Supplementary tables

Table S1. Spatial data used to discretize and parameterize the HRUs implemented in Raven.

Variable	Purpose	Source
Elevation	Delineating catchment boundaries; parameterizing HRUs for elevation, slope aspect, slope gradient	[1]Canadian Digital Elevation Model 3.0
Leading tree species, canopy closure, stand height, harvest year	Discretizing HRUs; informing parameterization of HRUs for leaf area index, canopy interception, canopy closure, regenerating stand height	[2]2012 VRI - Forest Vegetation Composite Polygons and Rank 1 Layer
Wildfire year		[3]Fire Incident Locations – Historical
BEC variant	Discretizing HRUs; informing parameterization of HRUs for leaf area index, canopy interception, canopy closure, clumpiness	[4]Biogeoclimatic Ecosystem Classification Map
Soil	Discretizing HRUs; informing parameterization of HRUs for soil texture, porosity, depth, permeability, runoff rate	[5]Soil Survey Spatial View

1. https://open.canada.ca/data/en/dataset/7f245e4d-76c2-4caa-951a-45d1d2051333; accessed May 2023
2. https://catalogue.data.gov.bc.ca/dataset/vri-historical-vegetation-resource-inventory-2002-2020-; accessed May 2023
3. https://open.canada.ca/data/en/dataset/e2dadc60-292f-4d98-b42b-56ca9e4fe694; accessed May 2023
4. https://open.canada.ca/data/en/dataset/f358a53b-ffde-4830-a325-a5a03ff672c3; accessed May 2023
5. https://catalogue.data.gov.bc.ca/dataset/soil-survey-spatial-view; accessed May 2023

Table S2. Summary of manual snowpack survey stations. The 2019 records were utilized for constraining model parameters, whereas the older records were utilized for calibration and validation.

Station	Elev. (m)	Slope (deg.)	Aspect (deg.)	Leading species	Crown clos. (%)	BEC variant	Record	Source
UP1	1629	4.1	146	Clearing	NA	ESSFdc1	1995-2009	Winkler et al., 2017
UP2	1660	4.6	209	Mature Pl	[1]83	ESSFdc1	1995-2015	
UP3	1644	4.6	240	Clearing	NA	ESSFdc1	1995-1997	
UP4	1658	5.6	289	Mature S/F	[2]70	ESSFdc1	1995-1997	
UP9	1884	10.8	232	3-5 m regen	NA	ESSFdc1	2000-2015	
UP10	1922	13.2	231	Mature Pl	[1]83	ESSFdc1	2000-2015	
UP11	1713	6.6	197	5-7 m regen	NA	ESSFdc1	2003-2009	
UP12	1723	8.9	222	Mature Pl	[2]65	ESSFdc1	2003-2009	
UP13	1675	4.4	163	3-5 m regen	NA	ESSFdc1	2005-2015	
2F08 (Greyback Reservoir)	1546	5.7	217	Mature S/F	[3]50-60	MSdm1	1953-2015	[4]BC Gov't
PPP1	801	15.7	356	Clearing	NA	PPxh1	2019	Smith, 2022
PPP2	710	9.6	315	Mature Py/Fd	[3]40-50	PPxh1	2019	
PIDF1	1283	5.1	207	Clearing	NA	IDFdm1	2019	
PIDF2	1297	19.7	153	Mature Fd	[3]70-80	IDFdm1	2019	
PIDF3	1221	21.7	319	Mature Fd	[3]70-80	IDFdm1	2019	
PIDF4	1258	18.4	327	Clearing	NA	IDFdm1	2019	
PMS1	1520	11.5	101	Mature Pl	[3]75-80	MSdm1	2019	
PMS2	1492	15.0	117	Clearing	NA	MSdm1	2019	
PESSF1	1810	14.7	99	Mature S/F	[3]55-65	ESSFdc1	2019	
PESSF2	1771	11.2	135	Clearing	NA	ESSFdc1	2019	

1. Measured using hemispherical photos.
2. Acquired from VRI data (Table S1).
3. Estimated visually in the field.
4. https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-science-data/water-data-tools/snow-survey-data; accessed May 2023

Table S3. Performance statistics from the model calibration and validation.

Dataset		Objective function	Performance	
			Calibration	Validation
Composite value		[1]Mean	0.87	0.79
Fit to spring freshet discharge	Penticton Creek	[2]NSE	0.81	0.81
	240 Creek	NSE	0.78	0.74
	241 Creek	NSE	0.77	0.80
	Dennis Creek	NSE	0.78	0.52
Fit to spring freshet discharge with 15-day smoother	Penticton Creek	NSE	0.87	0.87
	240 Creek	NSE	0.93	0.86
	241 Creek	NSE	0.91	0.88
	Dennis Creek	NSE	0.90	0.68
Spring freshet bias	Penticton Creek	[3]Absolute bias	0.97	0.96
	240 Creek	Absolute bias	0.98	0.91
	241 Creek	Absolute bias	0.93	0.94
	Dennis Creek	Absolute bias	0.90	0.94
Low flow bias	Penticton Creek	Absolute bias	0.87	0.35
	240 Creek	Absolute bias	0.79	0.72
	241 Creek	Absolute bias	0.79	0.71
	Dennis Creek	Absolute bias	0.61	0.47
Fit to SWE		NSE	0.95	0.93
SWE bias		Absolute bias	0.96	0.95
Precipitation bias at Penticton Airport		Absolute bias	1.00	0.97

1. Arithmetic mean of all metrics listed
2. Nash-Sutcliffe Efficiency
3. One minus absolute bias (normalized by mean of observed)

Table S4. Discharge (m³ s⁻¹) for 2 and 100 year return periods by event type, landcover condition, and climate condition. Values estimated through the event frequency analyses on output from the long-term simulations (Figure 10).

Climate condition	Landcover condition	Annual max discharge		Summer min discharge		Annual discharge	
		2 yr.	100 yr.	2 yr.	100 yr.	2 yr.	100 yr.
Current	Forested	13.8	22.9	0.172	0.0817	1.34	0.620
	Small burn	14.0	22.9	0.176	0.0827	1.35	0.631
	Large burn	15.8	26.9	0.209	0.0919	1.57	0.792
	1976	14.3	24.2	0.180	0.0836	1.48	0.683
	2012	14.3	23.0	0.175	0.0818	1.38	0.642
2050s	Forested	12.1	27.0	0.0832	0.0564	1.19	0.576
	Small burn	12.3	27.0	0.0837	0.0566	1.20	0.583
	Large burn	15.2	31.1	0.0915	0.0594	1.39	0.718
	1976	13.3	29.5	0.0860	0.0579	1.31	0.641
	2012	12.9	28.1	0.0842	0.0565	1.23	0.594
2080s	Forested	10.1	27.9	0.0610	0.0415	1.33	0.747
	Small burn	10.1	28.1	0.0612	0.0417	1.34	0.754
	Large burn	12.5	31.0	0.0660	0.0442	1.52	0.898
	1976	11.6	30.5	0.0627	0.0425	1.46	0.826
	2012	10.6	28.9	0.0615	0.0417	1.36	0.771

Supplementary figures
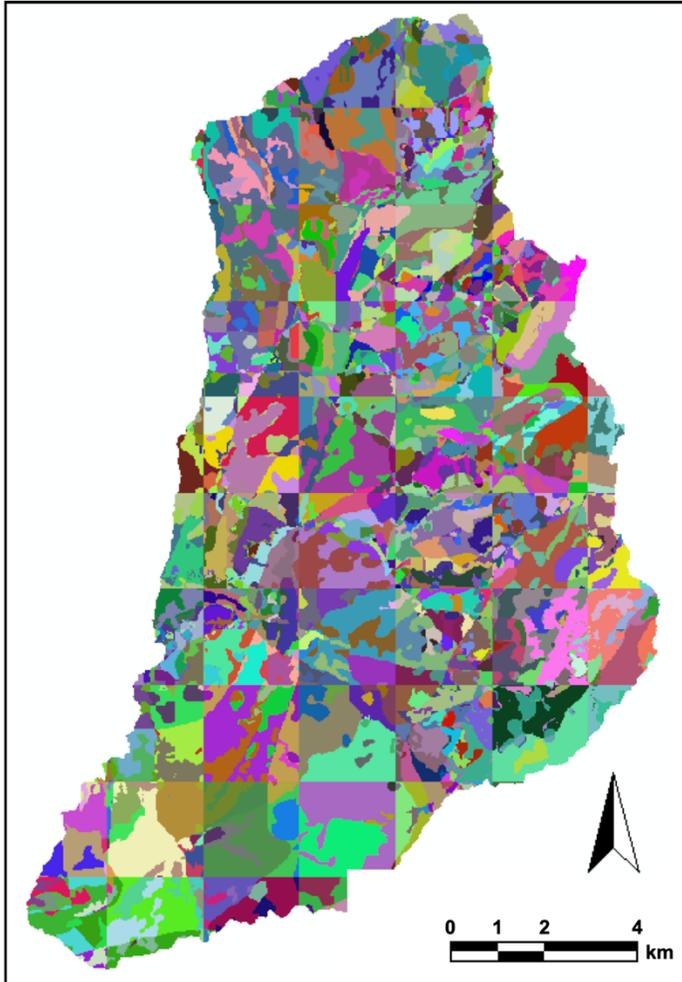
Figure S1. Discretization of the study catchment into 1,315 unique HRUs.
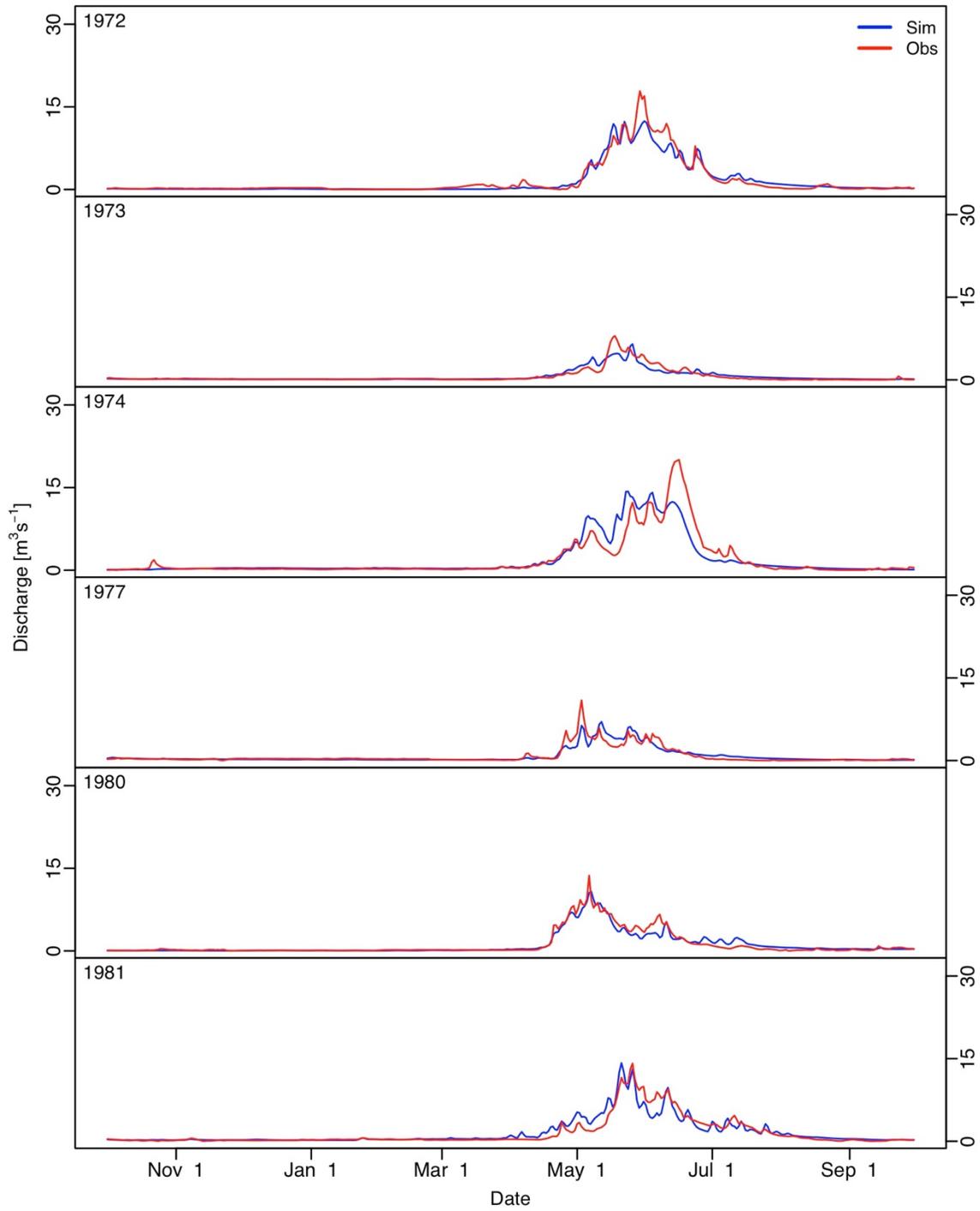
Figure S2.1. Penticton Creek discharge calibration plot.
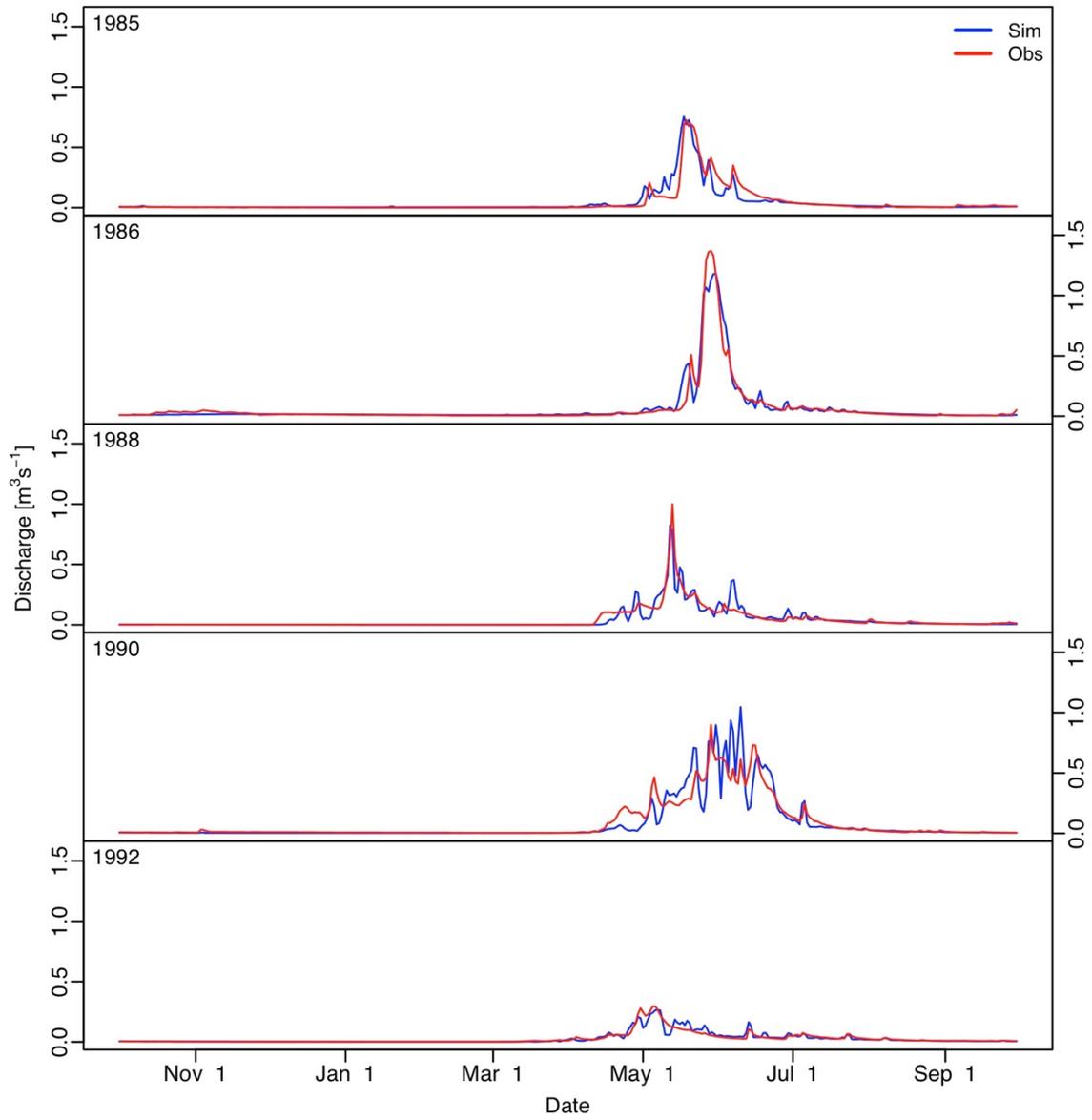
Figure S2.2. 240 Creek discharge calibration plot.
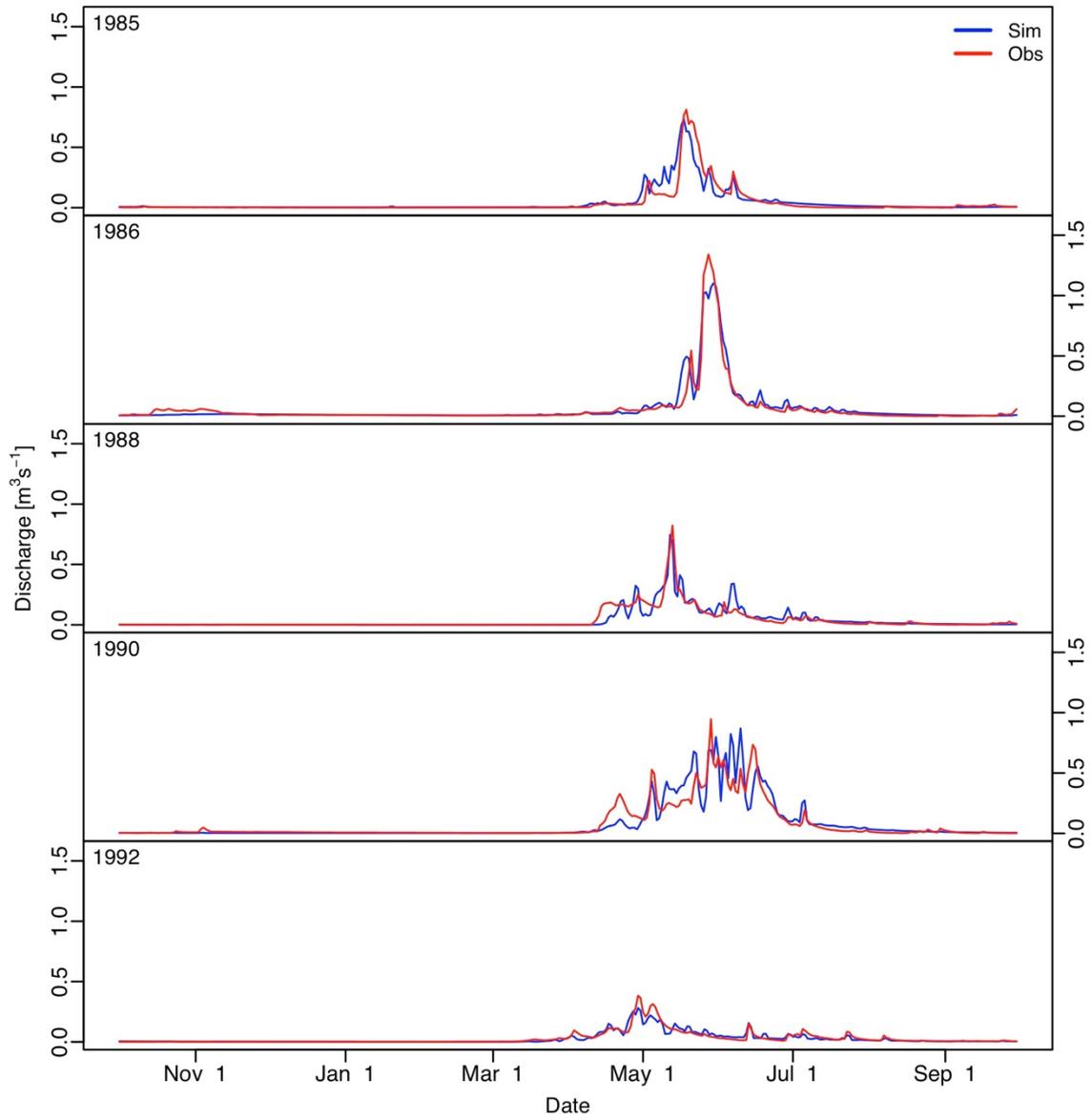
Figure S2.3. 241 Creek discharge calibration plot.
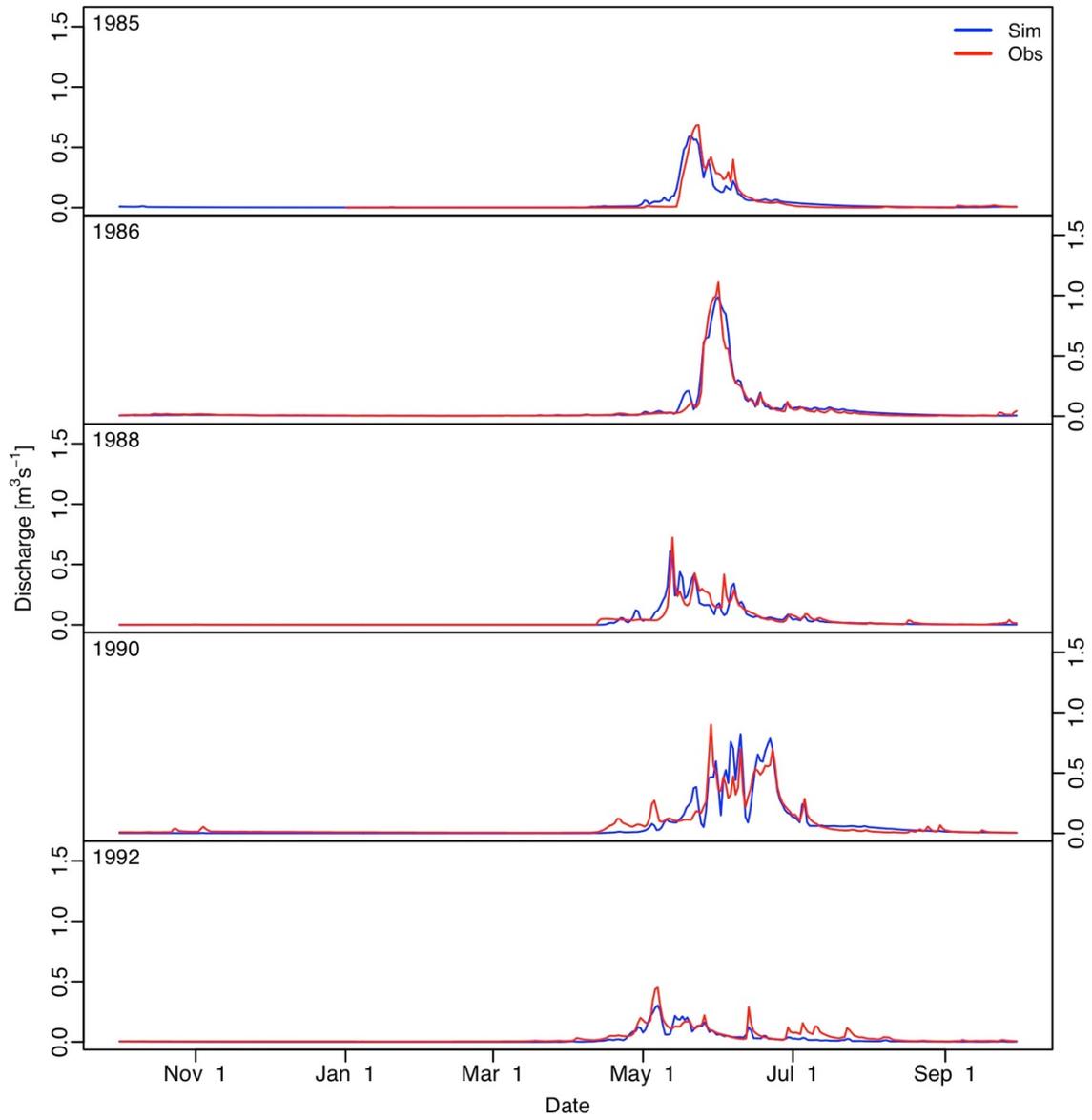
Figure S2.4. Dennis Creek discharge calibration plot.
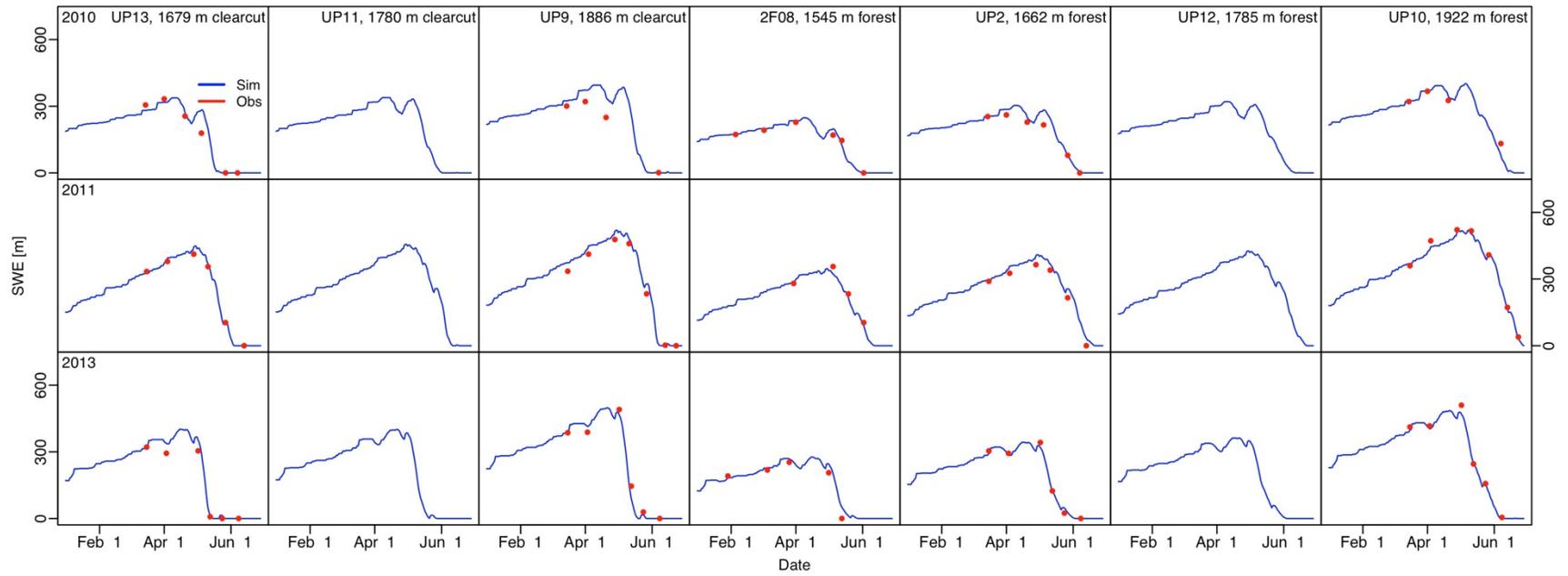
Figure S2.5. Snowpack calibration plot.
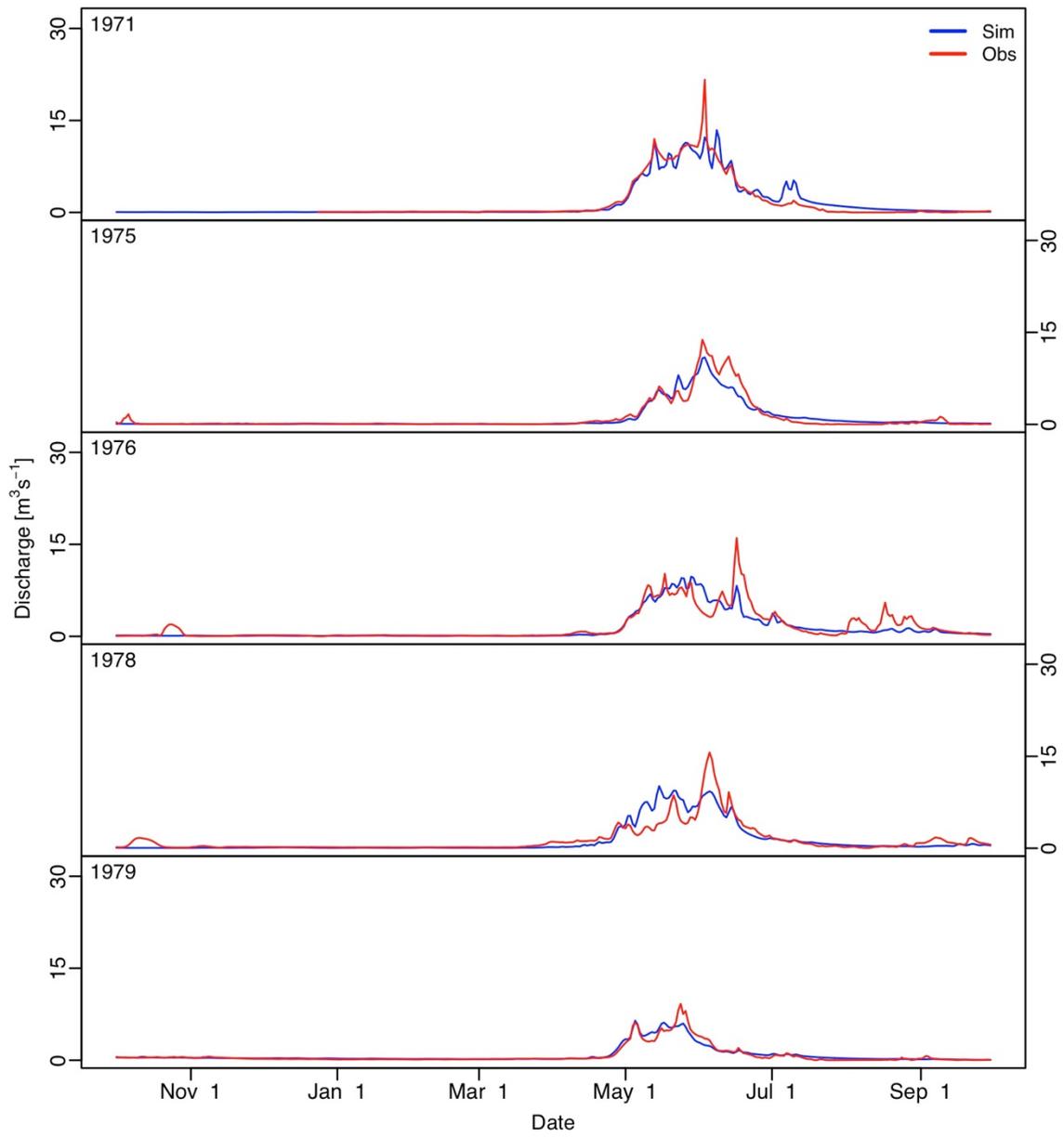
Figure S3.1. Penticton Creek discharge validation plot.
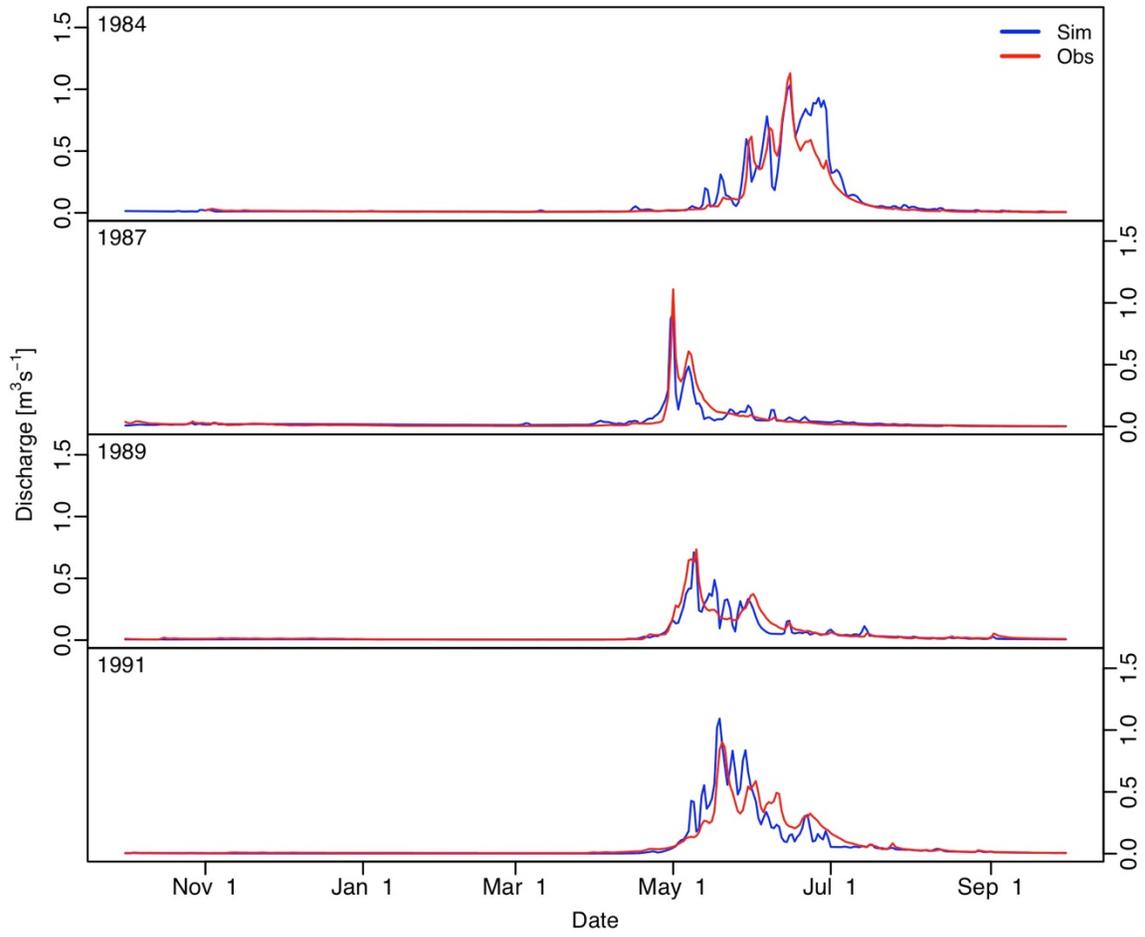
Figure S3.2. 240 Creek discharge validation plot.
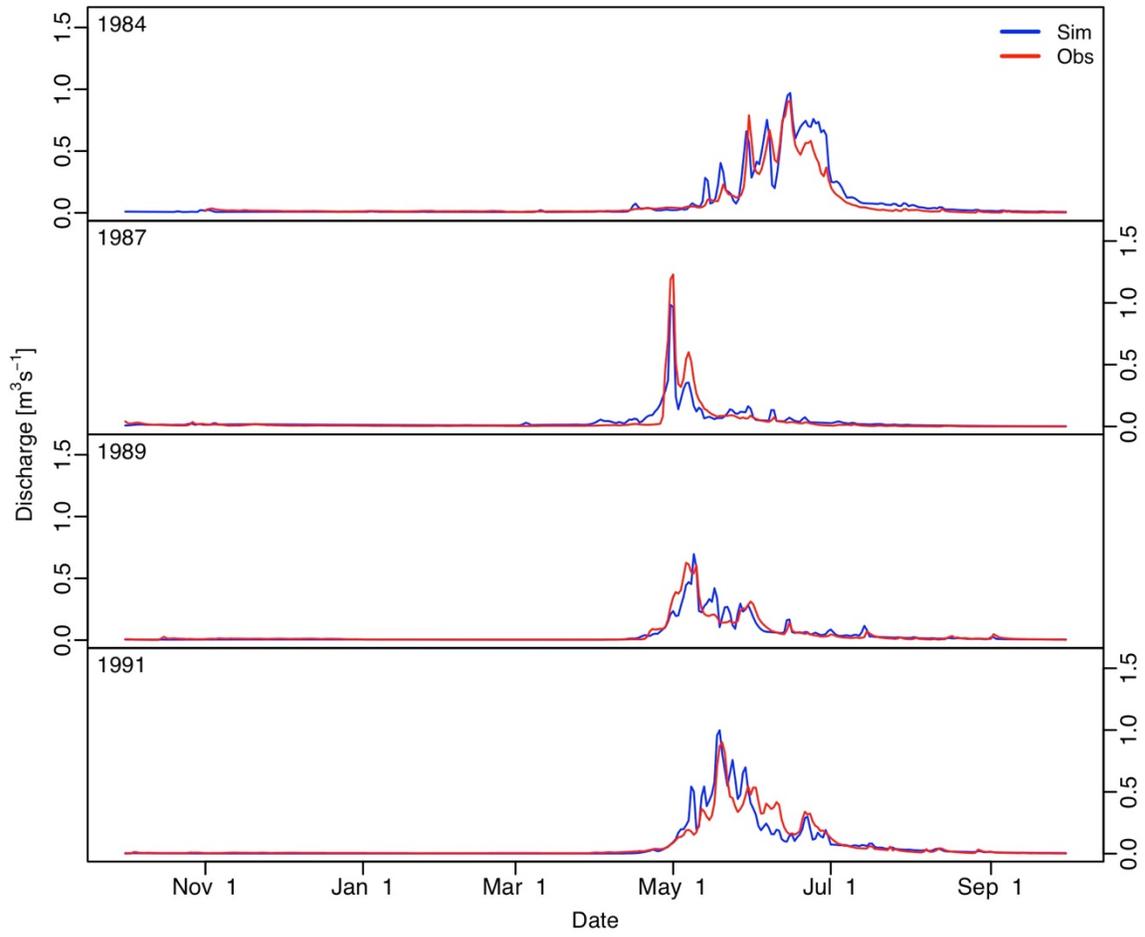
Figure S3.3. 241 Creek discharge validation plot.
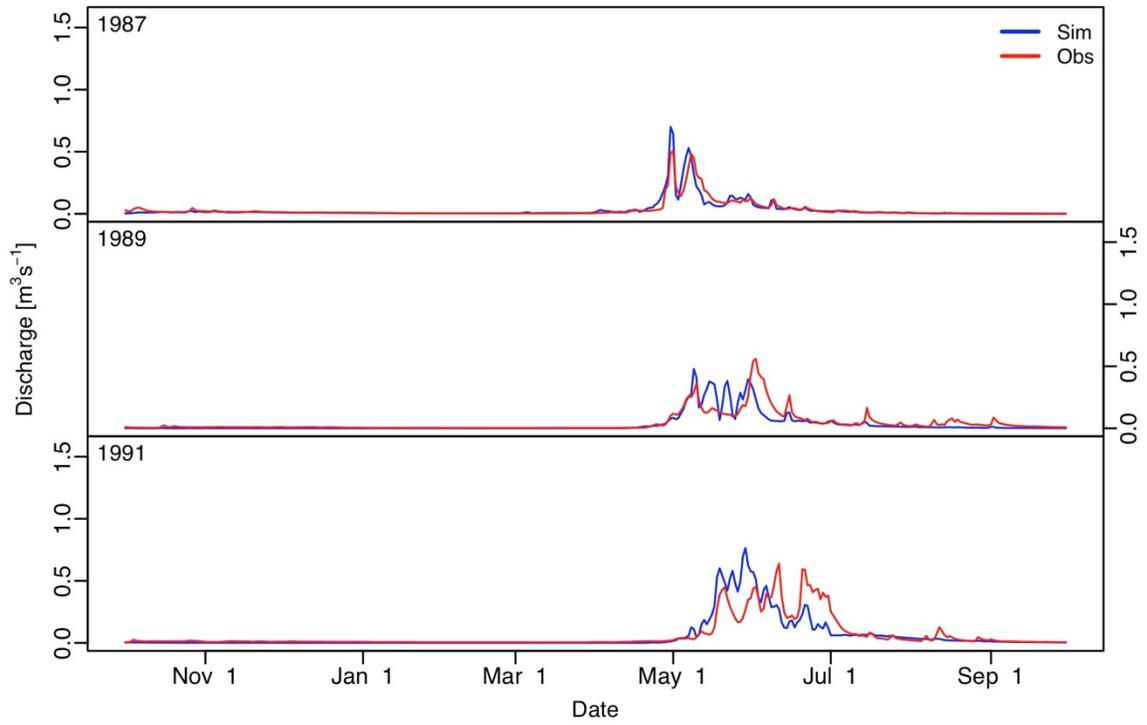
Figure S3.4. Dennis Creek discharge validation plot.
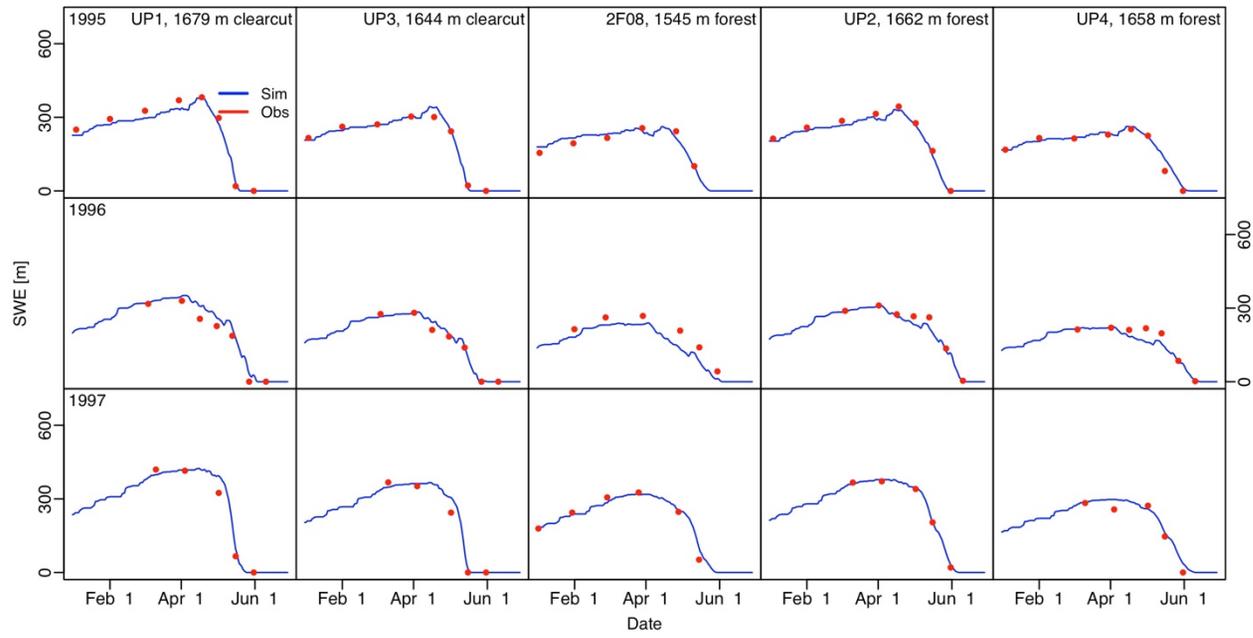
Figure S3.5. Snowpack validation plot.
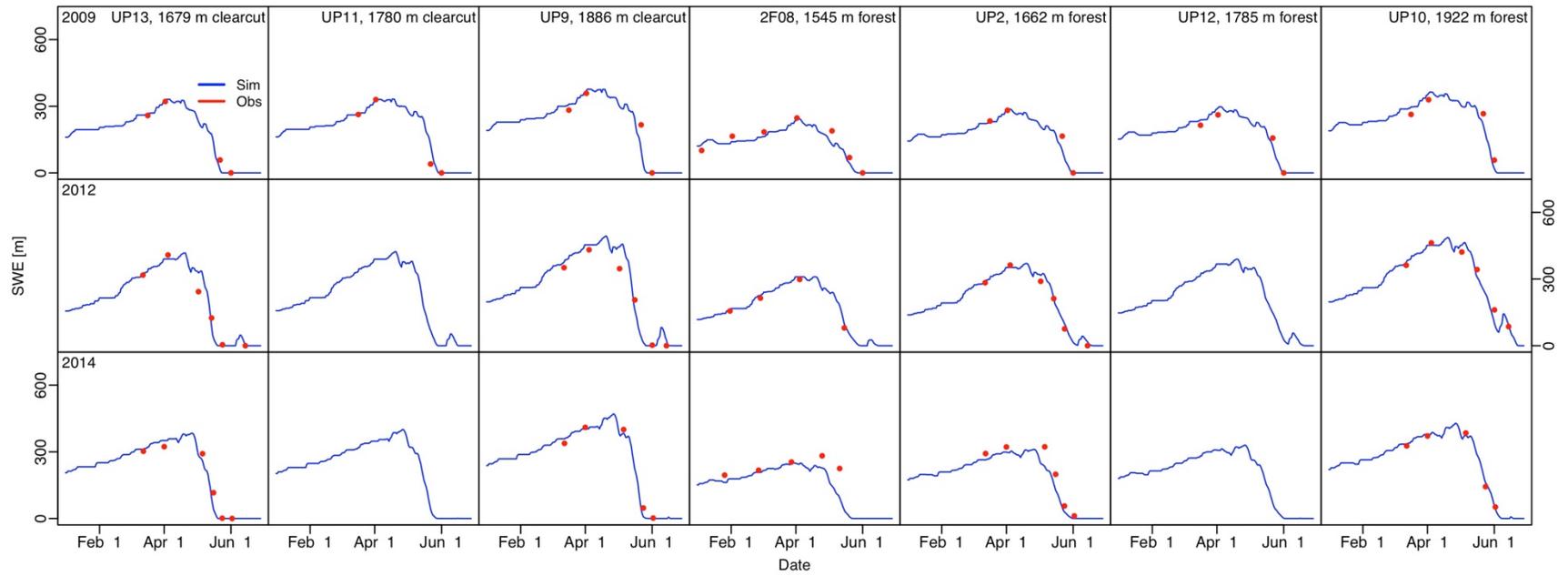
Figure S3.5. Continued.
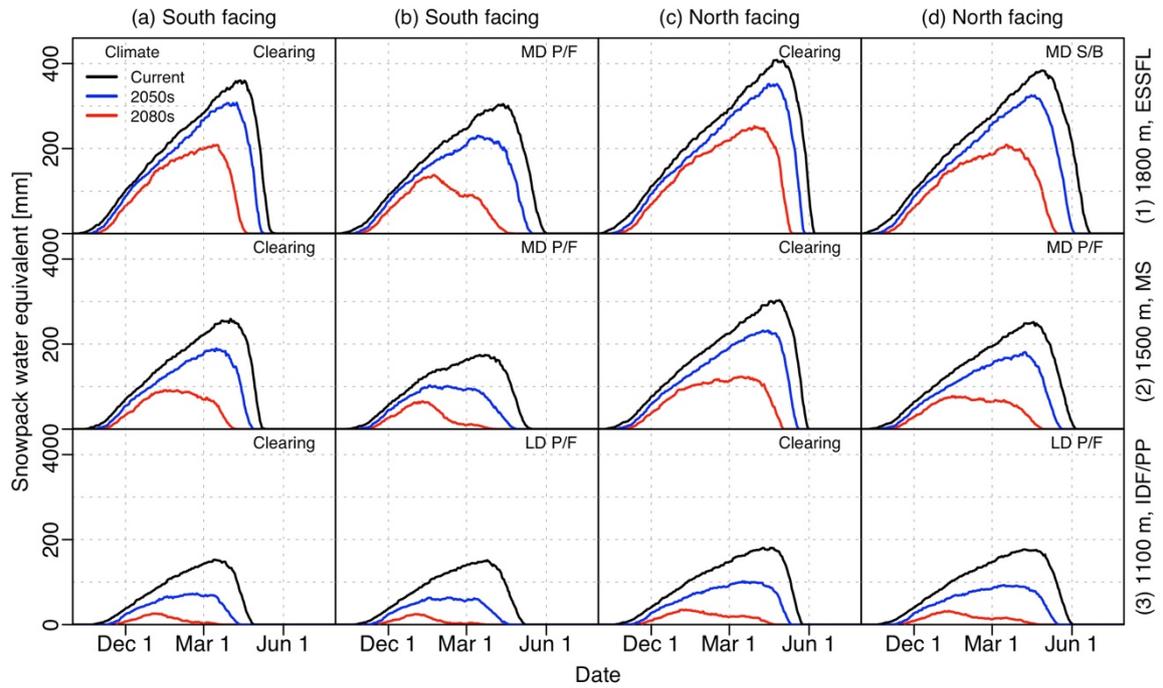
Figure S4. Median of daily SWE for north and south facing clearings and selected forest types at three elevations (output from site scale snowpack sensitivity analysis). The most common stand type is represented for each slope aspect and elevation. Refer to Sections 2.1 and 2.3.2 for vegetation codes.