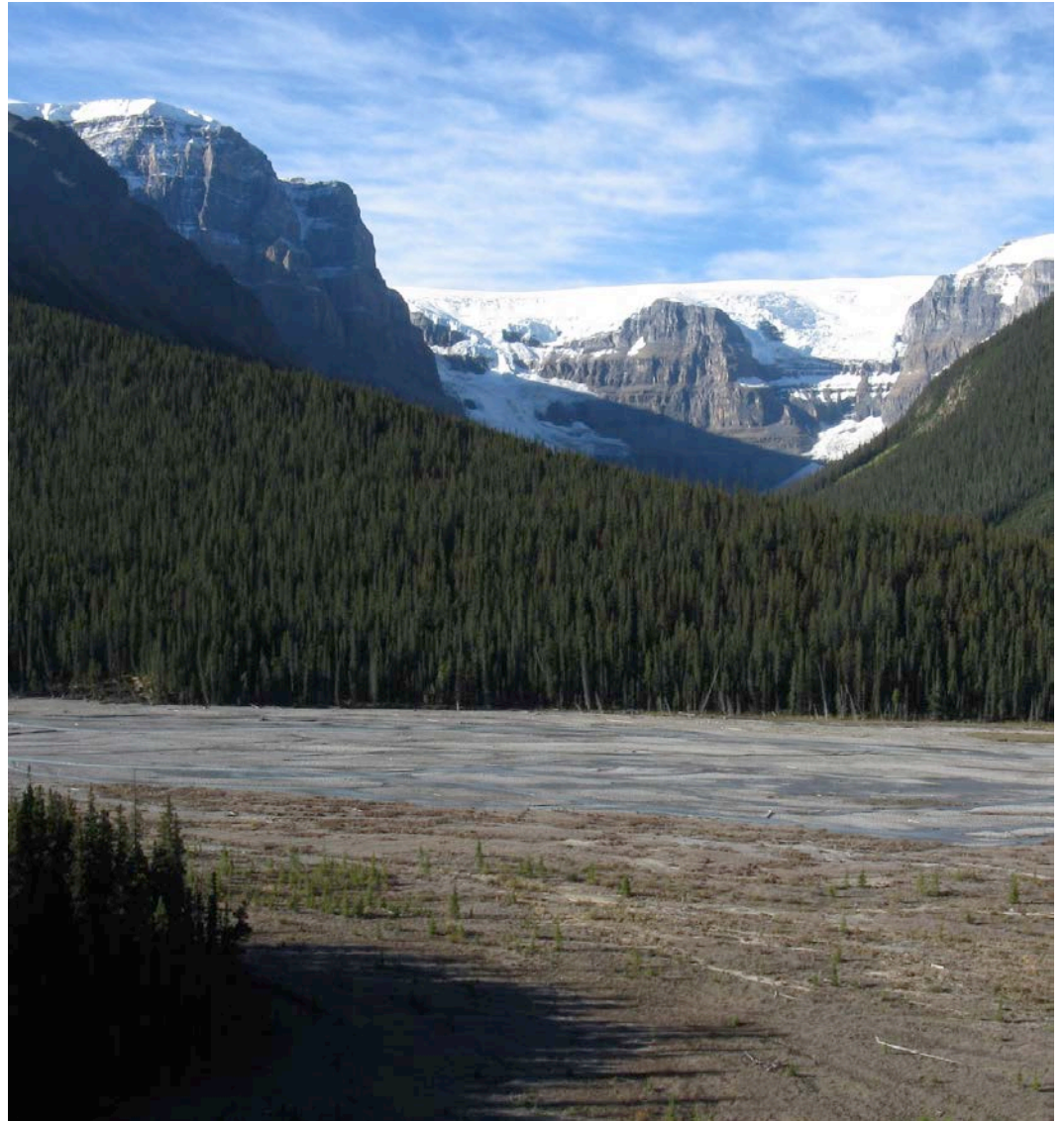


Long-Term Variability of the Flow of the Athabasca River

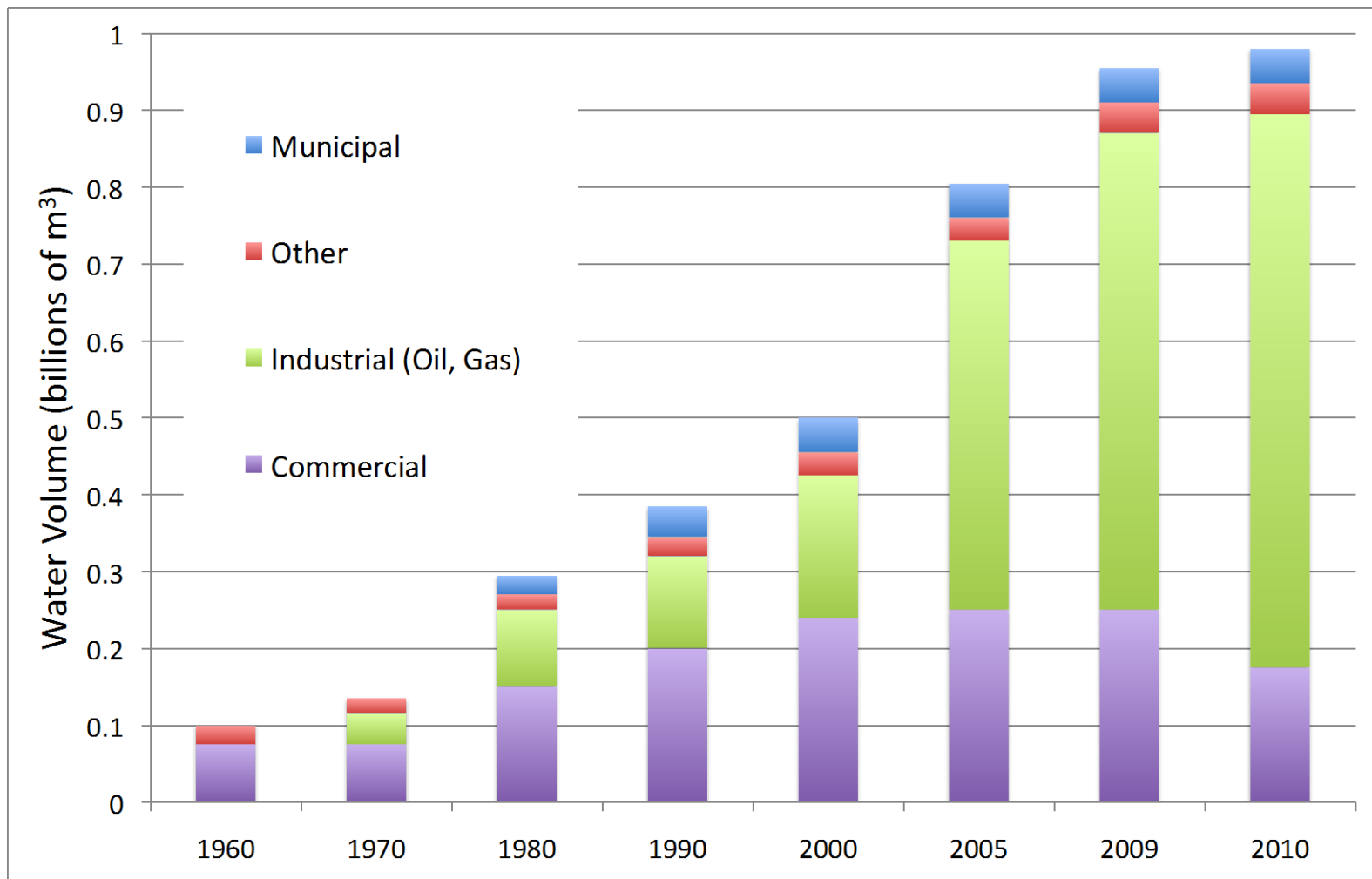
Dave Sauchyn
Ph.D., P.Geo.



University
of Regina

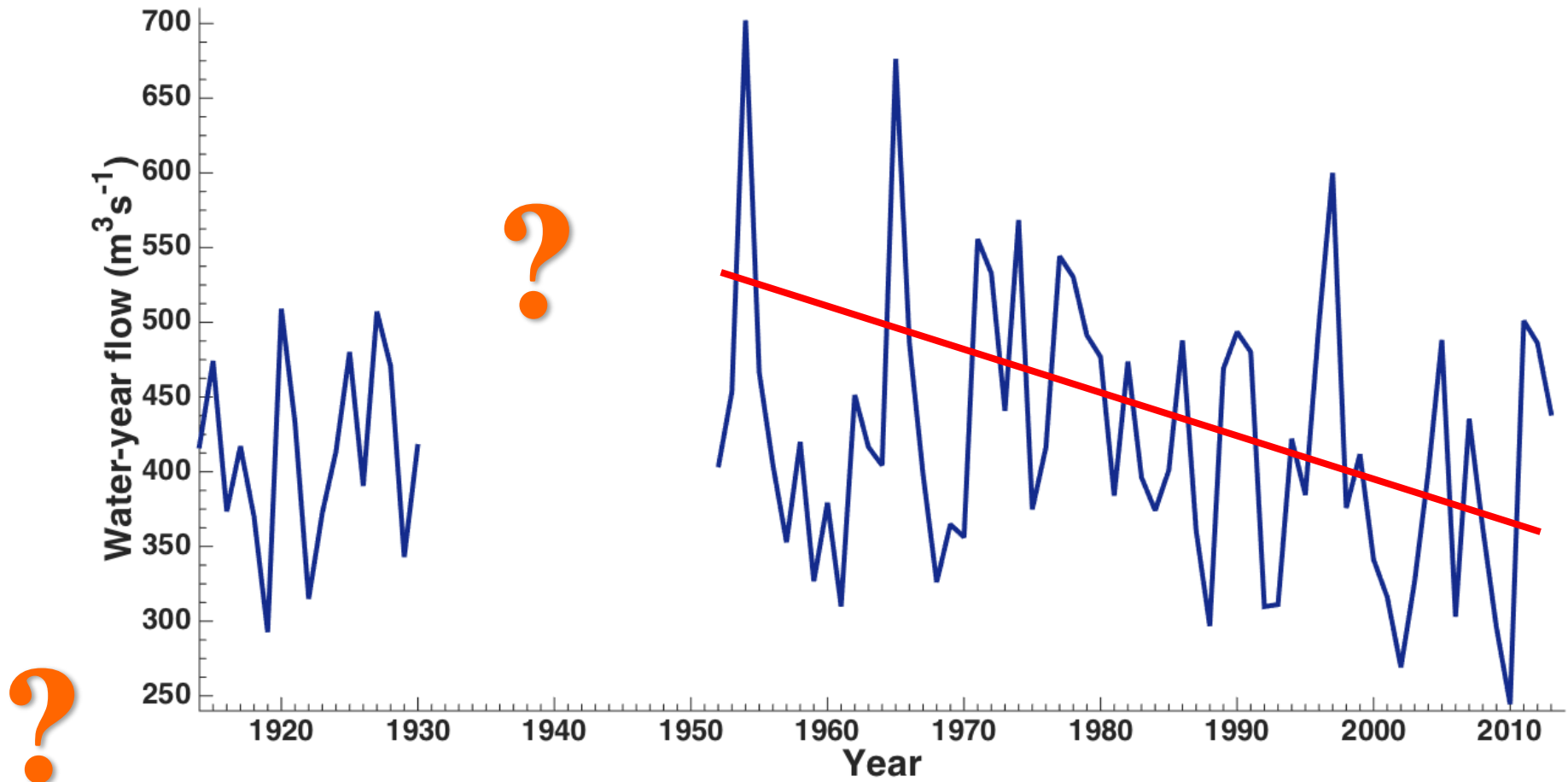


Surface Water Allocation, Athabasca River Basin

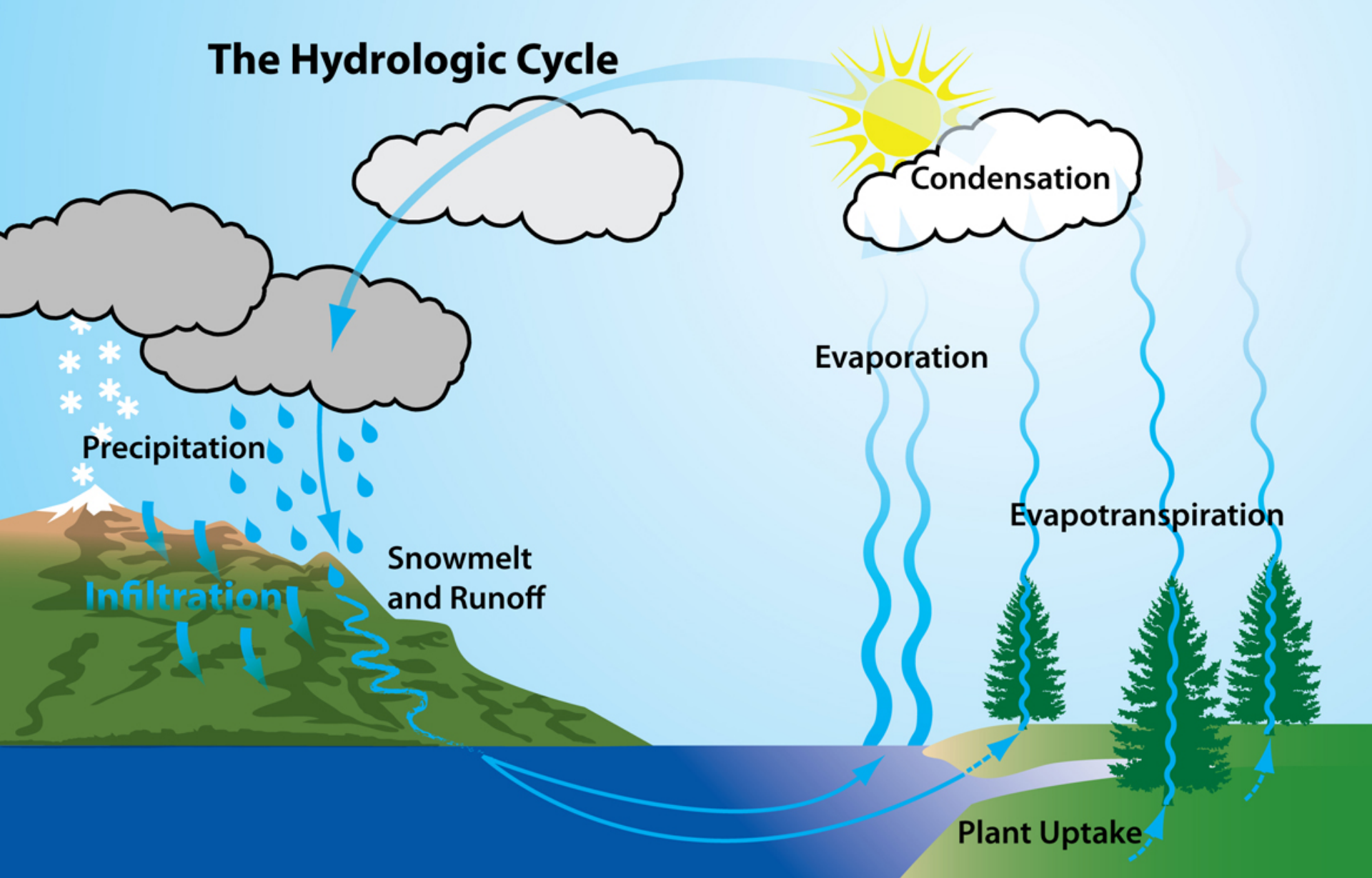


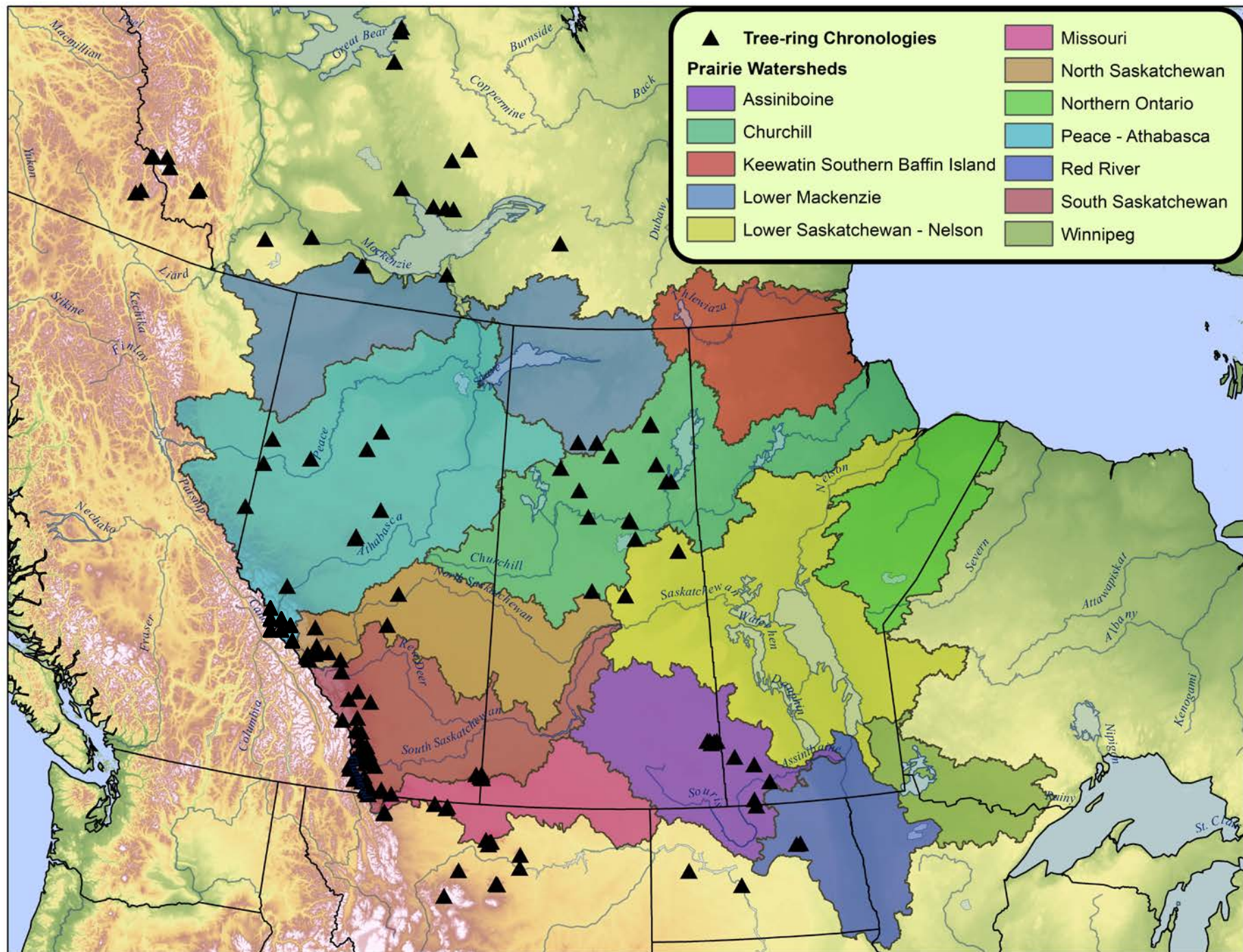
Source: Government of Alberta

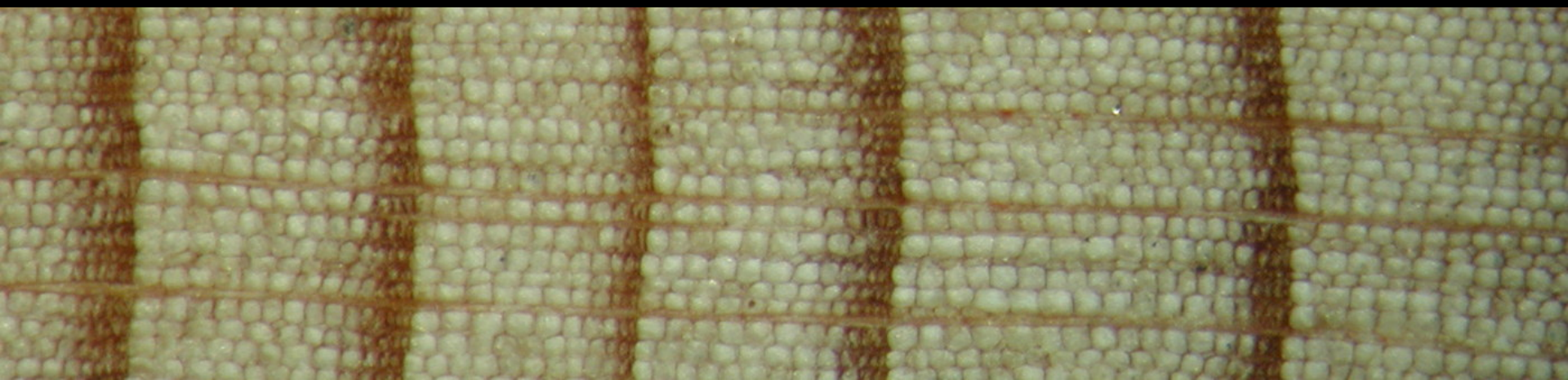
Mean water-year (October 1 to September 30) flow of the Athabasca River at Athabasca, 1913–2013



Streams and Trees Respond to the Same Weather Variables

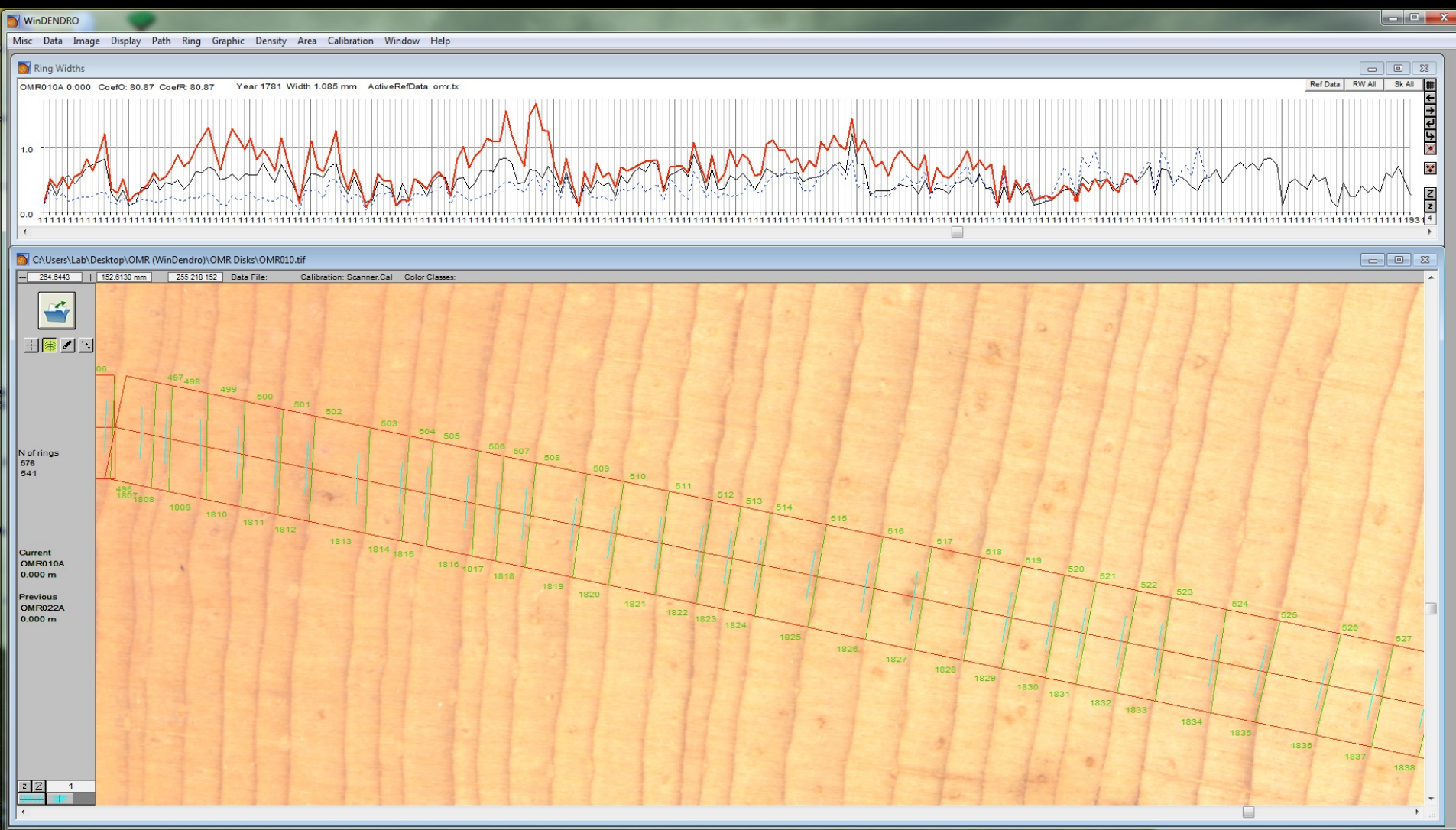




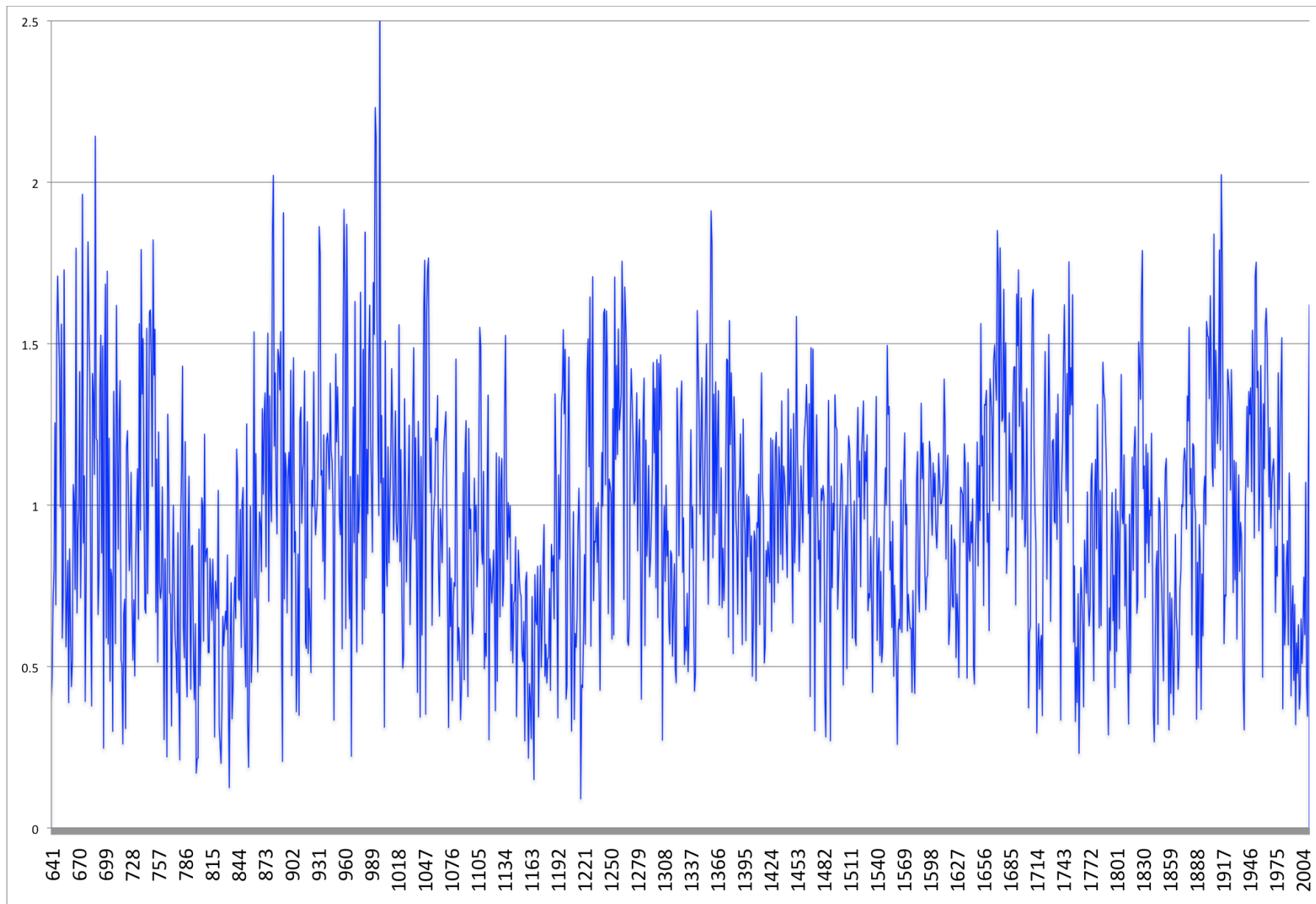




Semi-automated image analysis and measurement of tree rings



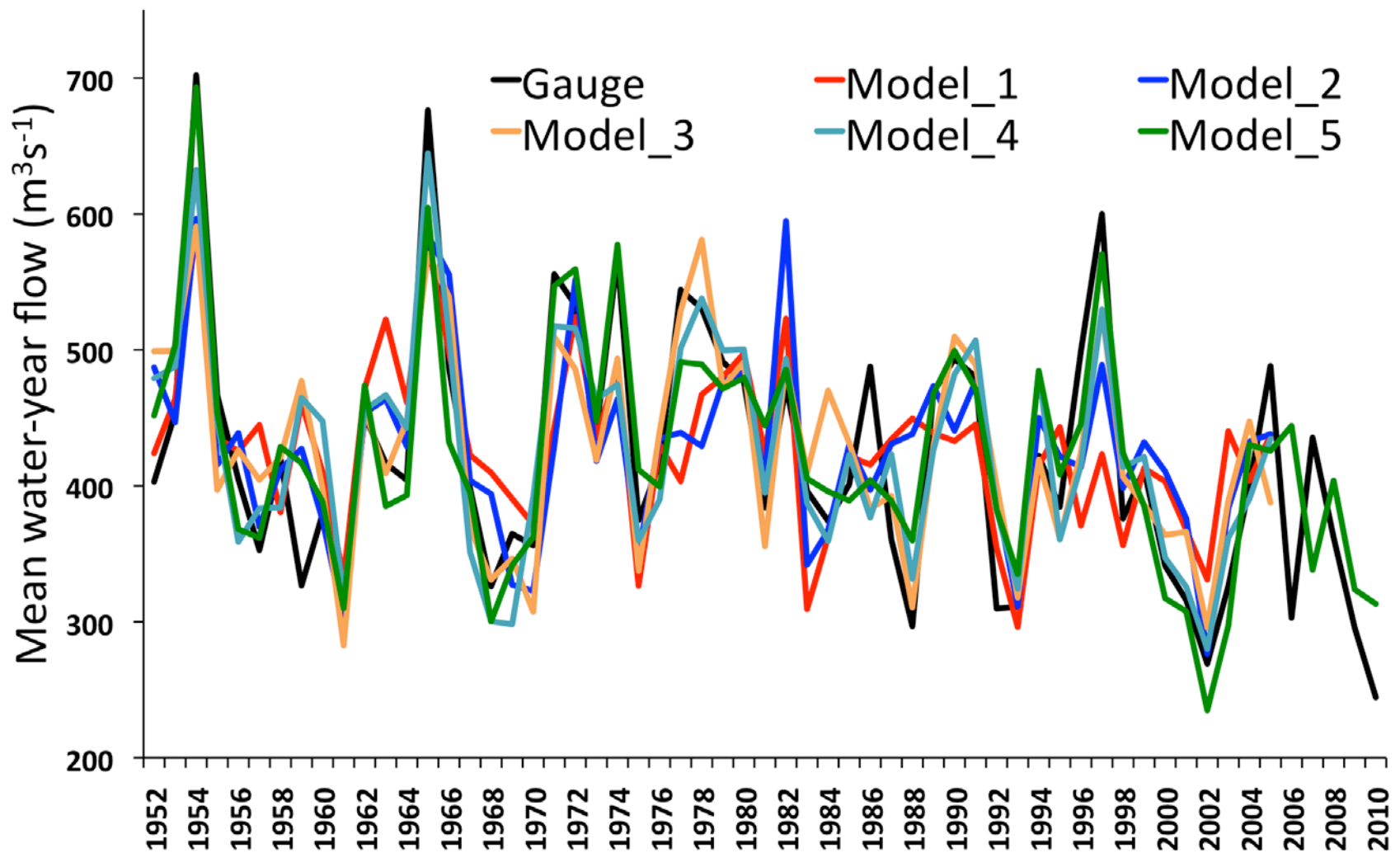
Kootenay Tree-Ring Plains Index Chronology, 641-2012





The Tree-Ring Data

Code	Name	Species ¹	Lat (° N)	Long (° W)	1 st Yr ²	Last Yr	# ³	<i>r</i> ⁴	ms ⁵	ac ⁶
dea	Douglas Fir Ecological Area	Psme	52.19	116.44	1471	2007	50	0.802	0.389	0.367
dmh	Deadman Hole	Psme	52.87	118.07	1699	2012	35	0.797	0.420	0.181
grn	Grey Nun	Pigl	53.62	113.65	1868	2011	40	0.636	0.305	0.503
jola	Johnson Lake	Psme	51.96	115.49	1446	2011	46	0.730	0.304	0.549
mgc	Maligne Canyon	Psme	52.92	118.00	1758	2012	19	0.705	0.229	0.396
plk	Patricia Lake	Psme	52.88	118.08	1725	2013	45	0.780	0.302	0.398
sfr	Siffleur Ridge	Pifl	52.04	116.39	1018	2012	62	0.776	0.383	0.544
skc	Saskatchewan Crossing	Pifl	51.97	116.72	1109	2007	60	0.667	0.286	0.336
swh	Swan Hills	Piba	54.80	115.60	1733	2004	22	0.572	0.201	0.575
ttb	Trail TwoB	Psme	52.92	118.09	1534	2013	148	0.774	0.376	0.276
two	Two O'Clock Creek	Psme	52.06	116.43	1496	2013	38	0.787	0.428	0.449
vrl	Virl Lake	Psme	52.87	118.25	1660	2013	49	0.789	0.265	0.442
wab	Wabasca	Piba	56.05	113.77	1815	2006	28	0.572	0.227	0.531
wbs	Wabasso Lake	Psme	52.80	117.96	1599	2013	29	0.825	0.422	0.362
wpp	Whirlpool Point	Pifl	52.00	116.45	1062	2013	32	0.751	0.463	0.270
wrc	Whiterabbit Creek	Psme	52.07	116.38	1555	2008	38	0.836	0.414	0.283

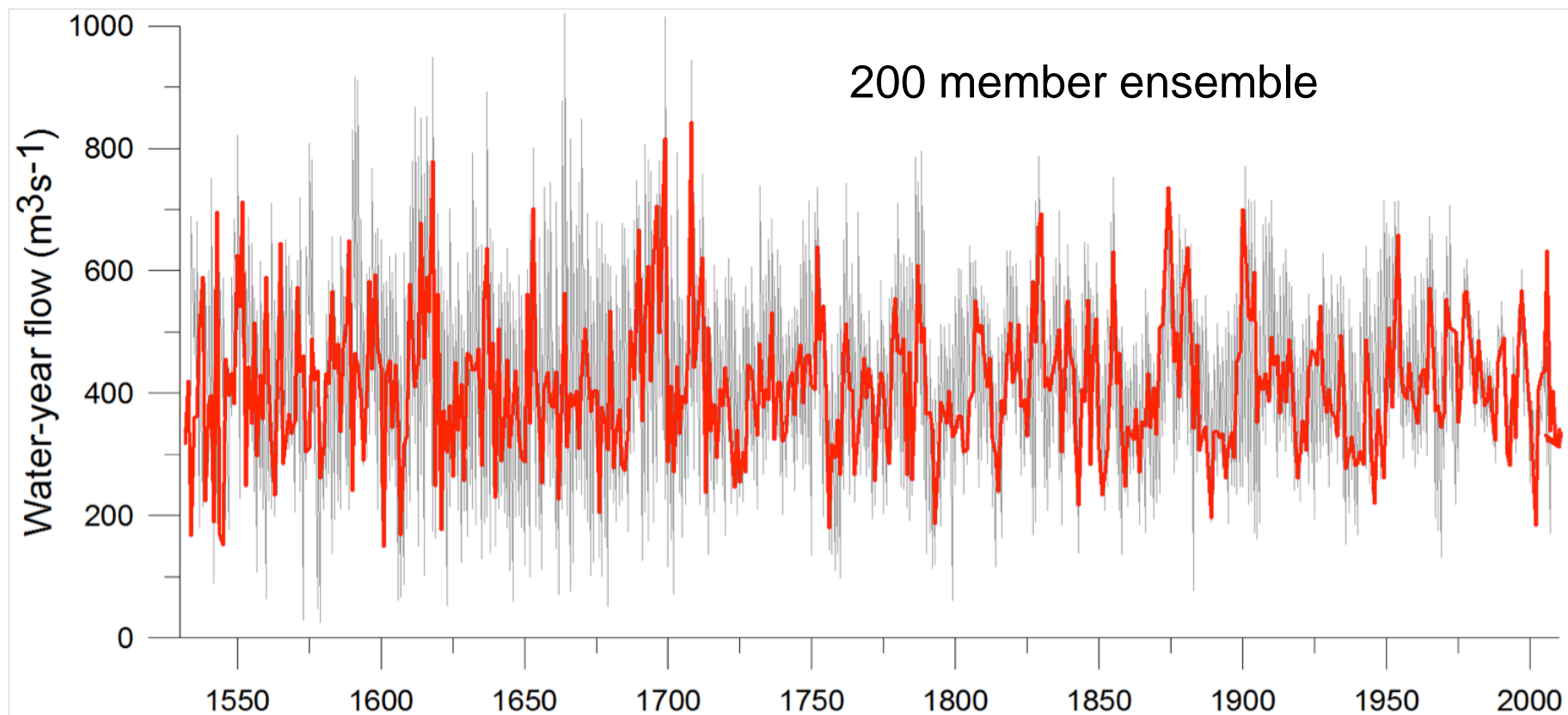
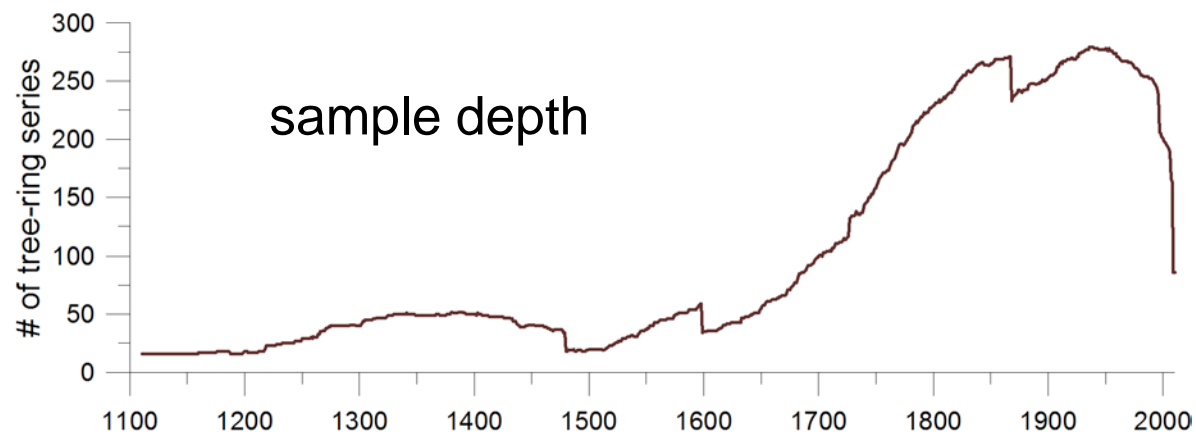


Observed versus modeled flow of the Athabasca River at Athabasca over the calibration period (1952–2010) for the five tree-ring models

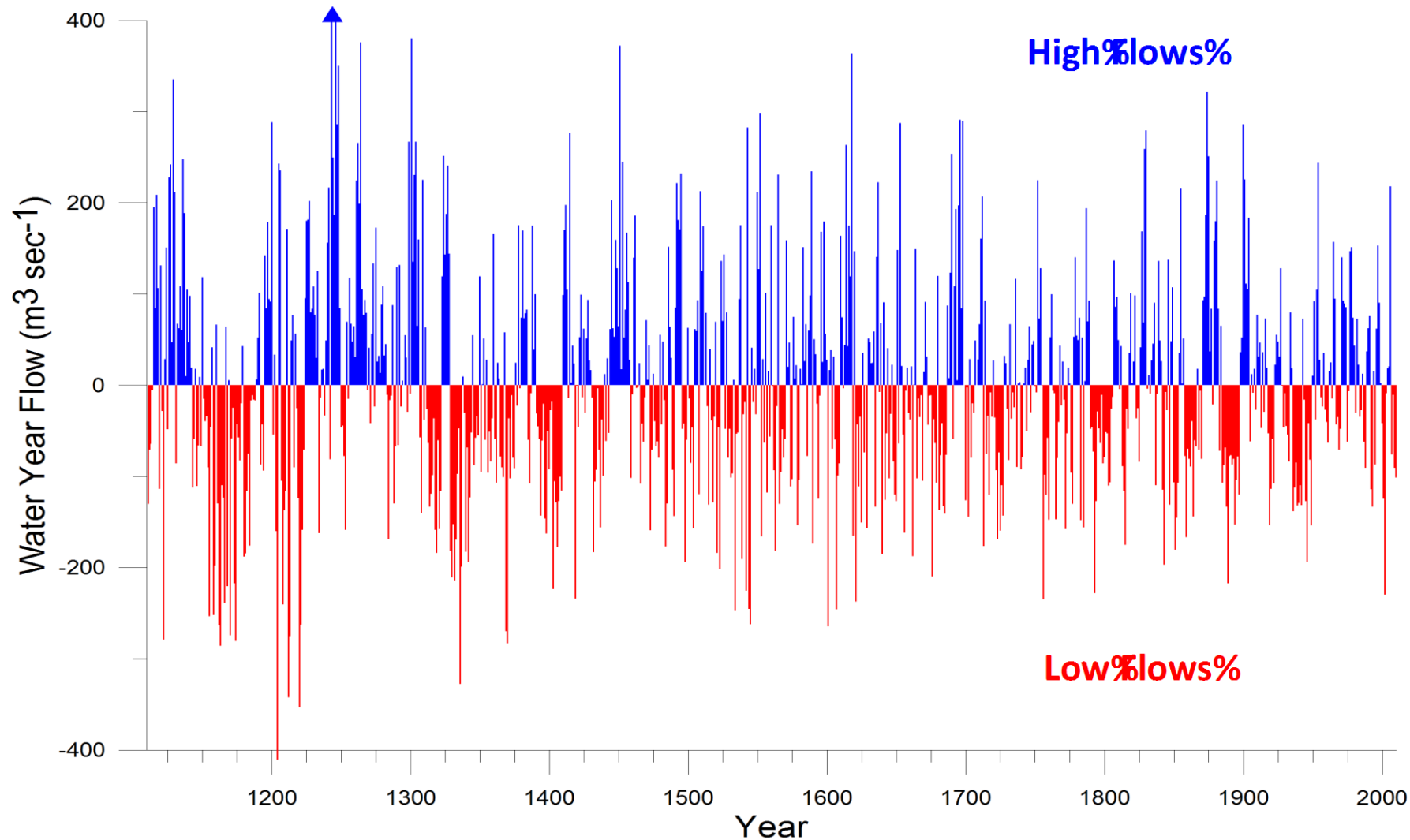
Table 2. The statistics of the five nested tree-ring models comprising the Athabasca River at Athabasca reconstruction for AD 1111–2010

Model no.	Yr1	R^2	R^2_{adj}	RE	RMSE _v	SE	<i>P</i>
5	1868	0.83	0.80	0.73	47.3	41.5	**
4	1725	0.74	0.68	0.62	56.3	52.5	**
3	1599	0.65	0.60	0.50	64.4	58.5	**
2	1482	0.54	0.47	0.34	78.9	66.8	**
1	1111	0.43	0.36	0.23	80.0	73.7	*

The regression model equations are given in [Table S4](#). Yr1, first year of reconstruction; *P*, *P* value of F statistic: ** < 0.0001, * < 0.001.



Departures from Water-Year Flow (m^3s^{-1}) Athabasca River at Athabasca, 1111-2010



Modern Analogues of Paleo Droughts

Year	% Δ^1	Modern Analog ²	Year	% Δ^1	Modern Analog ²
1790	-12.3	1969	1888	-40	2010
1791	-11.9	1984	1889	-9.9	1960
1792	-18.3	2000	1890	-61.2	NMA ²
1793	-55.4	NMA ²	1891	-55.3	NMA ²
1794	-31.2	2009	1892	-27.6	2006
1795	-7.8	1995	1893	-34.8	2002
1796	-12.2	1969	1894	-19.1	2000
1797	-16	1957	1895	-22.4	2003
1798	-3.4	1956	1896	-36.2	2002
1799	-21.4	1959	¹ Negative departure of inferred water year flow from the reconstruction mean ($418 \text{ m}^3 \text{ s}^{-1}$) ² Comparable modern (1952-2010) anomaly relative to mean water year flow of $419 \text{ m}^3 \text{ s}^{-1}$ ³ NMA: No modern analog		
1800	-19.7	2000			
1801	-13.2	1969			
1802	-13.5	2008			
1803	-27.2	2006			
1804	-26.4	1992			
1805	-7	1995			
1806	-3.9	1952			

Long-term variability and reliability of the flow of the Athabasca River



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Sauchyn, DJ, St Jacques, J-M, Luckman, BH. 2015 Long-term reliability of the Athabasca River (Alberta, Canada) as the water source for oil sands mining, **Proceedings of the National Academy of Sciences**, vol. 112 no. 41, 12621-12626, DOI10.1073/pnas.1509726112
Published online September 21, 2015



Oilsands may face severe water shortages, Athabasca River study suggests

'The river is much more variable than you would think based on measurements since 1950s'

By Emily Chung, [CBC News](#) | Posted: Sep 21, 2015 3:19 PM ET | Last Updated: Sep 25, 2015 4:00 PM ET

The river that provides water to the oilsands industry is much more prone to multi-year droughts than modern records show, suggesting that the industry's current level of water use may not be sustainable, a new study suggests.

But a study led by University of Regina researcher David Sauchyn has found that those water flow measurements aren't that representative of the river's long-term behaviour.





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Saturday September 26, 2015

The Oilsands and the Athabasca River's Fickle Flows



Athabasca River drought patterns hold warning for oil producers: study

IVAN SEMENIUK - SCIENCE REPORTER

The Globe and Mail (Includes correction)

Published Monday, Sep. 21, 2015 9:27PM EDT

Last updated Tuesday, Sep. 22, 2015 11:34AM EDT

Based on a 900-year record obtained from tree rings, researchers found that the Athabasca watershed has historically been subjected to **prolonged dry spells that are far more severe than anything the region has experienced** since the oil industry arrived there in the 1960s.

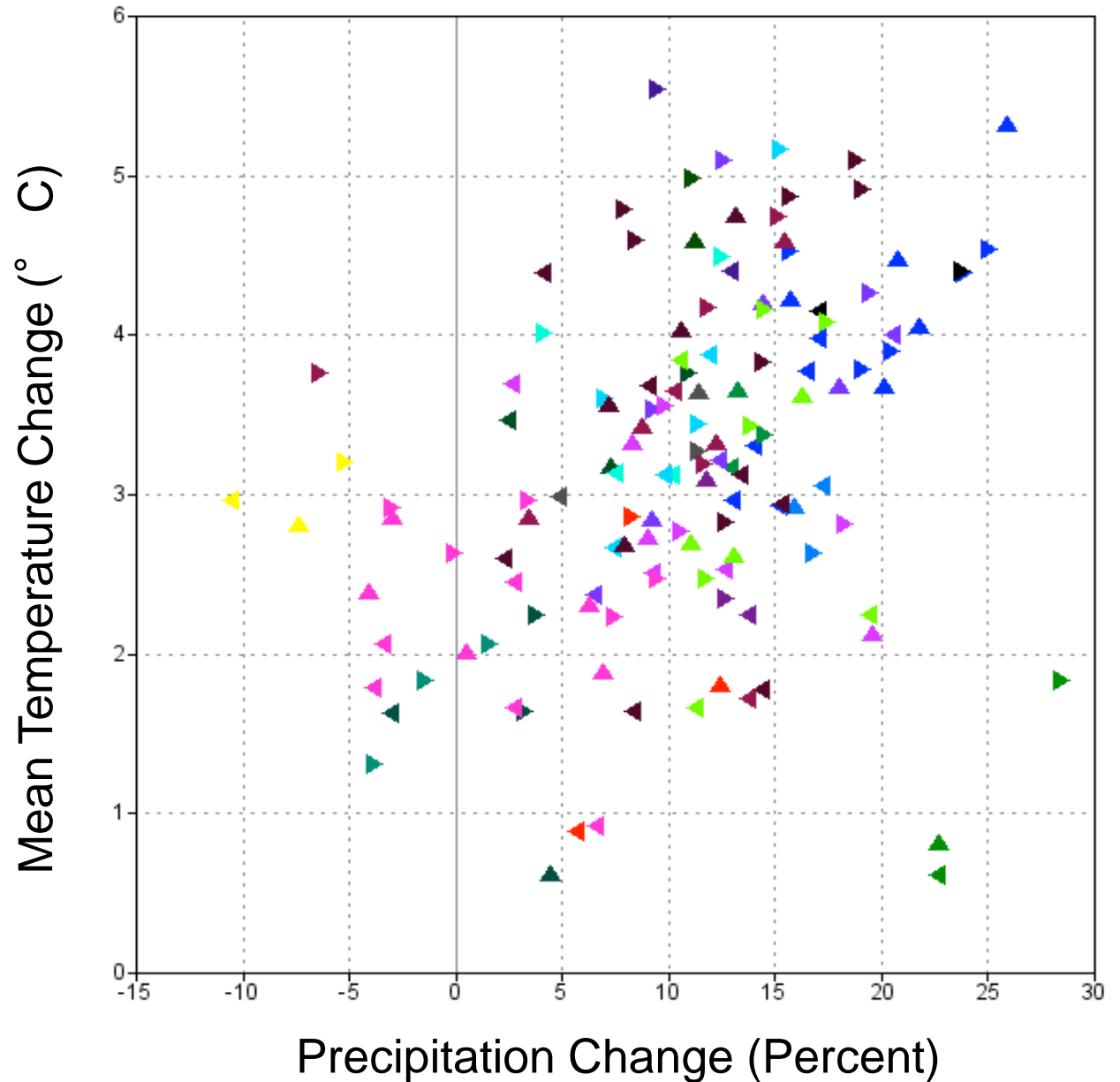
“In most centuries there were times when the water level fell and stayed low for decades,” said David Sauchyn, a paleohydrologist at the University of Regina in Saskatchewan and lead author of the study. **“If one of these prolonged droughts was to reoccur** there would have to be serious water conservation.”

Climate Change Projections, Northern Alberta

Winter

2040-69 vs
1961-90

Source: PCIC

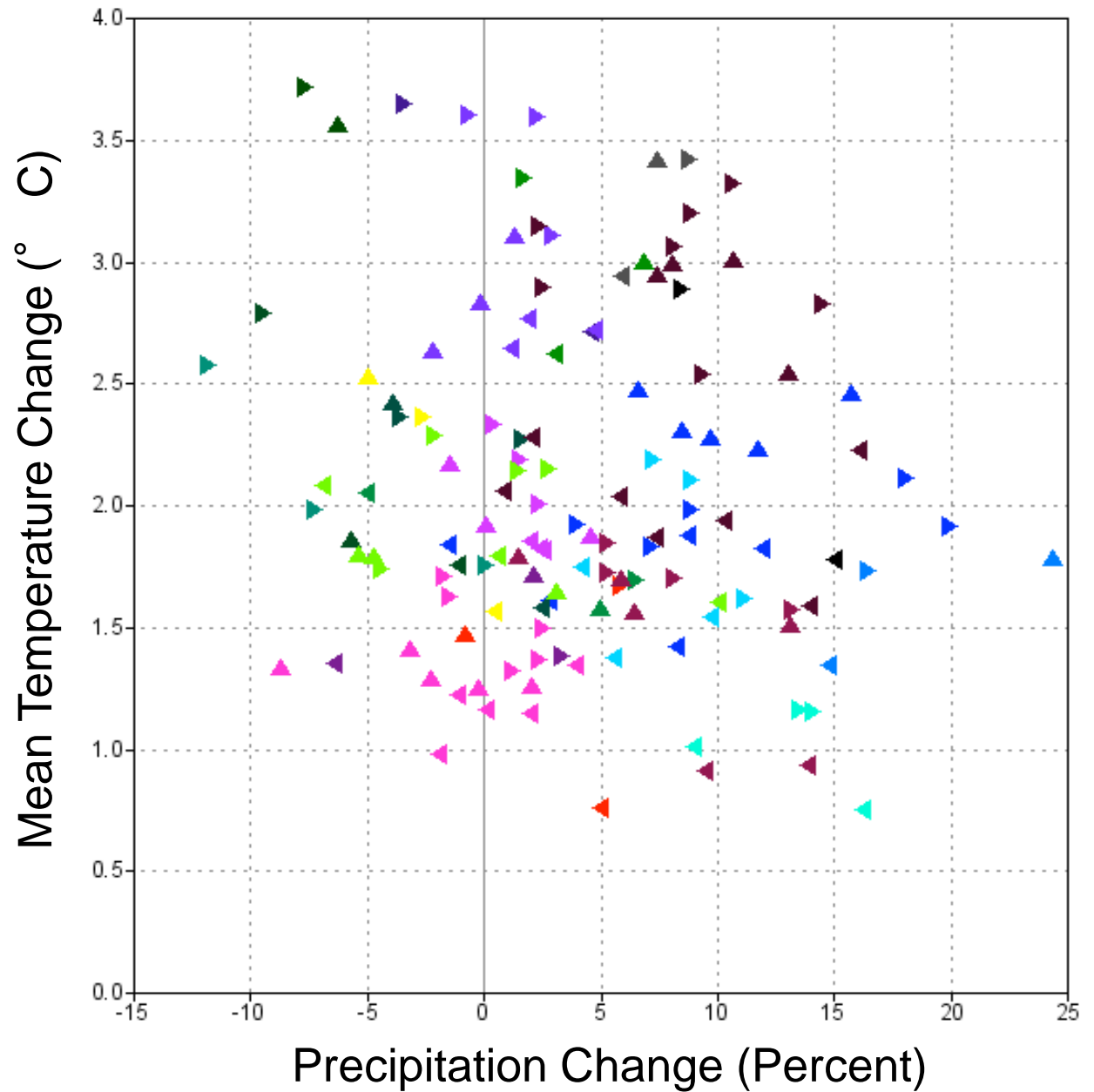


Climate Change Projections, Northern Alberta

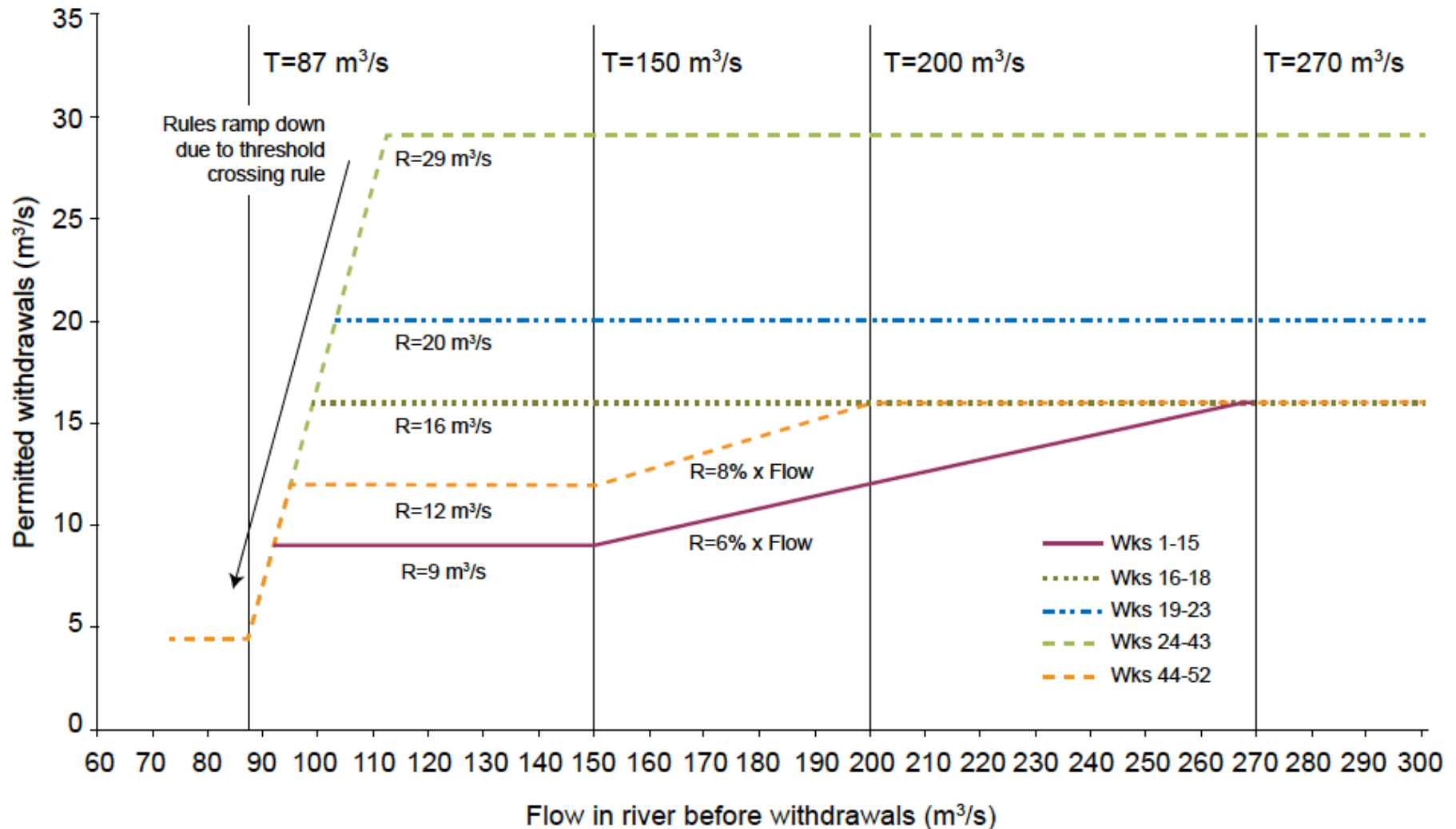
Summer

2040-69 vs
1961-90

Source: PCIC



Weekly Flow Triggers (T) and Cumulative Water Withdrawal Limits (R)



Government of Alberta. 2015. Surface Water Quantity Framework for the Lower Athabasca River

