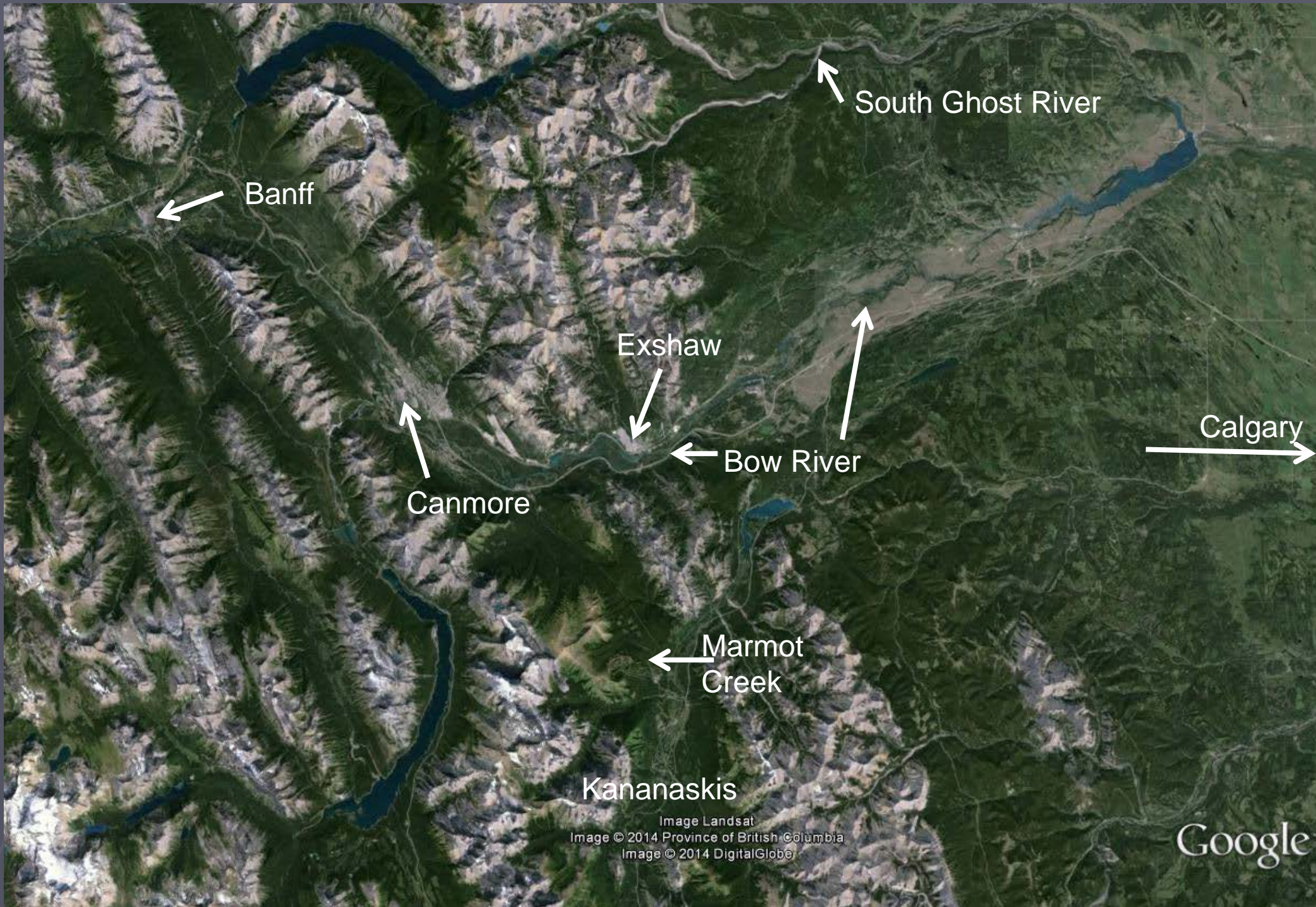


Overview of the Hydrometeorology of the Canadian Rockies Flood of June 2013

John Pomeroy, May Guan, Angus Duncan, Kevin Shook, Xing Fang, Kabir Rasouli, Paul Whitfield,
Nicolas Leroux, Chris Gabrielli

Centre for Hydrology & Global Institute for Water Security,
University of Saskatchewan, Saskatoon
www.usask.ca/hydrology





Banff

South Ghost River

Exshaw

Calgary

Bow River

Canmore

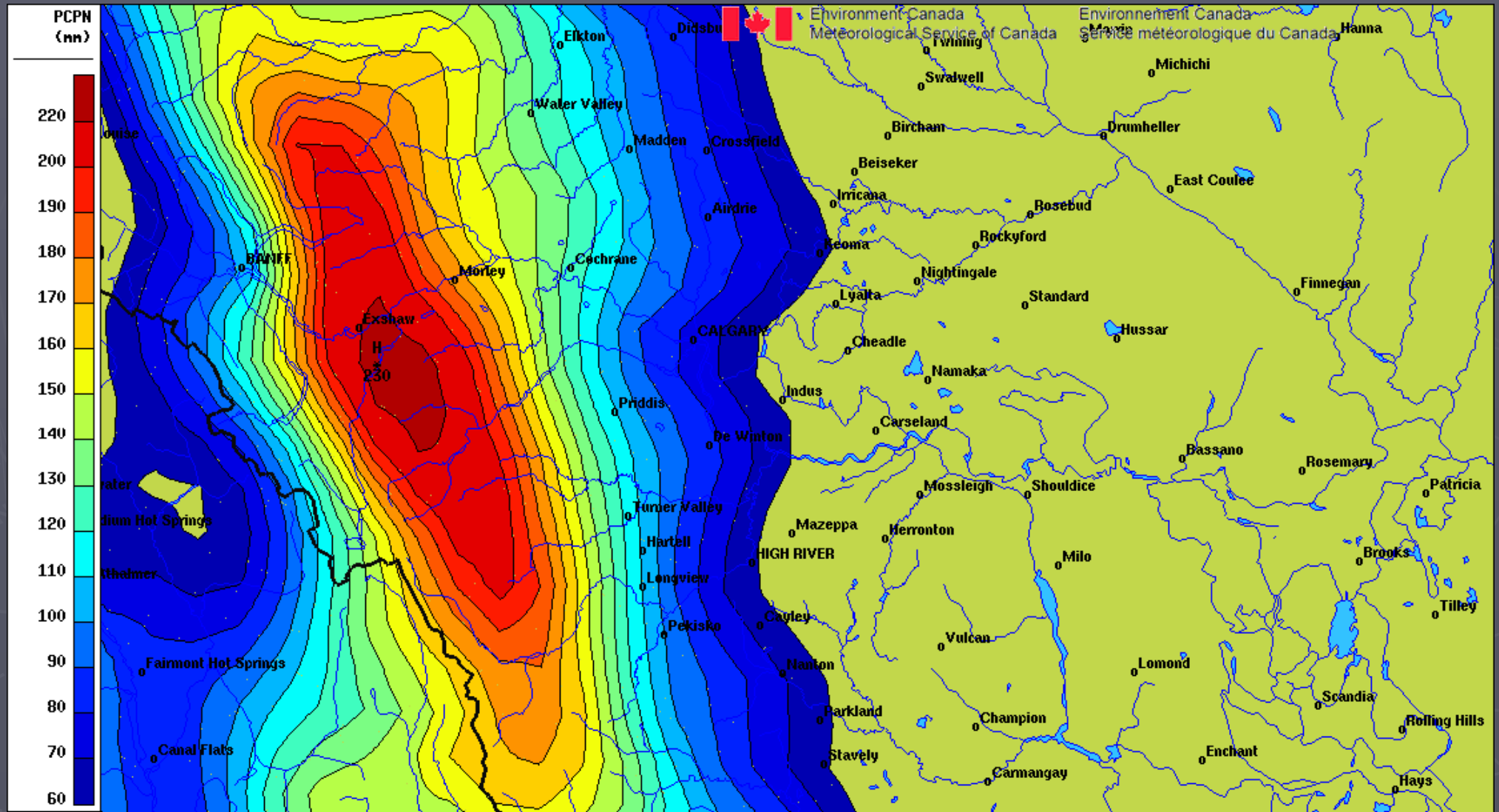
Marmot
Creek

Kananaskis

Image Landsat
Image © 2014 Province of British Columbia
Image © 2014 DigitalGlobe

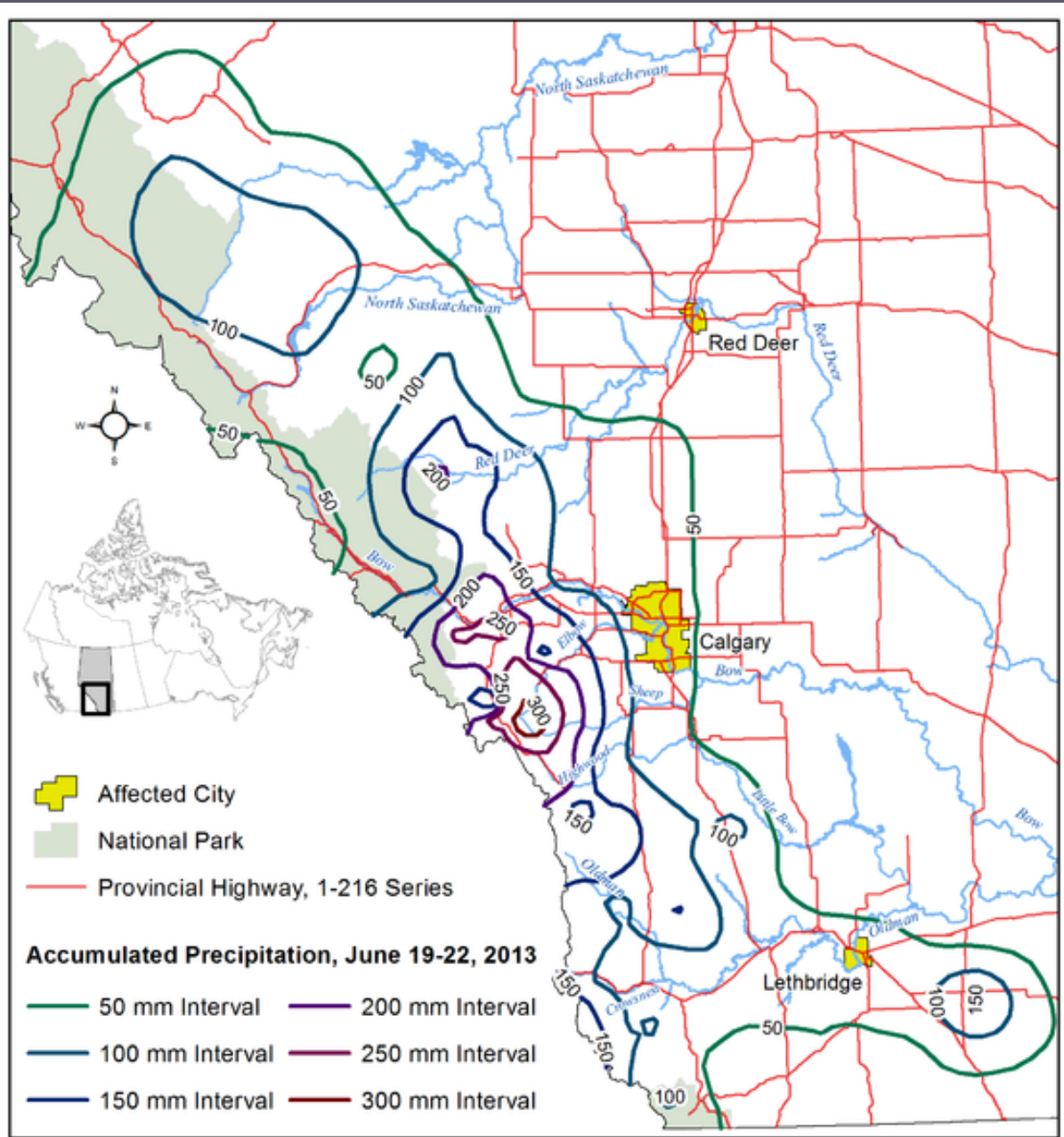
Google

Numerical Weather Prediction Model Reanalysis



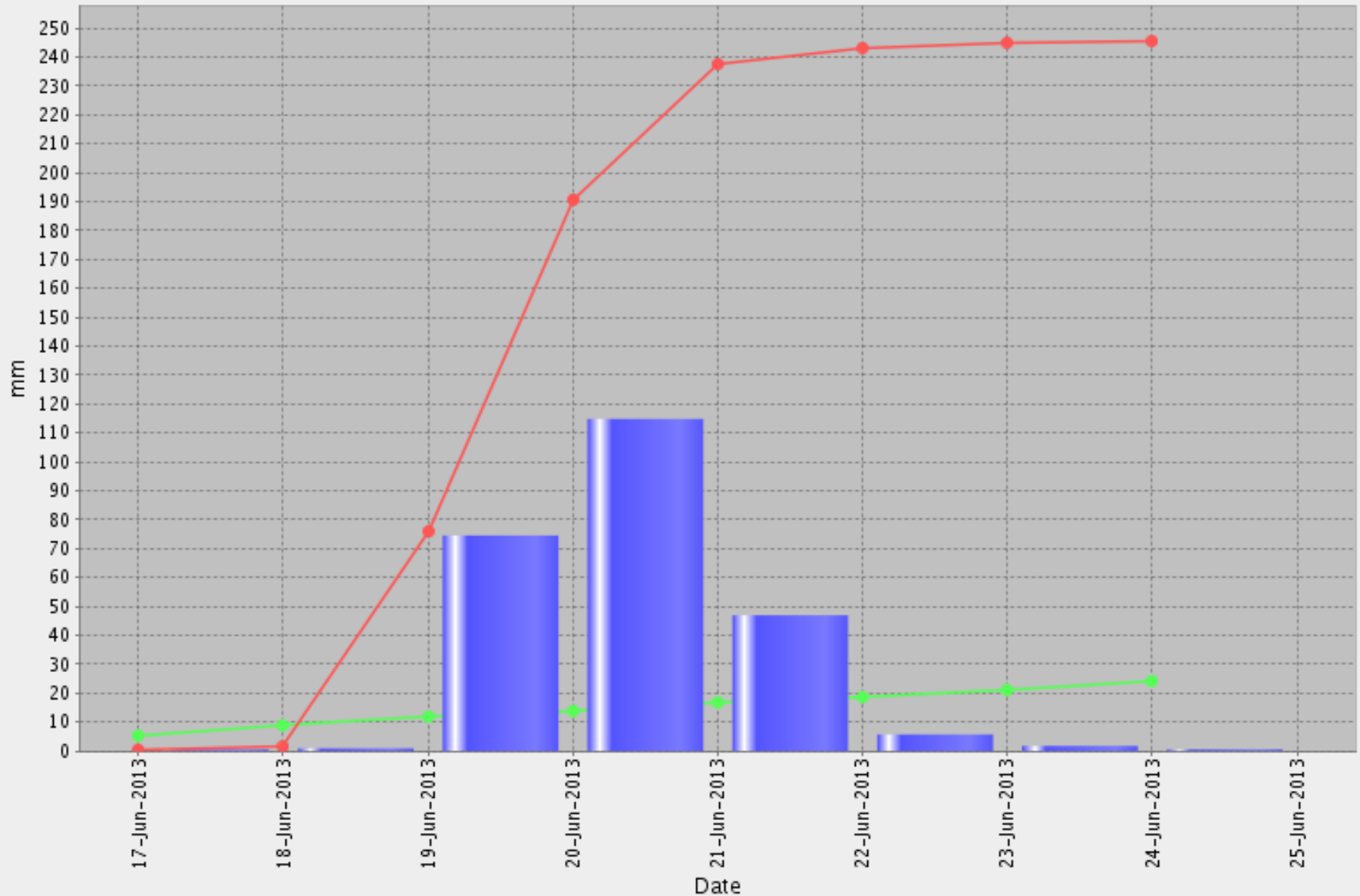
Environment Canada: CaPA Reanalysis Precipitation over 5 days

Rainfall Measurements



Precipitation in South Ghost

Daily Station Observations in Local Standard Time: Created August 08, 2013



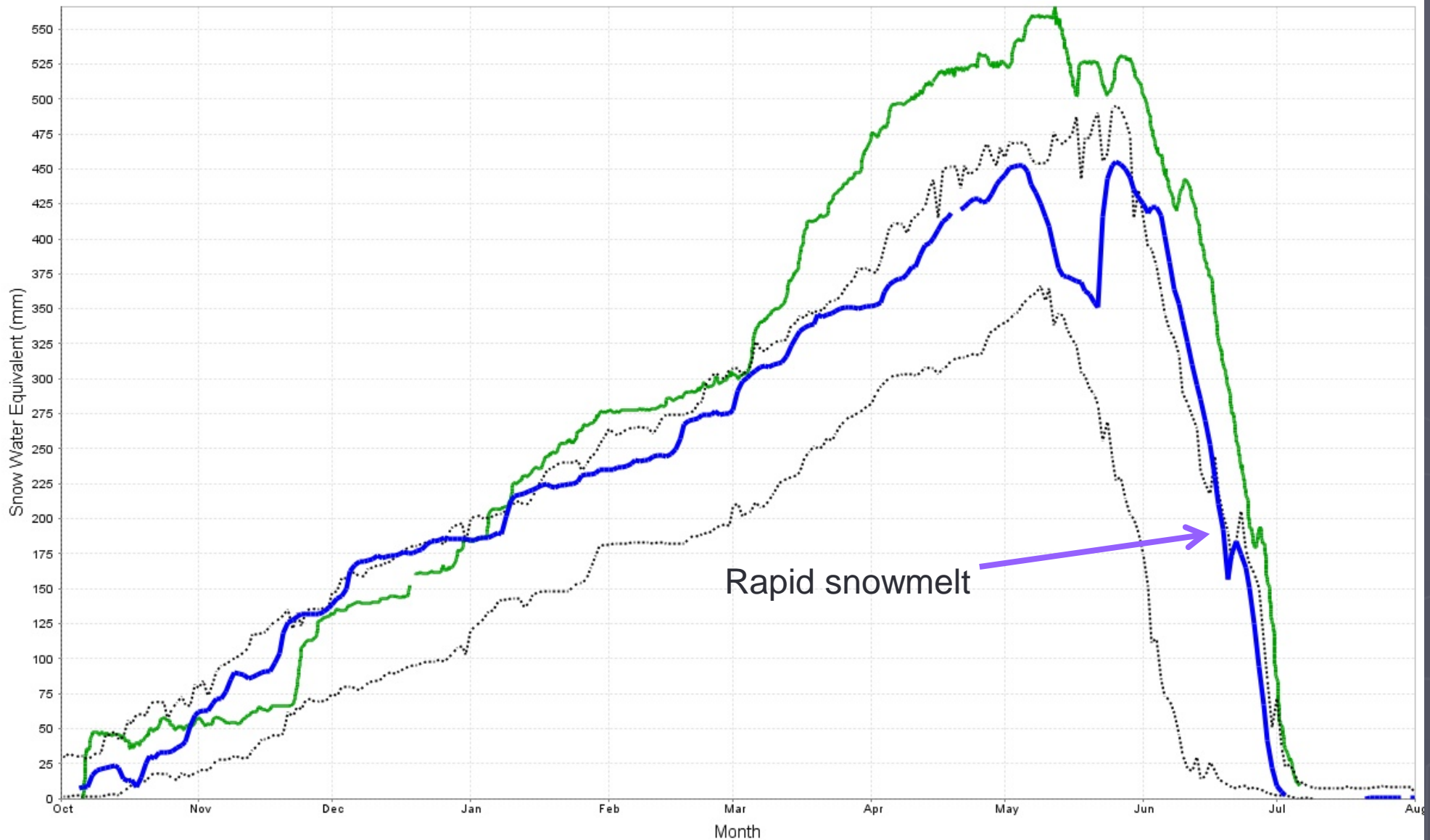
◆ Precip. Accumulated South Ghost Headwaters ■ Precip. South Ghost Headwaters ◆ Precip. Long Term South Ghost Headwaters

Nearby Snowpacks

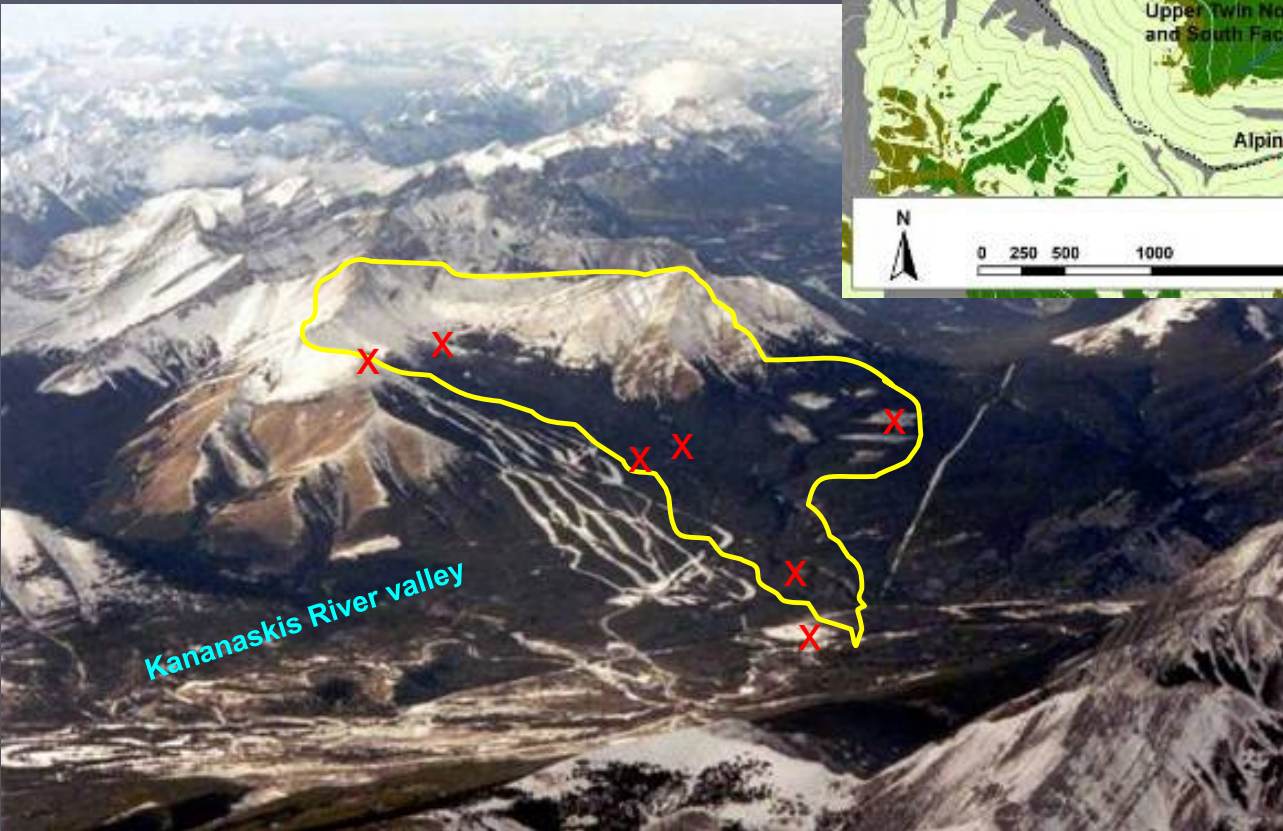
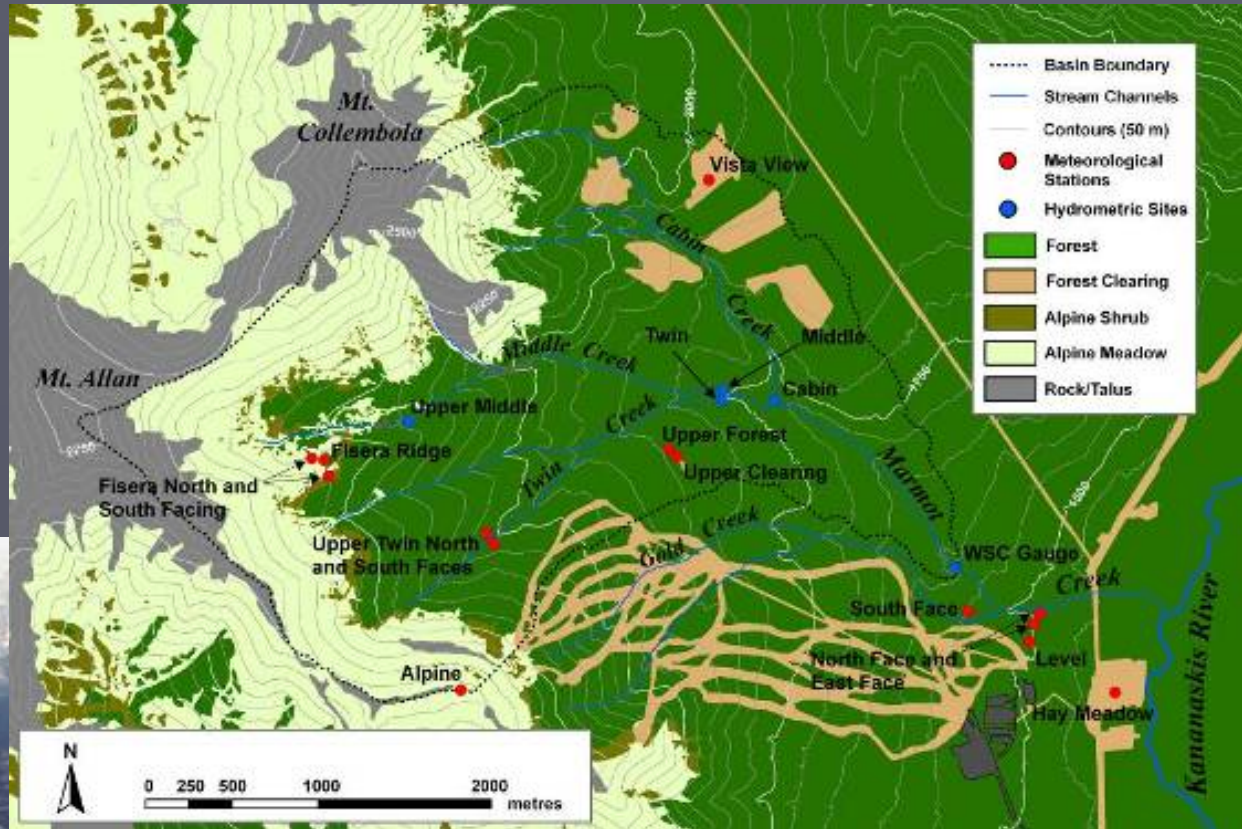
Little Elbow Summit (05BJ805 Elevation:2120.0m)

Snow Data* - Oct. 01, 2012 - Aug. 01, 2013

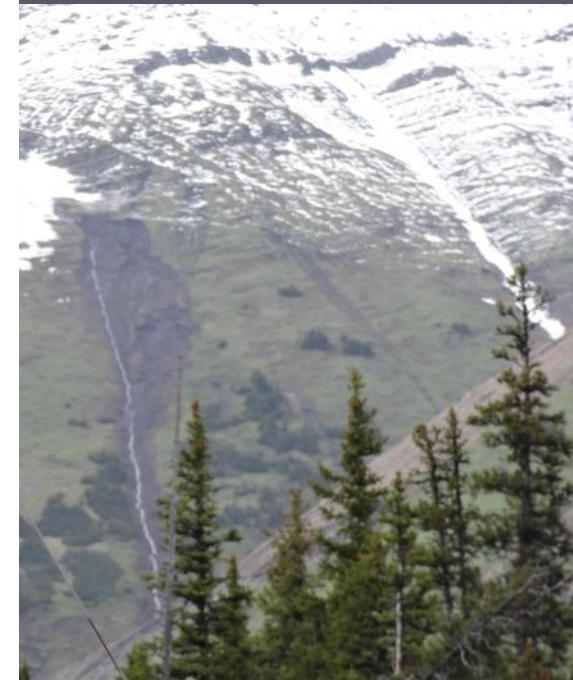
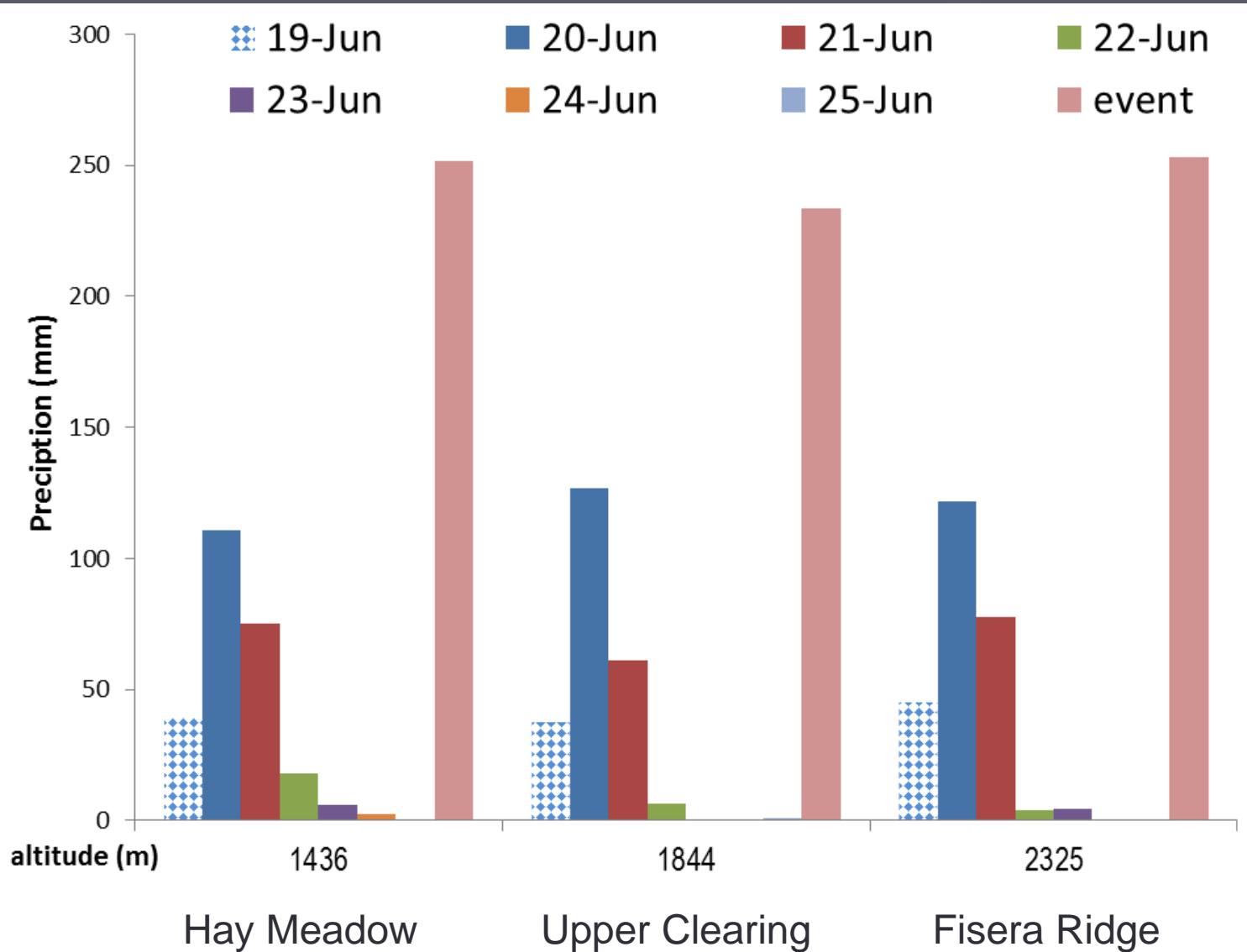
▲ Current Year ▲ Normal Range (Quartiles) ▲ Snow Past Year



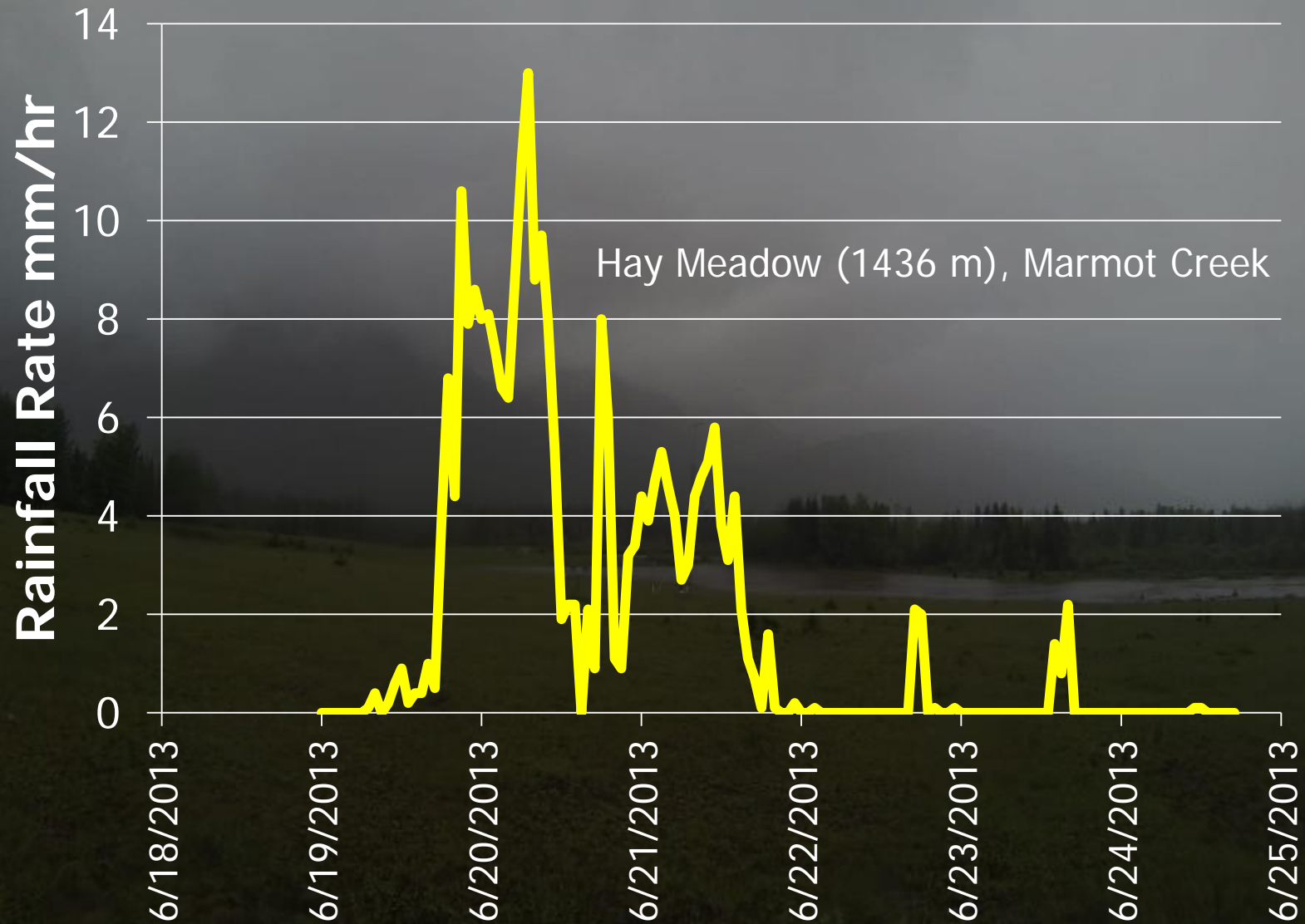
Marmot Creek Research Basin



Marmot Creek Multi-elevation Precipitation



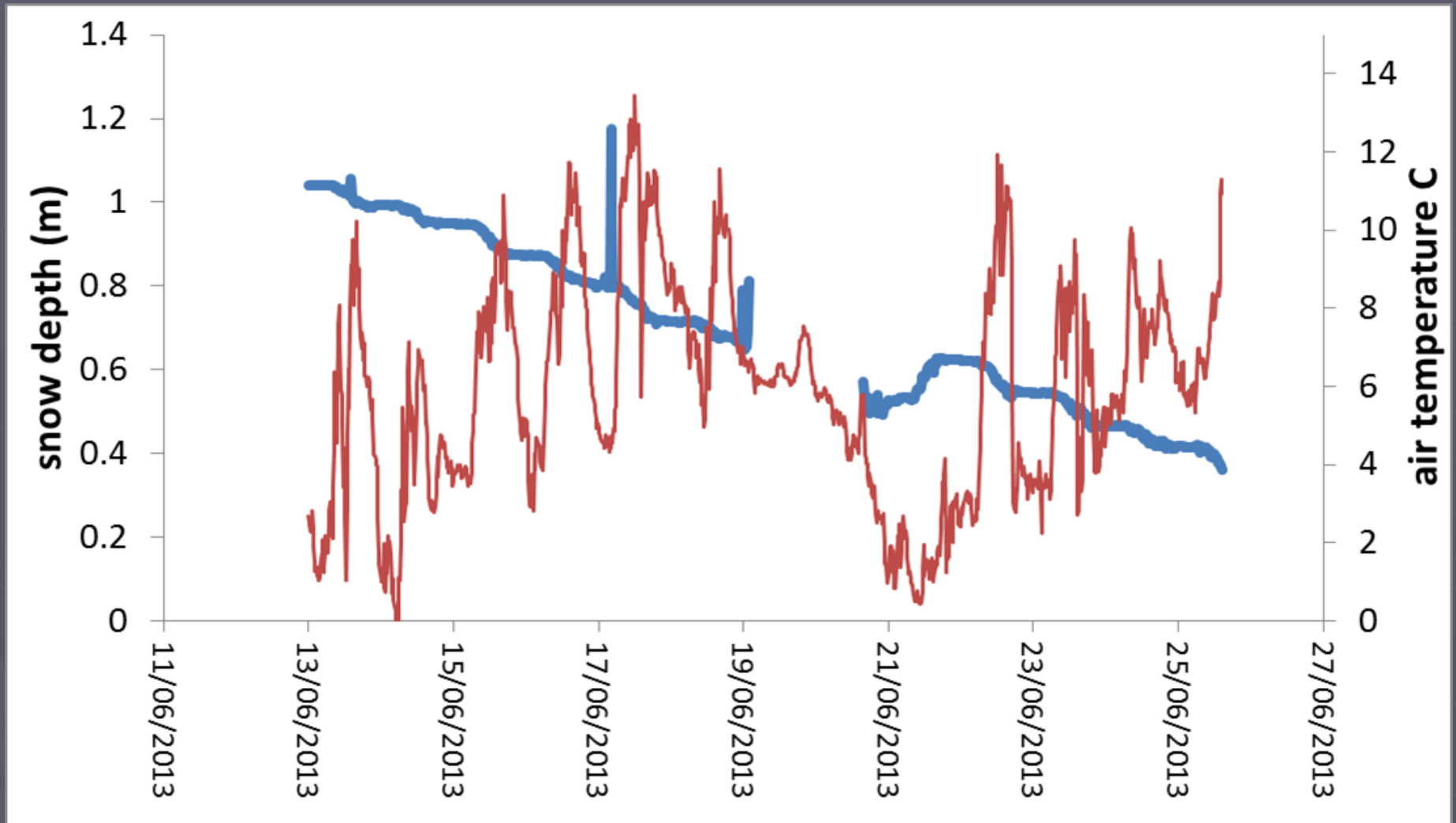
Hourly Rainfall Rate – Marmot Creek



Fisera Ridge Snowmelt

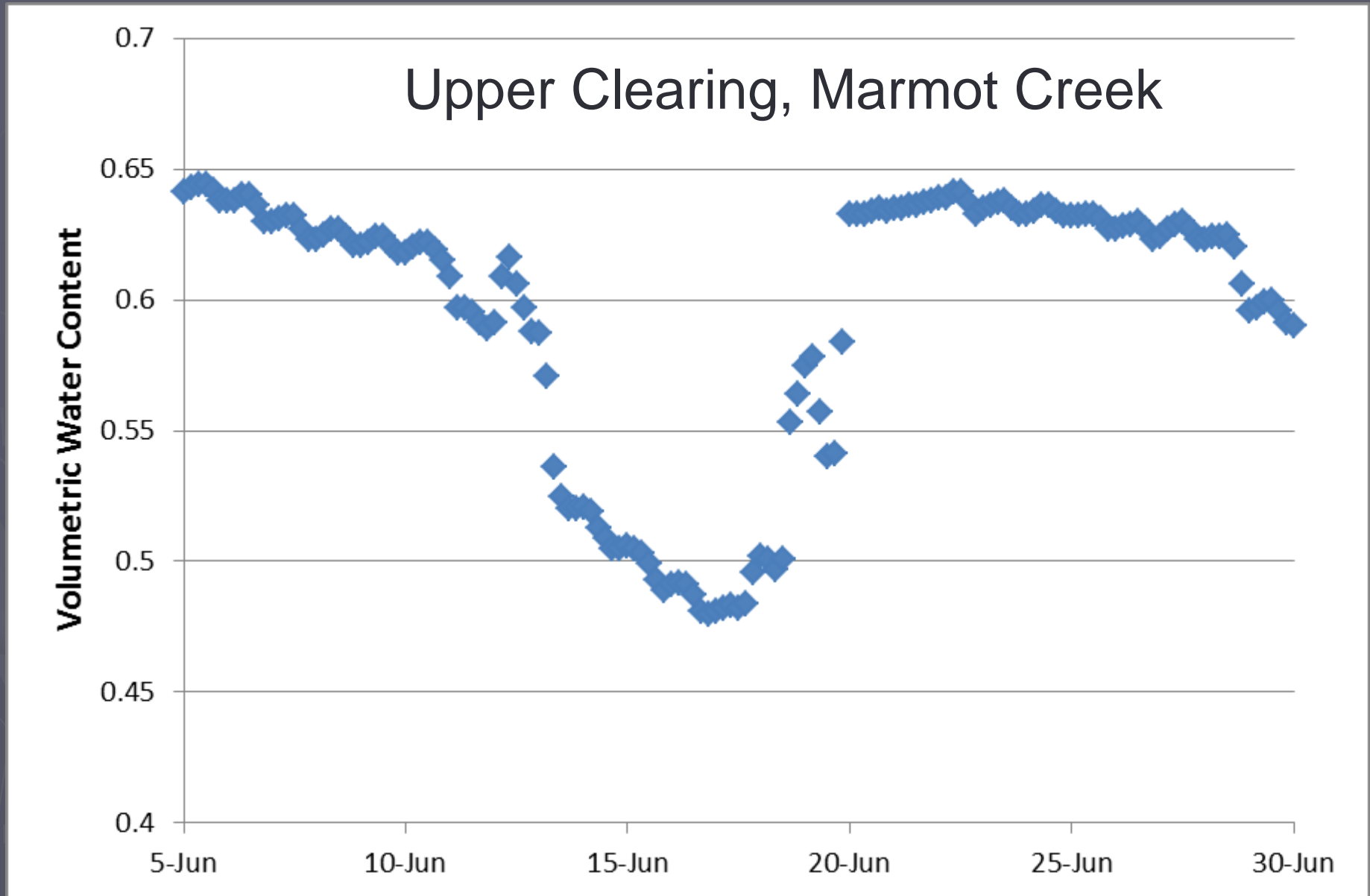


Fisera South-face Snowmelt



South Face Fisera	13 day (3 day)
Snow Loss (mm water)	218 (71.5)
Snow Depth loss (m)	0.64 (.21)
Snow Cover Change (%)	41

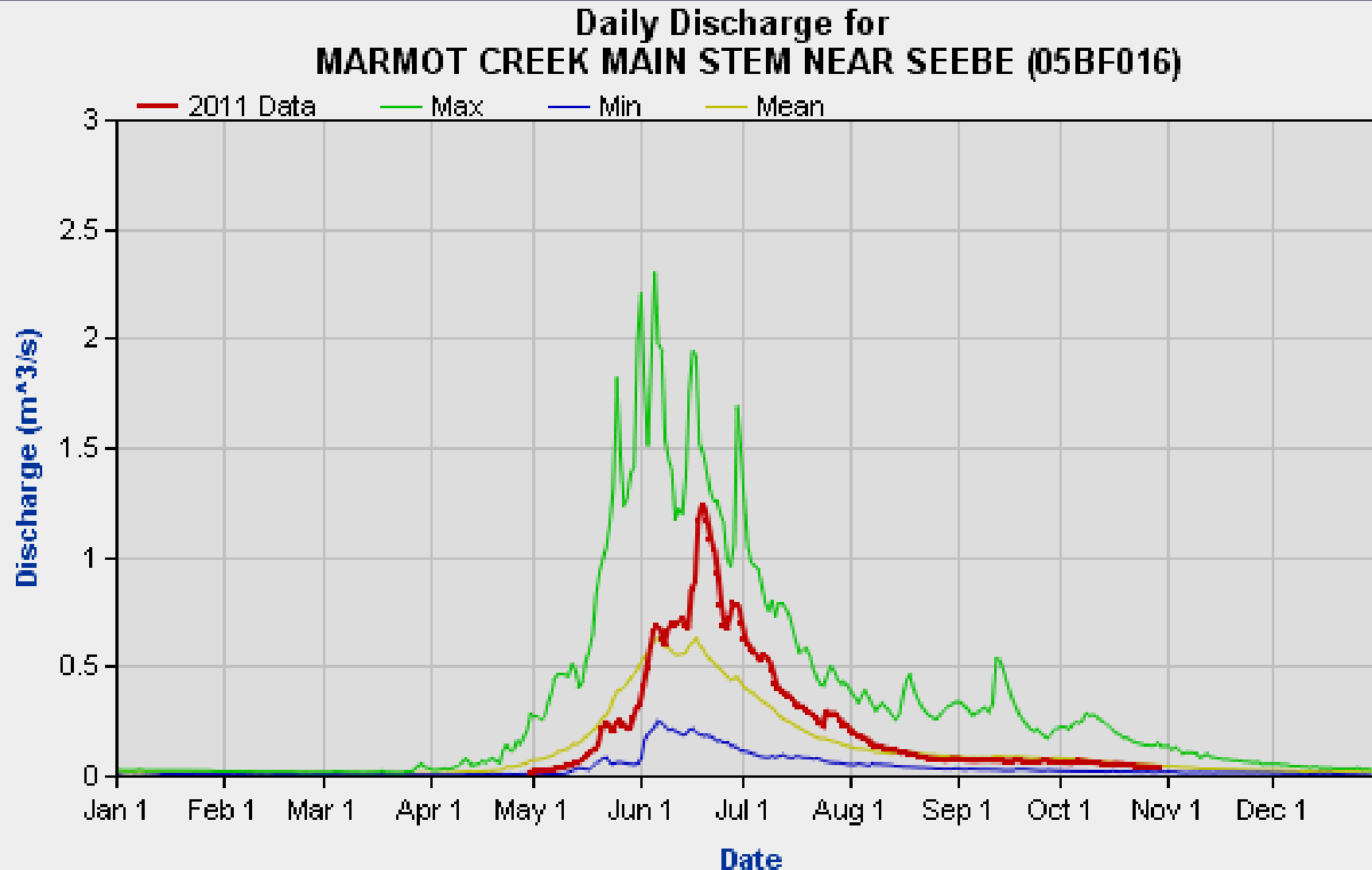
Soil Moisture Storage



Mountain Streams become Torrents



Marmot Creek 2011



Marmot Creek 20 June 2013



Video courtesy Chris Gabrielli, U of S

Marmot Creek 28 June 2013



Marmot Creek V-Notch Weir



July 2013

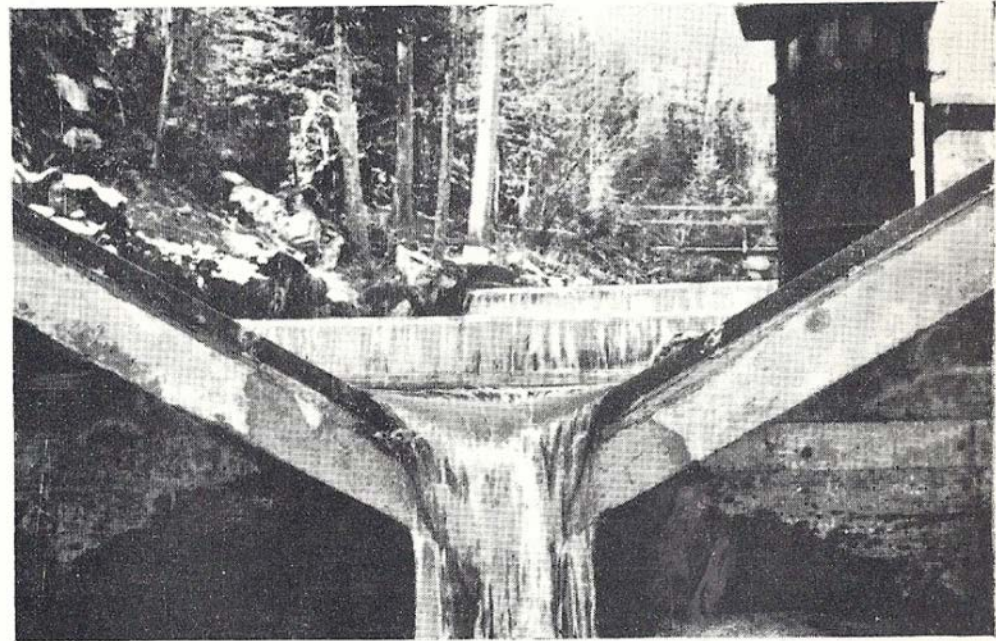
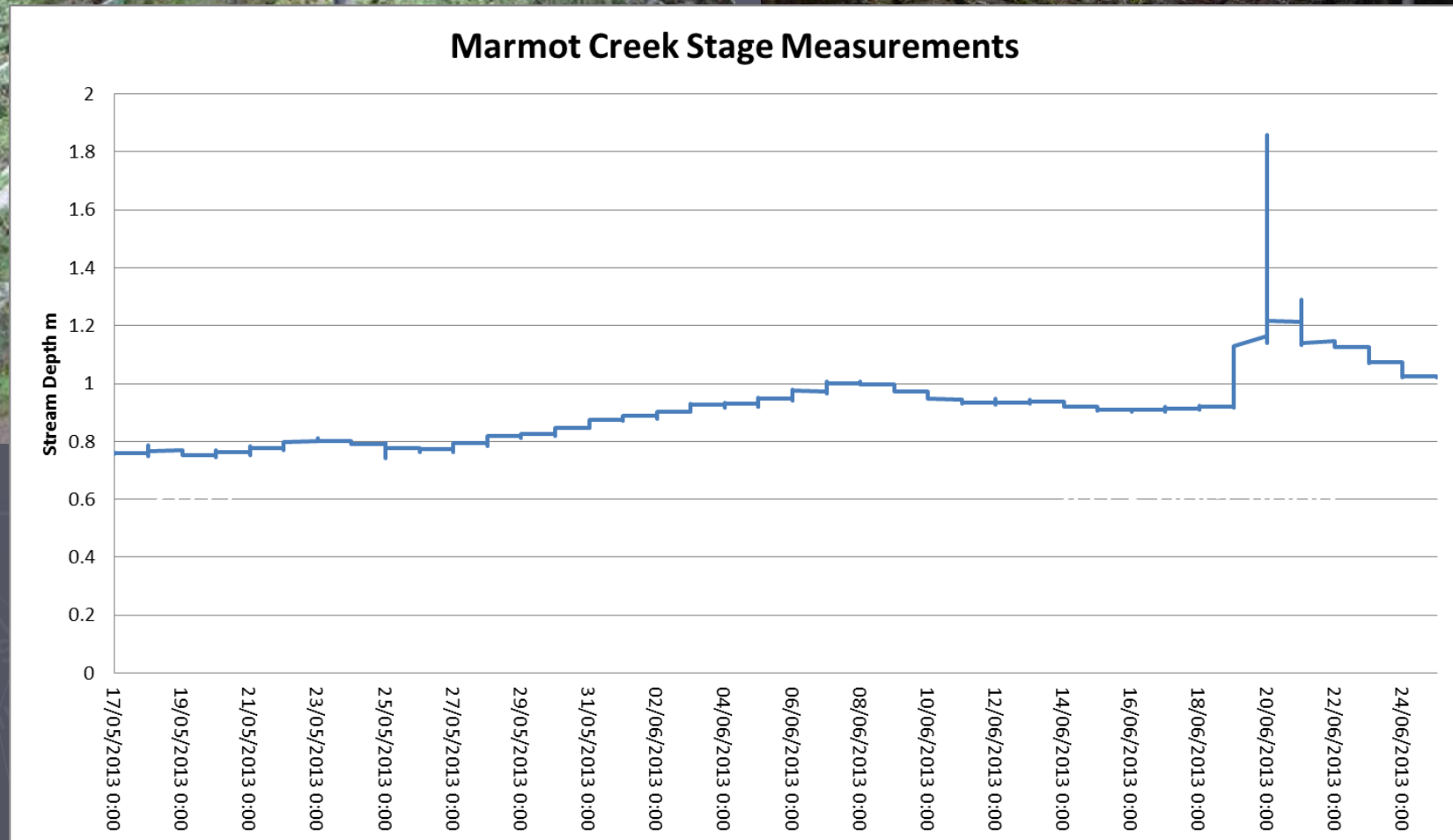
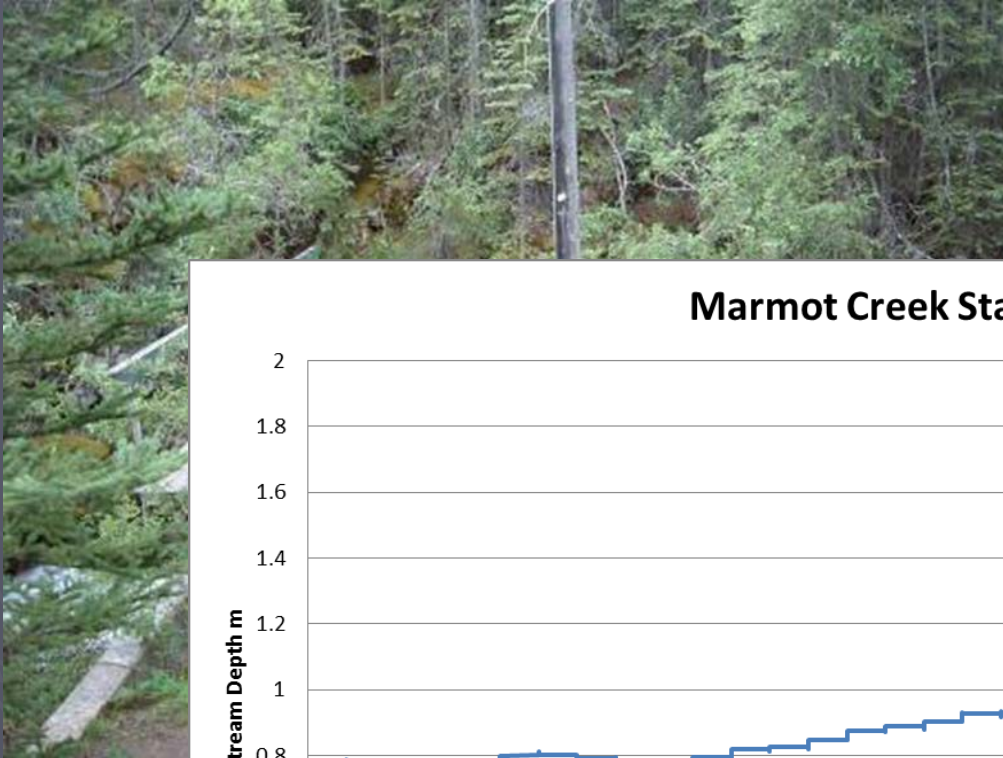


FIG. 6.14. 120° V-notch weir and recorder installation on Marmot Creek near Kananaskis, Alta. (Courtesy Water Resources Branch, Canada.)

~1963

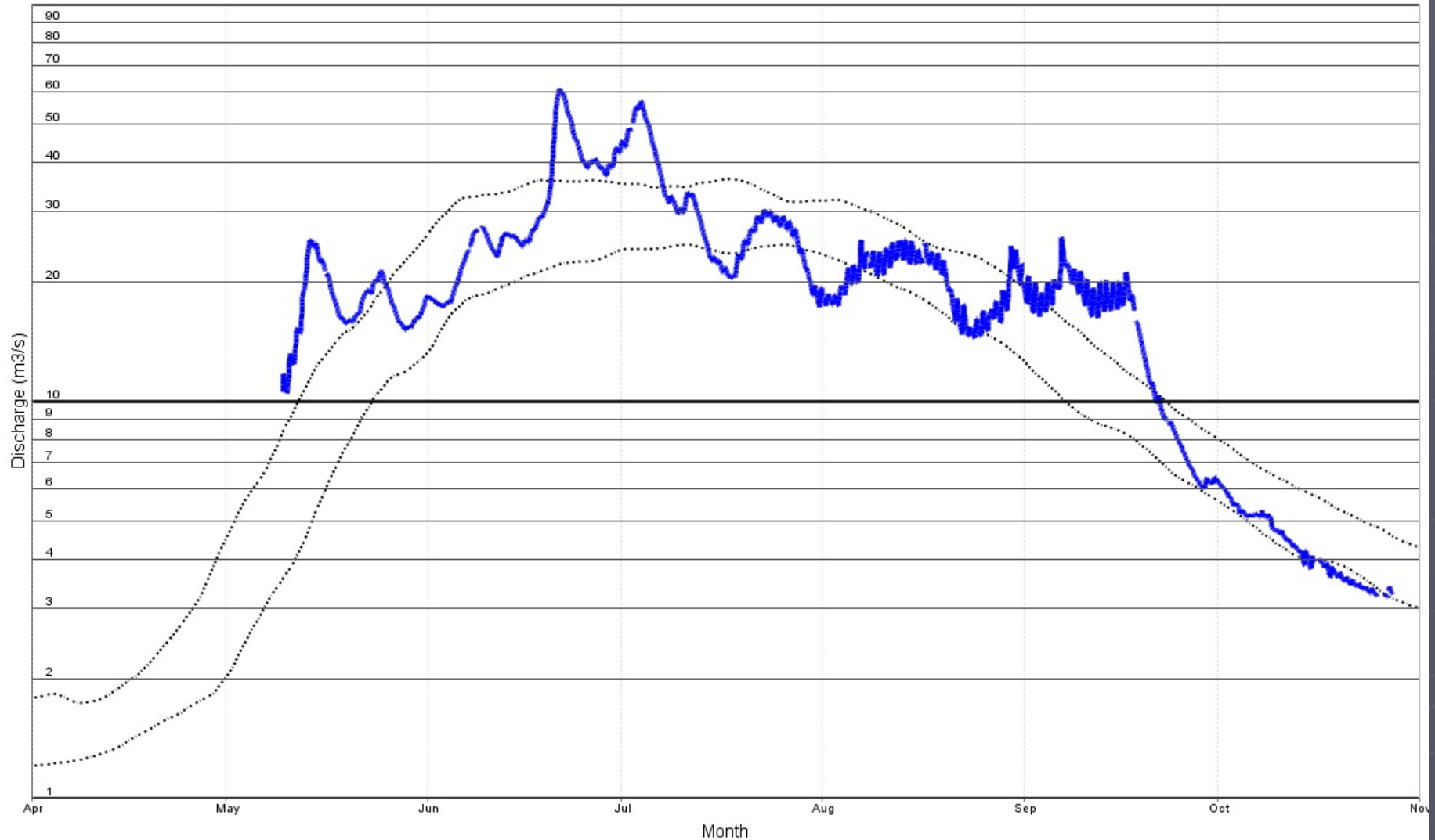
Marmot Creek Streamflow Gauge



Bow River at Lake Louise

Bow River at Lake Louise (05BA001)
River Data* - Apr. 01, 2013 - Nov. 01, 2013

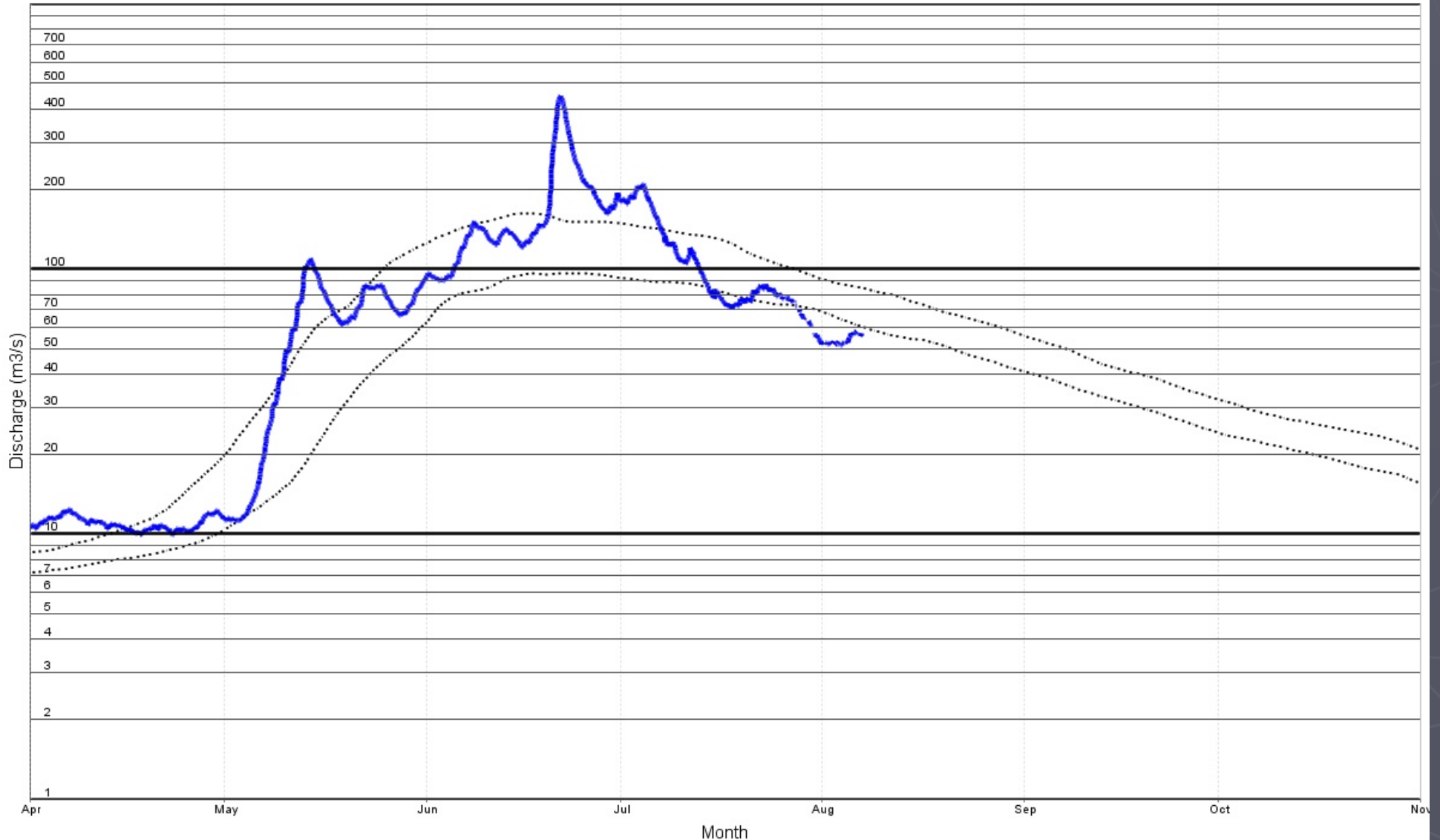
▲ Current Year ▲ Normal Range (Quartiles)



Bow River at Banff

Bow River at Banff (05BB001)
River Data* - Apr. 01, 2013 - Nov. 01, 2013

▲ Current Year ▲ Normal Range (Quartiles)



Bow River at Canmore



Wasootch Creek, Kananaskis

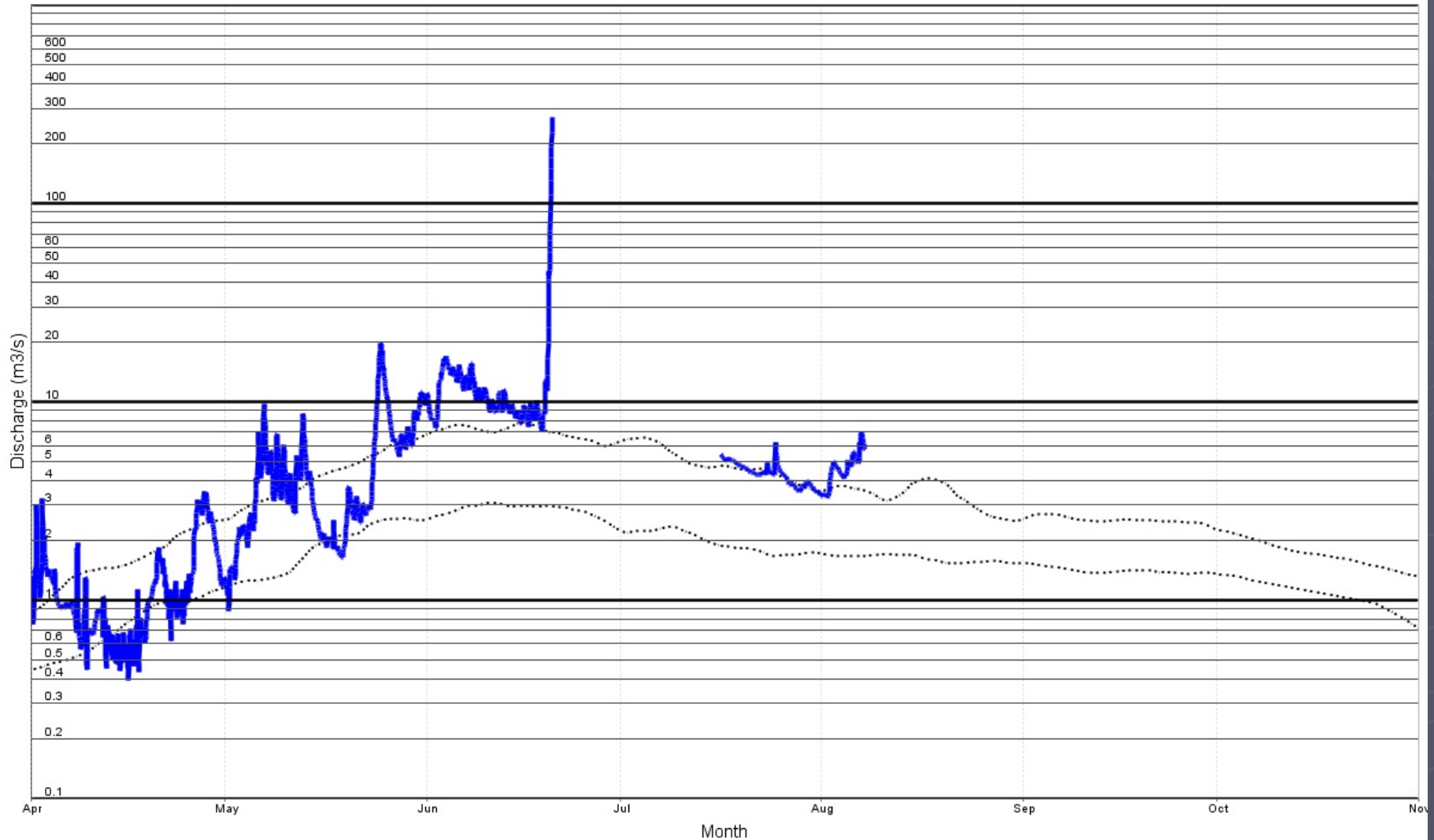


Video courtesy Chris Gabrielli, U of S

Waiparous Creek near Mouth

Waiparous Creek near the Mouth (05BG006)
River Data* - Apr. 01, 2013 - Nov. 01, 2013

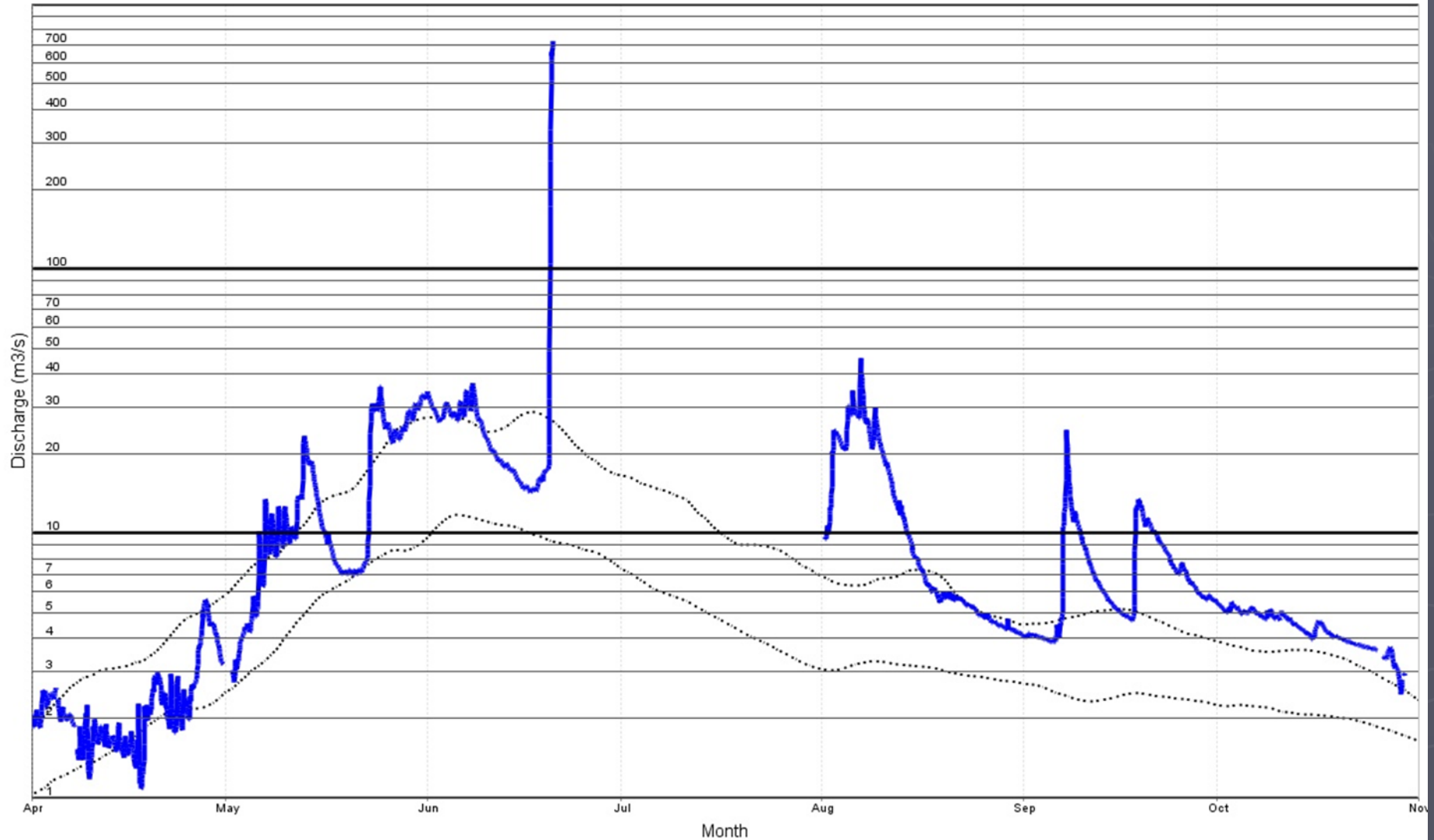
▲ Current Year ▲ Normal Range (Quartiles)



Sheep River at Black Diamond

Sheep River at Black Diamond (05BL014)
River Data* - Apr. 01, 2013 - Nov. 01, 2013

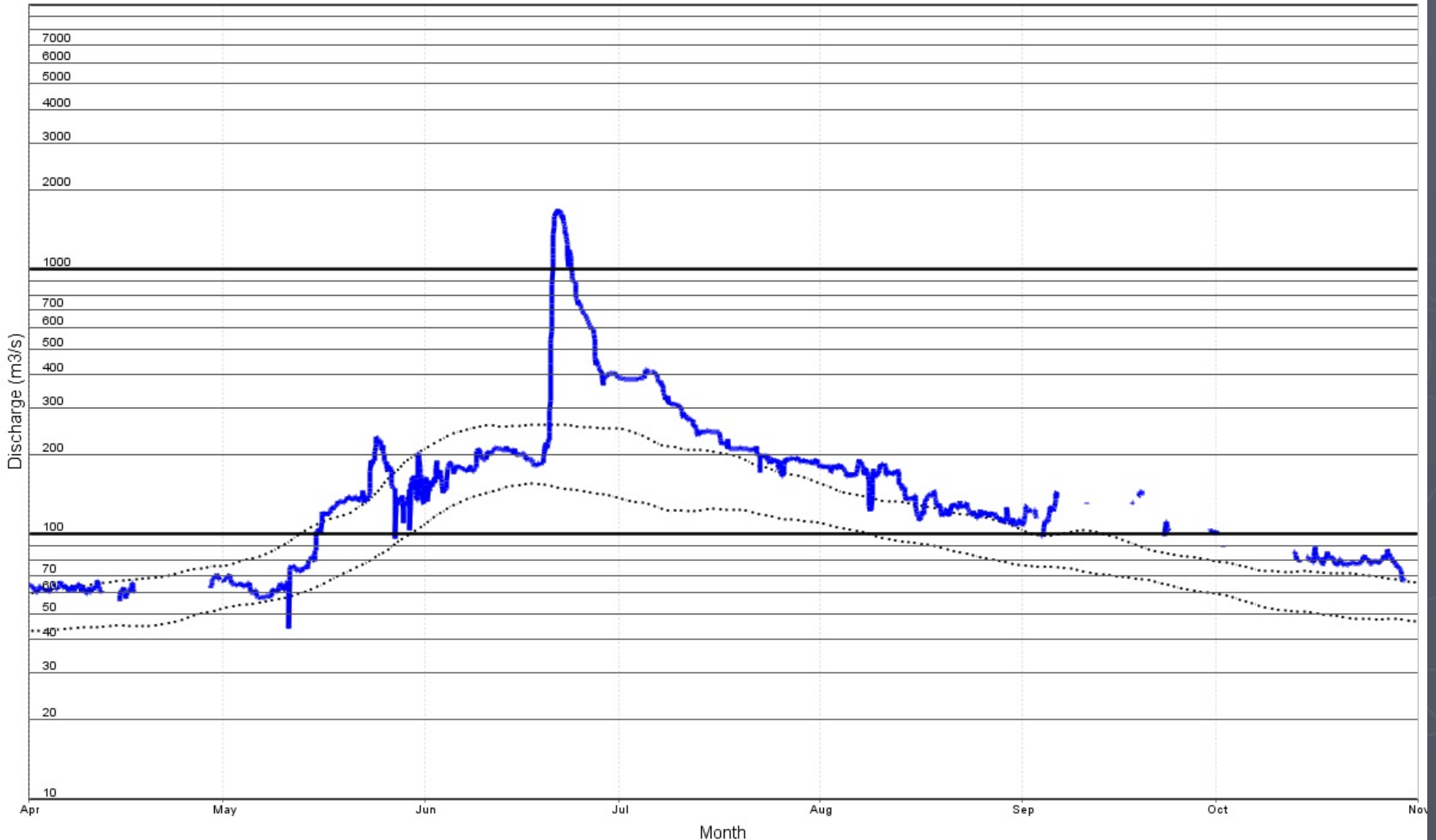
■ Current Year ▲ Normal Range (Quartiles)



Bow River at Calgary

Bow River at Calgary (05BH004)
River Data* - Apr. 01, 2013 - Nov. 01, 2013

▲ Current Year ▲ Normal Range (Quartiles)



How Frequent is This?



Average Flow in Bow River at Banff



Foothills/Front Range Streamflow

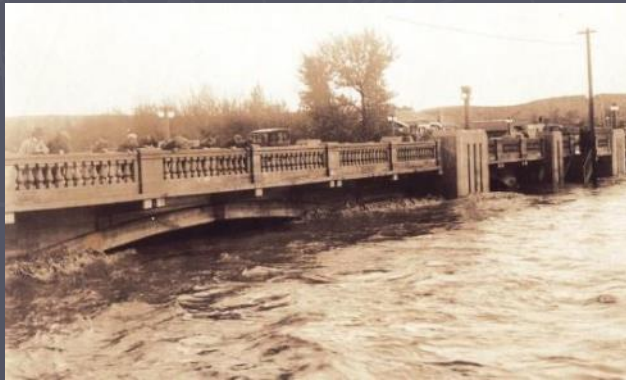
- ▶ High flows generated by intense rainfall events in spring associated with low pressure systems
- ▶ Associated with highest estimated flows



Early Floods on the Bow River



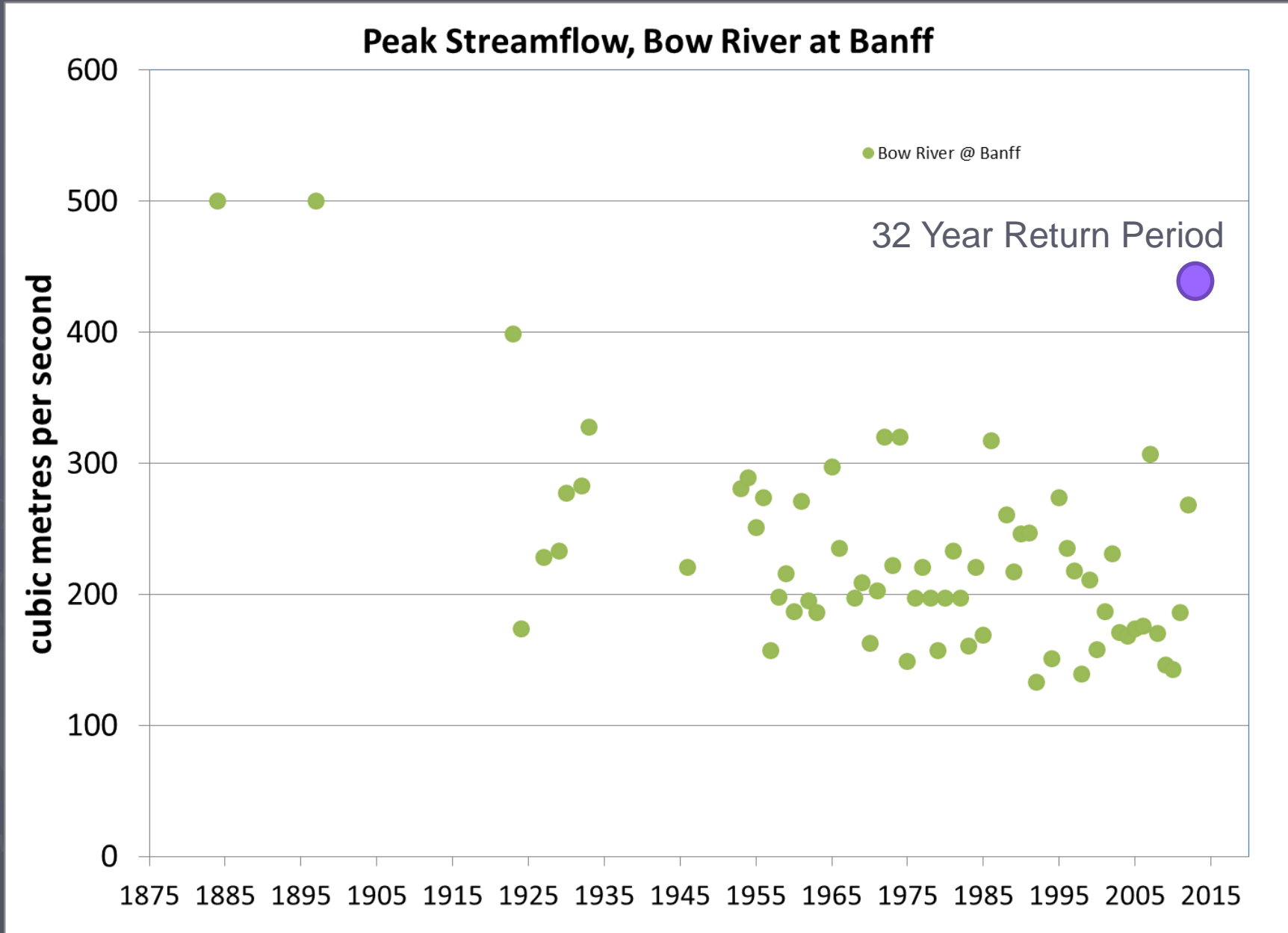
Dr. George M Dawson, Chief Geologist and then Director, Geological Survey of Canada 1875-1901. “considered to be the finest Canadian field scientist of his time. He surveyed the Prairies, British Columbia and the Yukon before the country was opened up”



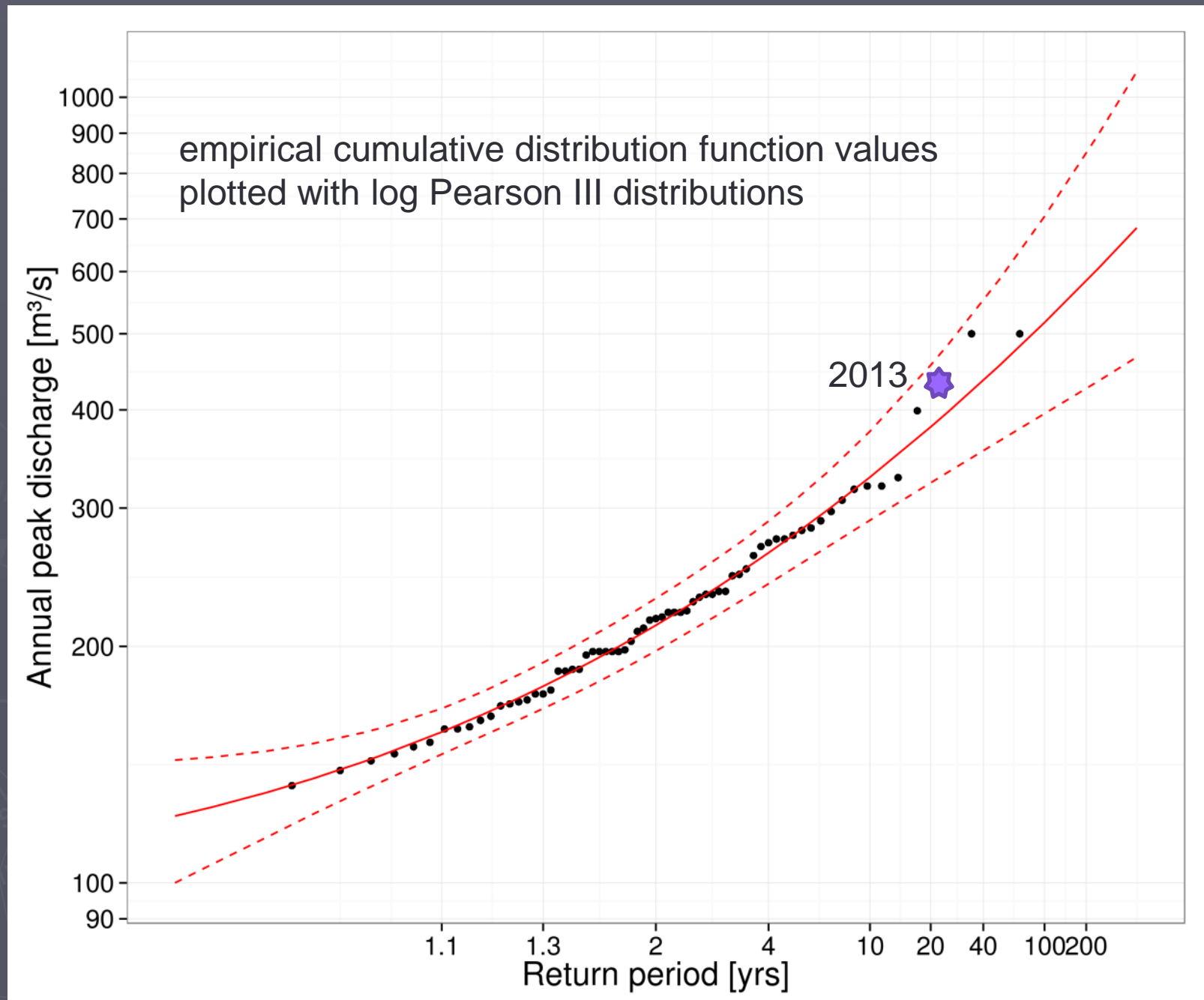
Mission Bridge 1923

Location	Year	Peak Flow m ³ /s
Fort Calgary	1879	2265
Banff	1884	500
Banff	1897	500
Calgary	1897	2265
Calgary	1902	1550
Banff	1923	399
Calgary	1932	1520
Banff	1933	328
Calgary	2013	1740
Banff	2013	439

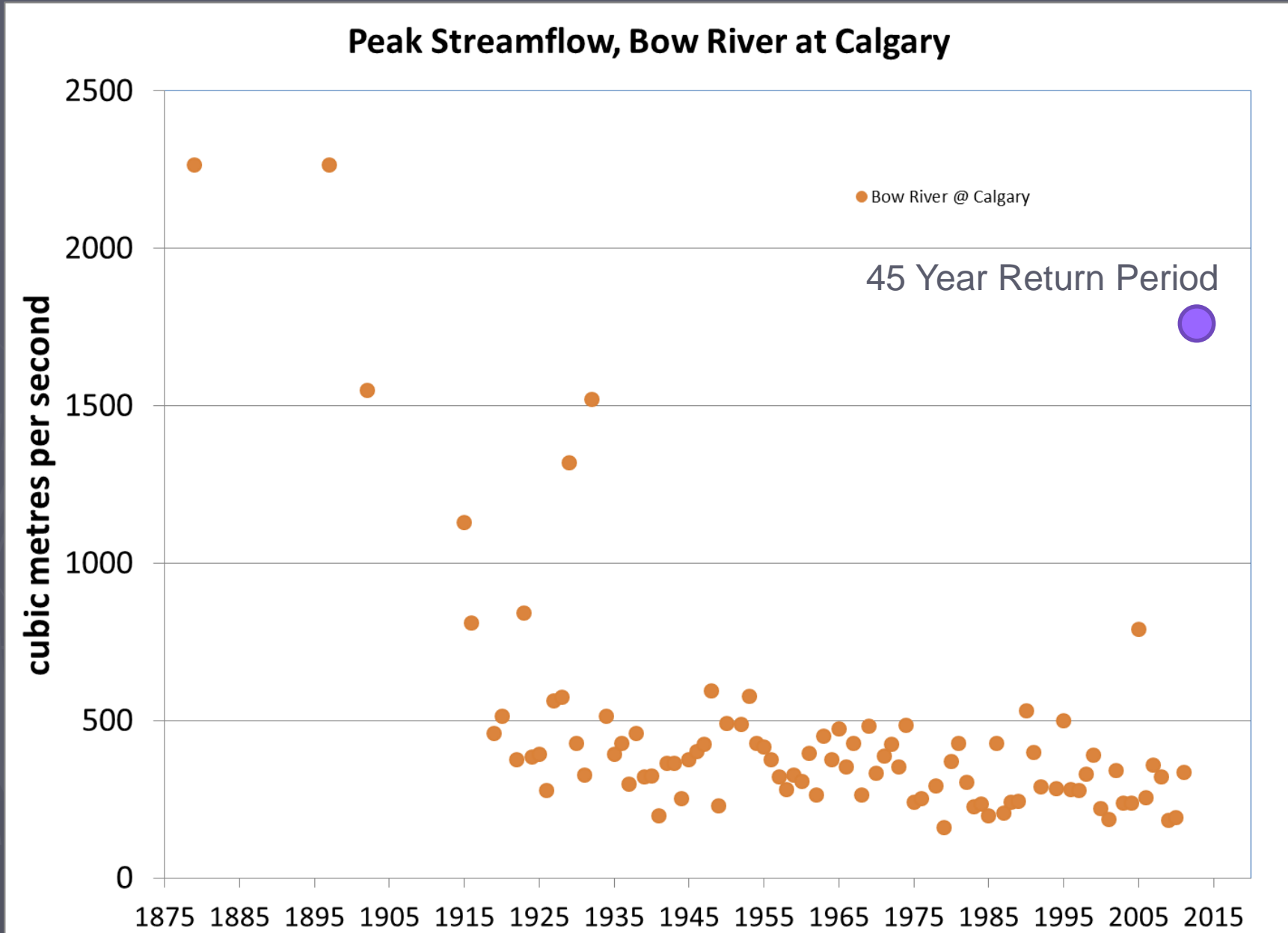
Historical Peak Flows - Banff



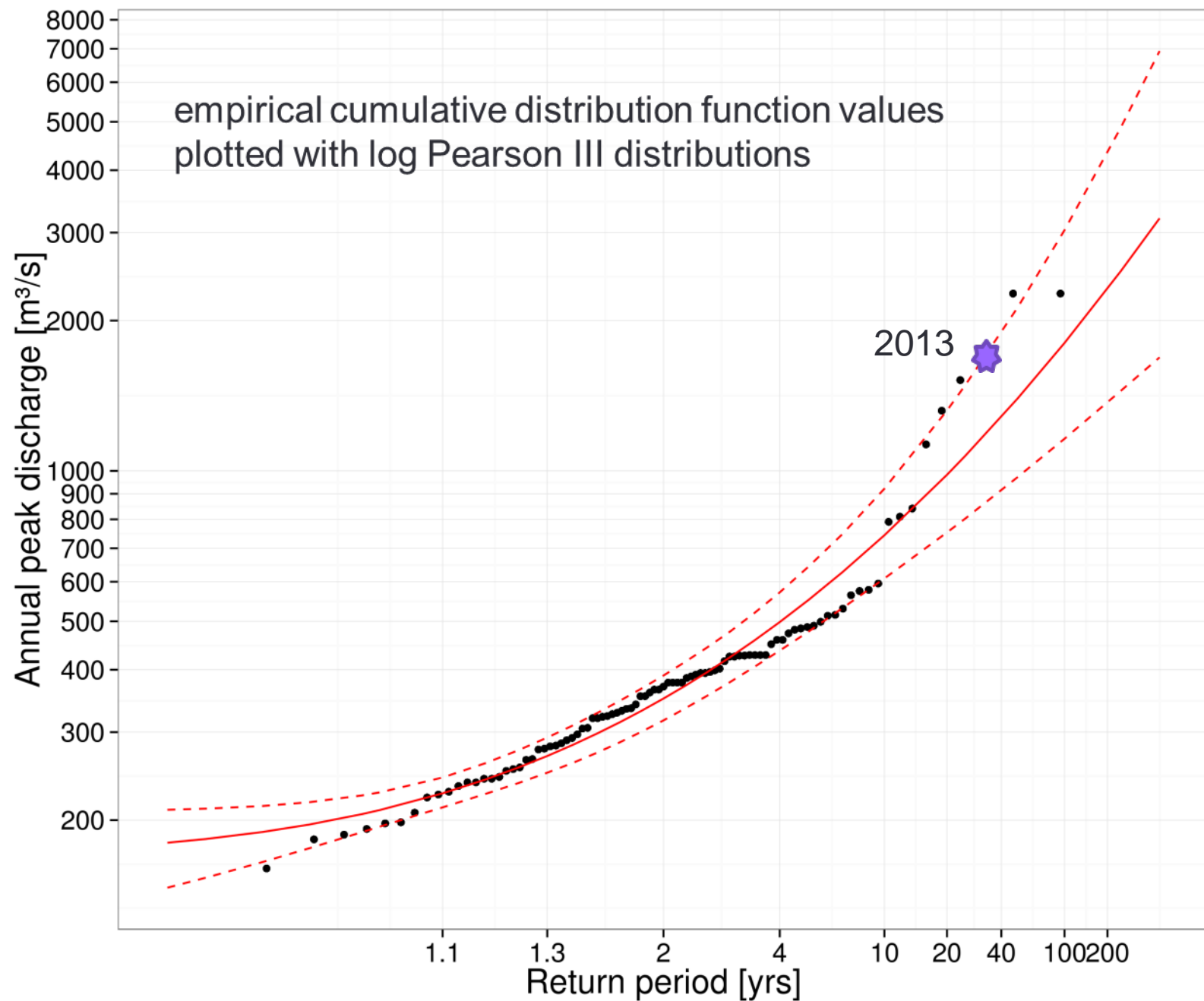
Return Period – Bow River at Banff



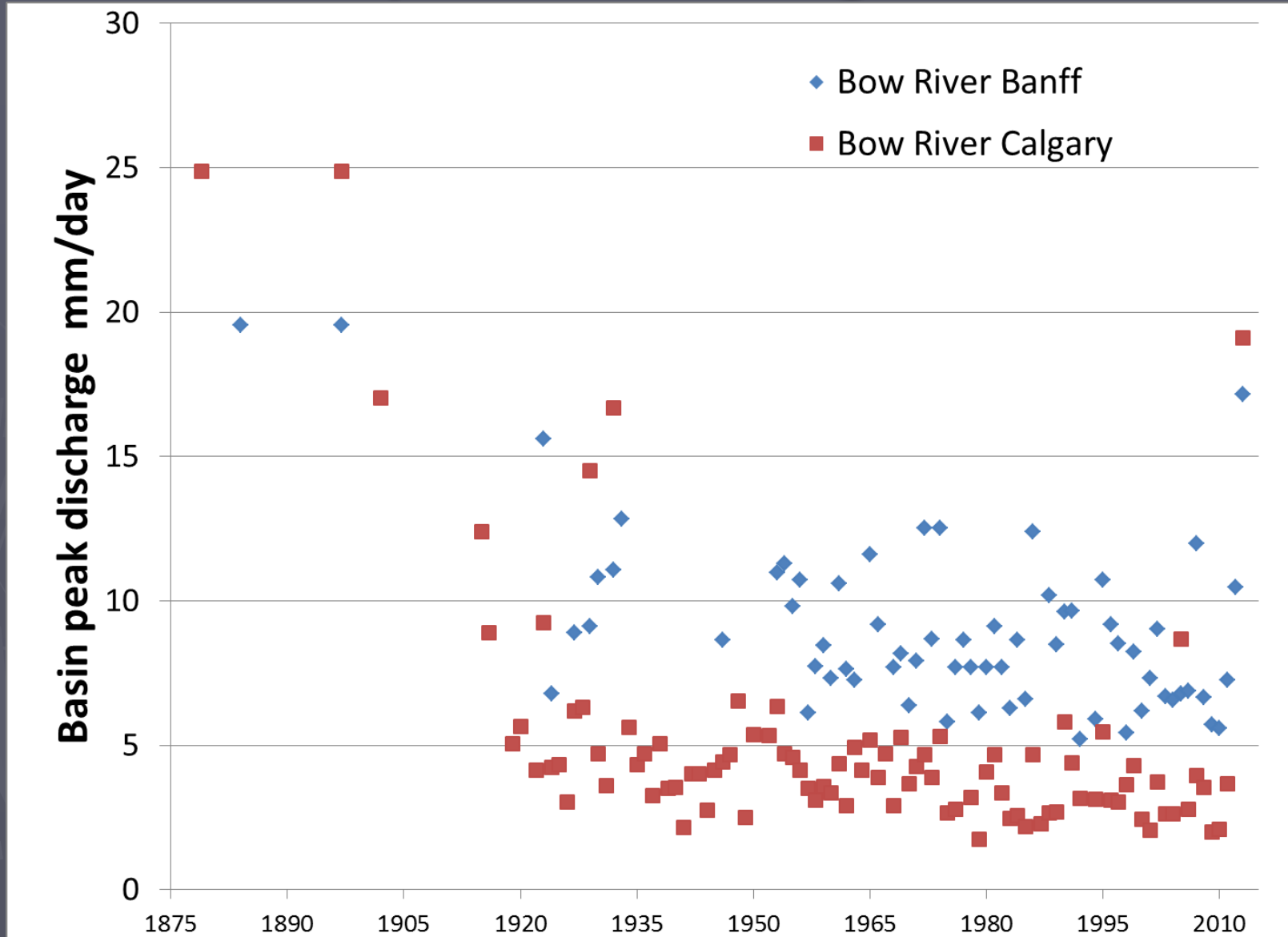
Historical Peak Flows - Calgary



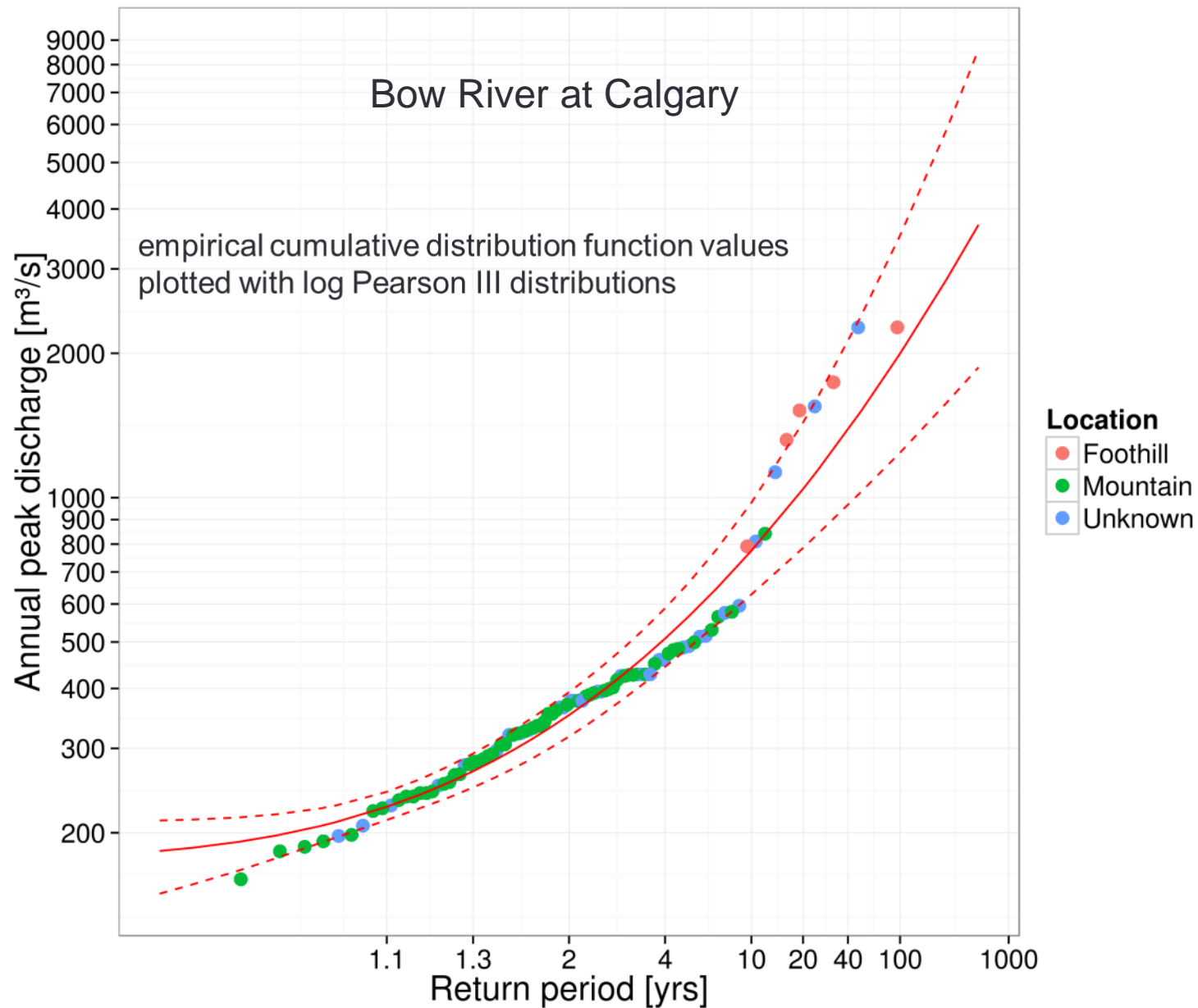
Return Period – Bow River at Calgary



Flood Generation Mechanisms Vary with Magnitude



Source and Mechanism of Flood Affect Return Period



Conclusions

- ▶ Rainfall in June 2013 event was not extraordinarily intense, but of long duration and covered a large area of the Bow River Basin with >200 mm depth of precipitation
- ▶ Near surface soil moisture storage in Marmot Creek filled in the first day and a half of heavy rain
- ▶ Snowmelt over frozen soils during the event contributed an additional 30% to precipitation delivery to alpine and treeline elevations in Marmot Creek.
- ▶ Flow generation mechanisms change with flood magnitude in the Bow River Basin
 - Large floods involve the Front Ranges and Foothills
 - Smaller peak annual flows from the Upper Bow River.
 - It is inappropriate to mix flow generation mechanisms in statistical analysis
- ▶ The Canadian Rockies Flood of 2013 was big, but not extraordinary, and was likely neither the flood of a century, nor the flood of a lifetime.