(-26) -12 (-1)
	SPD	(-17) -4 (20)	(-16) -7 (6)	(-22) -4 (30)	(-21) -10 (11)
	LWG	(-7) 3 (16)	(-7) 0 (12)	(-5) 6 (34)	(-7) 2 (25)
	LGS	(-7) 3 (16)	(-7) 0 (12)	(-5) 6 (33)	(-7) 2 (25)
	LMN	(-8) 2 (16)	(-8) 0 (12)	(-6) 5 (32)	(-9) 0 (22)
	IHR	(-8) 2 (16)	(-8) 0 (12)	(-6) 5 (31)	(-9) 0 (22)
	MCN	(-10) -2 (9)	(-10) -5 (2)	(-14) 0 (20)	(-17) -9 (4)
Lower Columbia	JDA	(-11) -2 (9)	(-10) -5 (1)	(-14) 0 (20)	(-17) -9 (4)
	TDA	(-10) -2 (9)	(-10) -5 (2)	(-13) 0 (20)	(-17) -9 (4)
	BON	(-10) -2 (8)	(-10) -5 (1)	(-13) -1 (19)	(-17) -9 (3)
Willamette	SVN	(-15) -2 (10)	(-16) -3 (8)	(-27) -4 (10)	(-27) -6 (8)

Table S3. December-February (DJF) Volume Percent Change. U is unregulated, R is regulated. Table shows the (10th) 50th (90th) percentiles of the ensemble. For each region, locations are sorted from upstream (top) to downstream (bottom) based on position of tributary confluence with the next lowest order stream using a top-down stream order approach (e.g., a headwater tributary has a higher stream order than the mainstem).

DJF

Region	Site ID	2030 U	2030 R	2070 U	2070 R
Upper Columbia	MCD	(-3) 17 (41)	(-12) -8 (0)	(10) 56 (106)	(-33) -18 (-7)
	RVC	(-2) 21 (44)	(-10) -6 (2)	(12) 65 (116)	(-27) -12 (0)
	ARD	(0) 24 (49)	(-8) -1 (2)	(16) 73 (120)	(-25) -5 (4)
	MUC	(3) 22 (48)	(-8) 0 (7)	(35) 66 (120)	(-13) 0 (13)
Kootenai	LIB	(-4) 14 (36)	(-17) -2 (10)	(14) 56 (105)	(-21) -2 (14)
	BFE	(0) 22 (51)	(-14) 2 (13)	(39) 66 (134)	(-9) 10 (32)
	DCD	(-2) 24 (51)	(-7) 1 (9)	(10) 80 (127)	(-22) 0 (15)
	CAN	(1) 23 (51)	(-10) 5 (15)	(44) 66 (134)	(0) 8 (38)
	BRI	(1) 22 (50)	(-10) 5 (16)	(43) 65 (133)	(2) 10 (40)
Pend Oreille	HGH	(-1) 40 (86)	(-24) -12 (6)	(44) 140 (266)	(-40) -23 (9)
	CFM	(4) 40 (82)	(-8) 5 (23)	(48) 137 (246)	(1) 26 (76)
	KER	(5) 40 (80)	(-4) 4 (16)	(51) 133 (235)	(0) 16 (49)
	TOM	(4) 34 (68)	(-2) 11 (25)	(59) 100 (184)	(16) 29 (74)
	NOX	(5) 38 (77)	(-1) 12 (29)	(68) 114 (211)	(19) 32 (80)
	CAB	(4) 36 (75)	(-1) 14 (31)	(66) 108 (202)	(21) 34 (84)

	PSL	(9) 58 (101)	(4) 50 (91)	(78) 178 (281)	(53) 137 (230)
	ALF	(6) 36 (71)	(0) 17 (35)	(63) 103 (194)	(24) 38 (82)
	BOX	(6) 35 (70)	(0) 17 (35)	(62) 102 (192)	(24) 39 (82)
	BDY	(6) 35 (70)	(0) 17 (35)	(61) 100 (191)	(24) 39 (83)
	SEV	(5) 34 (71)	(-1) 17 (36)	(60) 100 (192)	(25) 41 (85)
Spokane	PFL	(24) 69 (108)	(22) 61 (105)	(114) 178 (223)	(106) 167 (205)
	MON	(18) 60 (98)	(17) 53 (92)	(104) 158 (190)	(93) 147 (177)
	NIN	(15) 55 (92)	(15) 49 (87)	(97) 148 (172)	(86) 136 (162)
	LFL	(14) 51 (88)	(14) 45 (81)	(90) 139 (162)	(78) 122 (146)
Middle Columbia	GCL	(6) 30 (55)	(-6) 6 (15)	(55) 84 (143)	(3) 12 (32)
	CHL	(-5) 34 (75)	(-1) 3 (10)	(13) 130 (210)	(0) 15 (28)
	CHJ	(6) 30 (54)	(-6) 6 (15)	(54) 83 (142)	(3) 12 (32)
	WEL	(5) 30 (54)	(-6) 6 (15)	(54) 85 (143)	(3) 13 (34)
	RRH	(5) 30 (55)	(-6) 6 (15)	(54) 85 (145)	(3) 13 (34)
	RIS	(5) 30 (57)	(-5) 7 (16)	(55) 89 (148)	(4) 14 (36)
	WAN	(5) 30 (57)	(-5) 7 (16)	(55) 89 (149)	(4) 14 (37)
	PRD	(5) 30 (57)	(-5) 7 (16)	(55) 90 (149)	(4) 14 (37)
Yakima	KEE	(19) 52 (85)	(-18) 1 (31)	(90) 131 (174)	(-16) 21 (63)
	KAC	(16) 52 (84)	(-19) -3 (12)	(89) 135 (184)	(-18) 4 (74)
	CLE	(2) 51 (91)	(-30) -10 (17)	(60) 179 (289)	(-32) 6 (51)
	BUM	(15) 58 (107)	(8) 28 (70)	(95) 186 (273)	(52) 104 (184)
	RIM	(7) 34 (78)	(-27) -10 (72)	(64) 110 (185)	(-21) 29 (253)
Upper Snake	JCKY	(-3) 9 (29)	(-6) -1 (7)	(7) 57 (149)	(-6) 5 (33)
	PALI	(2) 16 (38)	(-9) 7 (27)	(24) 65 (142)	(7) 37 (94)
	HEII	(3) 16 (37)	(-7) 9 (28)	(25) 63 (133)	(10) 38 (92)
	LORI	(3) 16 (37)	(-7) 10 (28)	(26) 63 (133)	(10) 39 (94)
	REXI	(4) 22 (39)	(0) 13 (25)	(26) 72 (135)	(14) 42 (82)
	SHYI	(5) 22 (43)	(-4) 13 (30)	(32) 82 (172)	(15) 47 (106)
	BFTI	(5) 23 (44)	(-3) 13 (30)	(35) 88 (184)	(15) 47 (107)
	AMFI	(6) 23 (43)	(-18) 4 (36)	(36) 82 (164)	(-11) 35 (116)
	MILI	(8) 28 (46)	(-16) 6 (35)	(40) 85 (162)	(-4) 43 (118)
	KIMI	(8) 27 (45)	(-15) 7 (35)	(39) 82 (154)	(-2) 43 (113)
	SKHI	(6) 25 (38)	(-6) 11 (26)	(33) 70 (131)	(3) 37 (93)
	SWAI	(6) 24 (41)	(-4) 14 (31)	(31) 68 (122)	(6) 40 (95)
	ANDI	(10) 48 (105)	(-12) 10 (51)	(50) 178 (365)	(10) 63 (176)
	ARKI	(21) 57 (110)	(-12) 11 (53)	(84) 190 (331)	(19) 91 (226)
	LUCI	(21) 60 (112)	(-16) 22 (81)	(91) 192 (321)	(37) 130 (281)
	BIGI	(22) 61 (116)	(-9) 29 (101)	(95) 193 (323)	(54) 153 (321)
	OWY	(27) 79 (150)	(53) 309 (1576)	(81) 312 (395)	(227) 997 (5000)
	SNYI	(10) 32 (50)	(-3) 21 (44)	(44) 87 (158)	(17) 61 (131)

	DEDI	(1) 51 (114)	(-6) 3 (33)	(69) 204 (401)	(6) 50 (232)
	PABI	(24) 90 (154)	(-6) 23 (89)	(152) 281 (447)	(30) 109 (221)
	HRSI	(15) 61 (110)	(2) 31 (78)	(105) 201 (318)	(46) 116 (218)
	PRPI	(23) 69 (112)	(-17) 15 (57)	(140) 204 (311)	(17) 83 (164)
	WEII	(14) 39 (57)	(-1) 21 (41)	(59) 104 (176)	(28) 70 (141)
	BRN	(14) 39 (59)	(-3) 23 (43)	(61) 107 (176)	(30) 71 (139)
	OXB	(14) 39 (59)	(-3) 23 (43)	(61) 107 (176)	(30) 71 (139)
Lower Snake	ANA	(12) 34 (60)	(0) 25 (46)	(57) 103 (171)	(35) 74 (143)
	DWR	(20) 64 (97)	(-10) 15 (44)	(121) 187 (260)	(18) 44 (80)
	SPD	(18) 61 (104)	(0) 37 (73)	(111) 169 (256)	(58) 92 (160)
	LWG	(8) 36 (63)	(-2) 22 (48)	(67) 106 (168)	(39) 74 (134)
	LGS	(8) 36 (63)	(-2) 22 (48)	(67) 106 (168)	(39) 74 (134)
	LMN	(9) 39 (67)	(-2) 24 (51)	(72) 113 (176)	(42) 79 (141)
	IHR	(9) 39 (67)	(-2) 24 (51)	(71) 113 (176)	(42) 79 (141)
	MCN	(9) 31 (57)	(-2) 11 (23)	(59) 95 (152)	(12) 29 (57)
Lower Columbia	JDA	(8) 32 (56)	(-1) 11 (24)	(60) 95 (150)	(14) 31 (58)
	TDA	(8) 31 (56)	(-1) 12 (25)	(59) 92 (146)	(14) 31 (58)
	BON	(8) 32 (56)	(-1) 13 (26)	(61) 91 (142)	(15) 32 (59)
Willamette	SVN	(2) 16 (27)	(2) 17 (28)	(22) 28 (40)	(23) 29 (41)

Table S4. March-May (MAM) Volume Percent Change. U is unregulated, R is regulated. Table shows the (10th) 50th (90th) percentiles of the ensemble. For each region, locations are sorted from upstream (top) to downstream (bottom) based on position of tributary confluence with the next lowest order stream using a top-down stream order approach (e.g., a headwater tributary has a higher stream order than the mainstem).

MAM

Region	Site ID	2030 U	2030 R	2070 U	2070 R
Upper Columbia	MCD	(18) 33 (57)	(0) 17 (42)	(59) 95 (151)	(17) 63 (110)
	RVC	(19) 30 (56)	(10) 23 (43)	(58) 92 (142)	(42) 70 (114)
	ARD	(16) 28 (50)	(2) 21 (46)	(49) 78 (119)	(34) 55 (95)
	MUC	(9) 26 (43)	(3) 22 (39)	(43) 65 (96)	(38) 52 (88)
Kootenai	LIB	(7) 29 (46)	(1) 23 (38)	(42) 67 (106)	(33) 49 (75)
	BFE	(5) 25 (38)	(1) 21 (33)	(35) 54 (80)	(28) 42 (65)
	DCD	(13) 35 (58)	(9) 41 (79)	(51) 89 (145)	(77) 140 (214)
	CAN	(6) 27 (40)	(4) 25 (42)	(36) 60 (87)	(39) 58 (91)
	BRI	(6) 27 (41)	(4) 26 (42)	(36) 60 (88)	(39) 58 (93)
Pend Oreille	HGH	(17) 38 (61)	(0) 10 (23)	(49) 79 (118)	(8) 25 (56)
	CFM	(14) 34 (54)	(8) 24 (38)	(42) 70 (100)	(33) 50 (78)

	KER	(13) 33 (51)	(9) 27 (45)	(42) 67 (97)	(42) 60 (99)
	TOM	(12) 31 (44)	(8) 29 (41)	(39) 56 (80)	(38) 55 (84)
	NOX	(12) 30 (44)	(8) 29 (41)	(38) 56 (79)	(38) 55 (84)
	CAB	(11) 29 (43)	(8) 28 (40)	(36) 54 (75)	(36) 53 (81)
	PSL	(5) 17 (28)	(9) 27 (42)	(10) 28 (49)	(28) 50 (76)
	ALF	(9) 25 (38)	(8) 28 (42)	(29) 47 (68)	(38) 56 (87)
	BOX	(9) 25 (37)	(8) 28 (42)	(28) 46 (67)	(39) 56 (87)
	BDY	(9) 25 (37)	(8) 28 (42)	(28) 46 (67)	(38) 57 (86)
	SEV	(8) 25 (37)	(8) 28 (42)	(27) 46 (67)	(37) 56 (86)
Spokane	PFL	(-8) 1 (11)	(-4) 5 (18)	(-23) -9 (17)	(-16) 0 (33)
	MON	(-7) 1 (10)	(-4) 6 (18)	(-21) -9 (17)	(-14) 2 (33)
	NIN	(-7) 1 (10)	(-4) 6 (18)	(-20) -7 (18)	(-13) 3 (33)
	LFL	(-7) 1 (10)	(-4) 6 (17)	(-19) -6 (19)	(-12) 3 (33)
Middle Columbia	GCL	(7) 23 (35)	(3) 21 (29)	(33) 50 (73)	(27) 41 (65)
	CHL	(9) 32 (61)	(12) 55 (93)	(49) 77 (147)	(98) 152 (241)
	CHJ	(7) 23 (35)	(3) 21 (29)	(33) 50 (74)	(27) 41 (65)
	WEL	(7) 24 (35)	(2) 22 (29)	(33) 50 (74)	(30) 42 (64)
	RRH	(7) 25 (35)	(2) 23 (29)	(35) 52 (75)	(32) 44 (65)
	RIS	(7) 24 (35)	(2) 23 (29)	(35) 52 (74)	(32) 45 (64)
	WAN	(7) 25 (35)	(2) 23 (29)	(35) 52 (75)	(33) 45 (65)
	PRD	(7) 25 (35)	(2) 23 (29)	(35) 52 (75)	(33) 46 (65)
Yakima	KEE	(-2) 8 (18)	(-14) 0 (16)	(-24) -5 (17)	(-20) 8 (26)
	KAC	(-2) 7 (17)	(-39) -11 (14)	(-28) -5 (19)	(-37) -2 (25)
	CLE	(18) 36 (60)	(-11) 4 (25)	(37) 61 (110)	(18) 43 (99)
	BUM	(10) 27 (49)	(13) 37 (70)	(7) 30 (59)	(26) 60 (85)
	RIM	(0) 13 (29)	(-18) 0 (31)	(-10) 16 (41)	(-9) 16 (52)
Upper Snake	JCKY	(17) 44 (78)	(15) 57 (119)	(71) 93 (164)	(107) 161 (312)
	PALI	(14) 32 (61)	(9) 28 (58)	(45) 75 (134)	(44) 69 (128)
	HEII	(13) 30 (59)	(9) 27 (56)	(42) 72 (129)	(42) 66 (123)
	LORI	(13) 30 (59)	(10) 32 (69)	(42) 72 (129)	(50) 82 (148)
	REXI	(11) 27 (56)	(14) 35 (69)	(37) 60 (109)	(43) 74 (136)
	SHYI	(14) 31 (60)	(13) 36 (75)	(48) 72 (129)	(59) 90 (164)
	BFTI	(14) 31 (62)	(16) 42 (85)	(49) 73 (132)	(66) 102 (188)
	AMFI	(12) 30 (61)	(19) 33 (63)	(45) 71 (122)	(57) 82 (159)
	MILI	(13) 30 (59)	(30) 66 (117)	(43) 73 (118)	(97) 162 (264)
	KIMI	(13) 29 (58)	(29) 63 (110)	(42) 72 (116)	(91) 154 (248)
	SKHI	(14) 26 (49)	(15) 36 (65)	(35) 64 (101)	(51) 89 (144)
	SWAI	(13) 27 (49)	(16) 37 (67)	(33) 62 (96)	(50) 89 (140)
	ANDI	(10) 30 (70)	(21) 49 (81)	(28) 54 (147)	(60) 98 (169)
	ARKI	(9) 26 (46)	(19) 42 (63)	(22) 45 (93)	(48) 74 (125)

	LUCI	(9) 25 (47)	(19) 42 (66)	(18) 44 (88)	(48) 76 (136)
	BIGI	(10) 24 (46)	(23) 57 (96)	(18) 43 (85)	(66) 107 (204)
	OWY	(-8) 21 (65)	(-3) 55 (137)	(0) 40 (153)	(27) 87 (259)
	SNYI	(12) 28 (47)	(20) 45 (74)	(30) 63 (92)	(55) 99 (172)
	DEDI	(26) 45 (133)	(-1) 59 (141)	(43) 73 (356)	(92) 170 (317)
	PABI	(7) 21 (36)	(11) 30 (52)	(3) 28 (64)	(25) 54 (91)
	HRSI	(12) 25 (56)	(7) 20 (50)	(13) 34 (110)	(11) 35 (118)
	PRPI	(9) 24 (52)	(1) 17 (54)	(14) 32 (97)	(6) 32 (124)
	WEII	(10) 25 (43)	(12) 34 (58)	(25) 54 (84)	(36) 74 (134)
	BRN	(10) 25 (42)	(12) 32 (59)	(24) 52 (81)	(35) 72 (135)
	OXB	(10) 24 (42)	(12) 32 (59)	(24) 51 (81)	(35) 72 (135)
Lower Snake	ANA	(15) 25 (41)	(18) 30 (49)	(28) 50 (82)	(38) 63 (103)
	DWR	(4) 14 (26)	(-2) 7 (19)	(-1) 11 (42)	(5) 16 (34)
	SPD	(5) 17 (30)	(3) 17 (26)	(5) 18 (47)	(9) 23 (43)
	LWG	(12) 22 (36)	(14) 25 (40)	(24) 44 (67)	(31) 53 (81)
	LGS	(13) 22 (36)	(15) 25 (40)	(24) 45 (68)	(32) 53 (82)
	LMN	(13) 23 (36)	(15) 26 (41)	(24) 45 (68)	(32) 54 (83)
	IHR	(13) 23 (37)	(15) 26 (41)	(24) 45 (69)	(32) 54 (83)
	MCN	(7) 24 (34)	(4) 25 (33)	(33) 48 (69)	(37) 47 (68)
Lower Columbia	JDA	(7) 25 (33)	(4) 25 (33)	(33) 48 (68)	(38) 47 (68)
	TDA	(7) 24 (33)	(4) 25 (32)	(33) 46 (67)	(37) 45 (66)
	BON	(7) 23 (32)	(4) 24 (31)	(32) 44 (64)	(34) 43 (63)
Willamette	SVN	(-15) -5 (0)	(-14) -4 (0)	(-22) -11 (1)	(-21) -10 (2)

Table S5. June-August (JJA) Volume Percent Change. U is unregulated, R is regulated. Table shows the (10th) 50th (90th) percentiles of the ensemble. For each region, locations are sorted from upstream (top) to downstream (bottom) based on position of tributary confluence with the next lowest order stream using a top-down stream order approach (e.g., a headwater tributary has a higher stream order than the mainstem).

JJA

Region	Site ID	2030 U	2030 R	2070 U	2070 R
Upper Columbia	MCD	(-9) -5 (-1)	(-2) 14 (25)	(-33) -20 (-6)	(3) 21 (39)
	RVC	(-10) -6 (-2)	(-8) 1 (8)	(-36) -23 (-8)	(-15) -4 (6)
	ARD	(-12) -8 (-4)	(-2) 4 (13)	(-39) -26 (-12)	(0) 12 (21)
	MUC	(-17) -12 (-8)	(-9) -5 (1)	(-45) -31 (-17)	(-17) -10 (-2)
Kootenai	LIB	(-22) -14 (-10)	(-14) -5 (2)	(-51) -37 (-20)	(-20) -9 (-1)
	BFE	(-23) -17 (-11)	(-19) -11 (-2)	(-52) -39 (-22)	(-31) -19 (-13)
	DCD	(-10) -6 (-1)	(-4) 3 (21)	(-38) -24 (-9)	(-30) -11 (16)
	CAN	(-22) -16 (-10)	(-18) -11 (-5)	(-53) -39 (-21)	(-39) -28 (-15)

	BRI	(-23) -16 (-11)	(-19) -12 (-7)	(-54) -40 (-22)	(-42) -30 (-17)
Pend Oreille	HGH	(-34) -22 (-13)	(-15) 1 (24)	(-65) -54 (-31)	(-12) 0 (17)
	CFM	(-31) -23 (-14)	(-26) -16 (-11)	(-63) -53 (-31)	(-51) -39 (-24)
	KER	(-31) -22 (-13)	(-25) -16 (-8)	(-62) -51 (-30)	(-48) -38 (-23)
	TOM	(-29) -20 (-13)	(-27) -17 (-10)	(-60) -45 (-28)	(-54) -41 (-26)
	NOX	(-30) -21 (-13)	(-29) -18 (-11)	(-61) -47 (-29)	(-56) -43 (-27)
	CAB	(-30) -21 (-13)	(-28) -18 (-11)	(-60) -46 (-29)	(-55) -42 (-27)
	PSL	(-40) -30 (-17)	(-40) -29 (-15)	(-67) -54 (-38)	(-69) -56 (-34)
	ALF	(-30) -21 (-13)	(-29) -19 (-11)	(-58) -45 (-28)	(-56) -43 (-27)
	BOX	(-29) -21 (-13)	(-28) -19 (-10)	(-58) -44 (-28)	(-55) -42 (-26)
	BDY	(-29) -21 (-13)	(-28) -19 (-10)	(-58) -44 (-28)	(-55) -42 (-26)
	SEV	(-29) -21 (-13)	(-28) -19 (-10)	(-58) -45 (-28)	(-55) -42 (-26)
Spokane	PFL	(-49) -38 (-21)	(-52) -41 (-23)	(-72) -61 (-49)	(-75) -65 (-54)
	MON	(-44) -34 (-19)	(-49) -38 (-22)	(-67) -55 (-44)	(-73) -62 (-50)
	NIN	(-42) -32 (-18)	(-46) -36 (-21)	(-63) -52 (-40)	(-70) -58 (-46)
	LFL	(-40) -30 (-17)	(-44) -33 (-20)	(-61) -50 (-38)	(-67) -55 (-43)
Middle Columbia	GCL	(-20) -14 (-10)	(-15) -9 (-3)	(-48) -36 (-22)	(-27) -18 (-11)
	CHL	(-31) -14 (-4)	(-49) -19 (-1)	(-63) -40 (-15)	(-88) -64 (-19)
	CHJ	(-20) -14 (-9)	(-14) -9 (-3)	(-48) -36 (-22)	(-27) -18 (-11)
	WEL	(-21) -14 (-10)	(-15) -10 (-4)	(-49) -37 (-22)	(-29) -19 (-14)
	RRH	(-21) -14 (-10)	(-16) -10 (-4)	(-49) -37 (-22)	(-31) -20 (-15)
	RIS	(-21) -15 (-10)	(-17) -10 (-5)	(-50) -37 (-22)	(-32) -21 (-16)
	WAN	(-21) -14 (-10)	(-17) -10 (-5)	(-50) -37 (-22)	(-32) -21 (-15)
	PRD	(-21) -14 (-10)	(-17) -10 (-5)	(-50) -37 (-22)	(-32) -21 (-16)
Yakima	KEE	(-63) -42 (-24)	(0) 6 (16)	(-81) -68 (-43)	(-2) 12 (28)
	KAC	(-62) -41 (-25)	(-1) 10 (35)	(-80) -69 (-46)	(5) 37 (80)
	CLE	(-41) -24 (-11)	(3) 6 (12)	(-80) -59 (-29)	(-4) 7 (13)
	BUM	(-53) -34 (-20)	(-41) -25 (-13)	(-81) -64 (-39)	(-67) -51 (-27)
	RIM	(-37) -25 (-14)	(-4) 1 (6)	(-64) -47 (-27)	(-8) 1 (8)
Upper Snake	JCKY	(-27) -14 (-1)	(-12) -5 (4)	(-56) -43 (-17)	(-31) -18 (-3)
	PALI	(-25) -13 (0)	(-11) -3 (5)	(-49) -37 (-14)	(-26) -16 (-2)
	HEII	(-24) -12 (0)	(-11) -3 (5)	(-47) -36 (-14)	(-26) -16 (-2)
	LORI	(-24) -12 (0)	(-16) -4 (10)	(-47) -36 (-14)	(-38) -24 (-3)
	REXI	(-17) -9 (0)	(-18) -9 (1)	(-40) -29 (-9)	(-40) -29 (-9)
	SHYI	(-22) -11 (0)	(-19) -6 (8)	(-45) -34 (-12)	(-47) -33 (-7)
	BFTI	(-22) -11 (0)	(-27) -7 (11)	(-46) -35 (-12)	(-63) -45 (-8)
	AMFI	(-21) -10 (1)	(-2) 4 (11)	(-43) -32 (-10)	(-13) -7 (9)
	MILI	(-20) -10 (1)	(-24) 8 (52)	(-44) -32 (-10)	(-79) -47 (31)
	KIMI	(-19) -10 (1)	(-20) 8 (46)	(-43) -31 (-10)	(-69) -40 (29)
	SKHI	(-15) -7 (4)	(-5) 9 (25)	(-36) -23 (-4)	(-16) -1 (29)

	SWAI	(-14) -5 (6)	(-7) 8 (23)	(-33) -18 (0)	(-20) -1 (32)
	ANDI	(-27) -12 (3)	(-17) -7 (6)	(-53) -35 (-8)	(-30) -19 (1)
	ARKI	(-27) -12 (0)	(-15) -7 (3)	(-52) -35 (-8)	(-33) -19 (-1)
	LUCI	(-27) -12 (0)	(-13) -5 (3)	(-52) -36 (-10)	(-29) -16 (0)
	BIGI	(-27) -11 (0)	(-20) -9 (12)	(-51) -34 (-8)	(-42) -24 (10)
	OWY	(-24) 6 (58)	(-11) 0 (23)	(-30) 4 (110)	(-18) -1 (37)
	SNYI	(-15) -5 (6)	(-10) 5 (24)	(-33) -16 (2)	(-24) -2 (29)
	DEDI	(-39) -20 (-6)	(-10) -1 (10)	(-65) -54 (-29)	(-21) -11 (2)
	PABI	(-40) -23 (-10)	(-18) -6 (1)	(-69) -53 (-30)	(-34) -23 (-3)
	HRSI	(-32) -18 (-7)	(-22) -12 (-3)	(-61) -47 (-26)	(-41) -29 (-13)
	PRPI	(-34) -18 (-7)	(-34) -16 (-4)	(-61) -47 (-25)	(-58) -42 (-16)
	WEII	(-16) -6 (3)	(-16) -1 (12)	(-36) -19 (-1)	(-32) -12 (14)
	BRN	(-17) -6 (3)	(-15) -1 (11)	(-36) -19 (-1)	(-30) -12 (14)
	OXB	(-17) -6 (3)	(-15) -1 (11)	(-36) -19 (-1)	(-30) -12 (14)
Lower Snake	ANA	(-22) -10 (-2)	(-24) -9 (-1)	(-45) -30 (-10)	(-48) -30 (-7)
	DWR	(-41) -29 (-18)	(-6) -1 (4)	(-67) -56 (-42)	(-15) -7 (-1)
	SPD	(-41) -25 (-18)	(-27) -16 (-10)	(-69) -55 (-40)	(-48) -36 (-26)
	LWG	(-26) -13 (-6)	(-24) -9 (-4)	(-48) -34 (-15)	(-45) -29 (-11)
	LGS	(-26) -13 (-6)	(-24) -9 (-3)	(-48) -34 (-15)	(-45) -29 (-11)
	LMN	(-28) -13 (-7)	(-26) -11 (-4)	(-50) -36 (-16)	(-48) -32 (-13)
	IHR	(-28) -13 (-7)	(-27) -11 (-4)	(-50) -36 (-16)	(-48) -32 (-13)
	MCN	(-21) -14 (-11)	(-17) -10 (-6)	(-49) -34 (-21)	(-36) -24 (-15)
Lower Columbia	JDA	(-21) -14 (-11)	(-17) -10 (-6)	(-49) -34 (-21)	(-36) -23 (-15)
	TDA	(-21) -14 (-11)	(-17) -10 (-6)	(-49) -34 (-21)	(-36) -23 (-15)
	BON	(-21) -14 (-11)	(-17) -10 (-6)	(-49) -34 (-21)	(-35) -23 (-15)
Willamette	SVN	(-38) -25 (-16)	(-35) -22 (-13)	(-58) -40 (-25)	(-54) -35 (-22)

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