What History Tells Us About Floods Along The Rocky Mountain East Slopes

Canadian Water Resources Association, March 25, 2014

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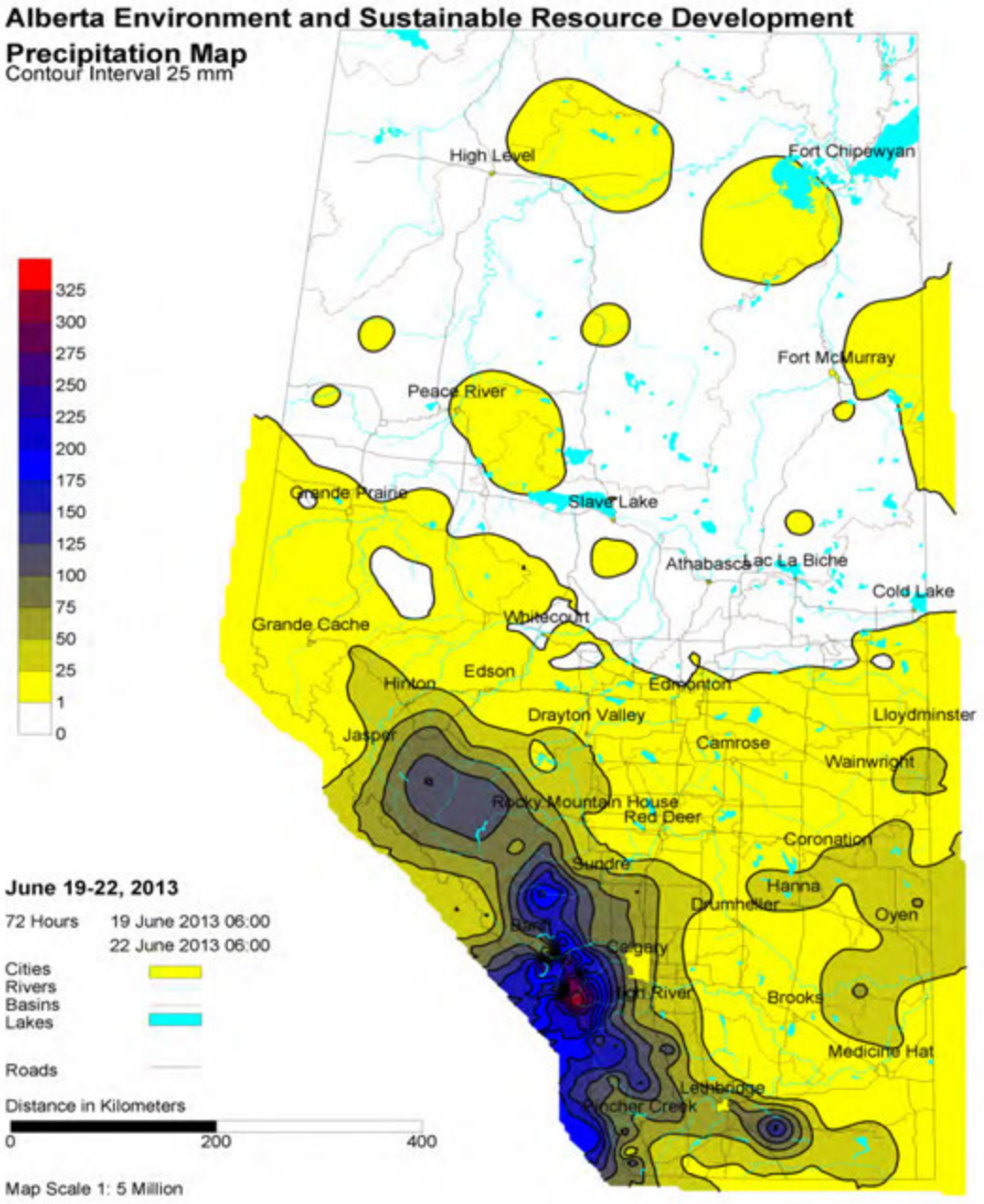
Major Floods are Caused by Cold Low Systems

- Moist air from Gulf of Mexico carried north
- Creates upslope condition along East Slopes
- Results in heavy rainfall in front ranges
- Storm path influenced by jet stream
- Primarily impacts Montana, South and Central Alberta
- Regional scale – not basin specific

Example:
June 2013 Storm



River Basins Examined

- Athabasca River at Athabasca, AB
- North Saskatchewan River at Edmonton, AB
- Red Deer River at Red Deer, AB
- Bow River at Calgary, AB
- Oldman River near Lethbridge, AB
- Milk River at Milk River, AB
- Marias River near Shelby, MT
- Missouri River at Fort Benton, MT

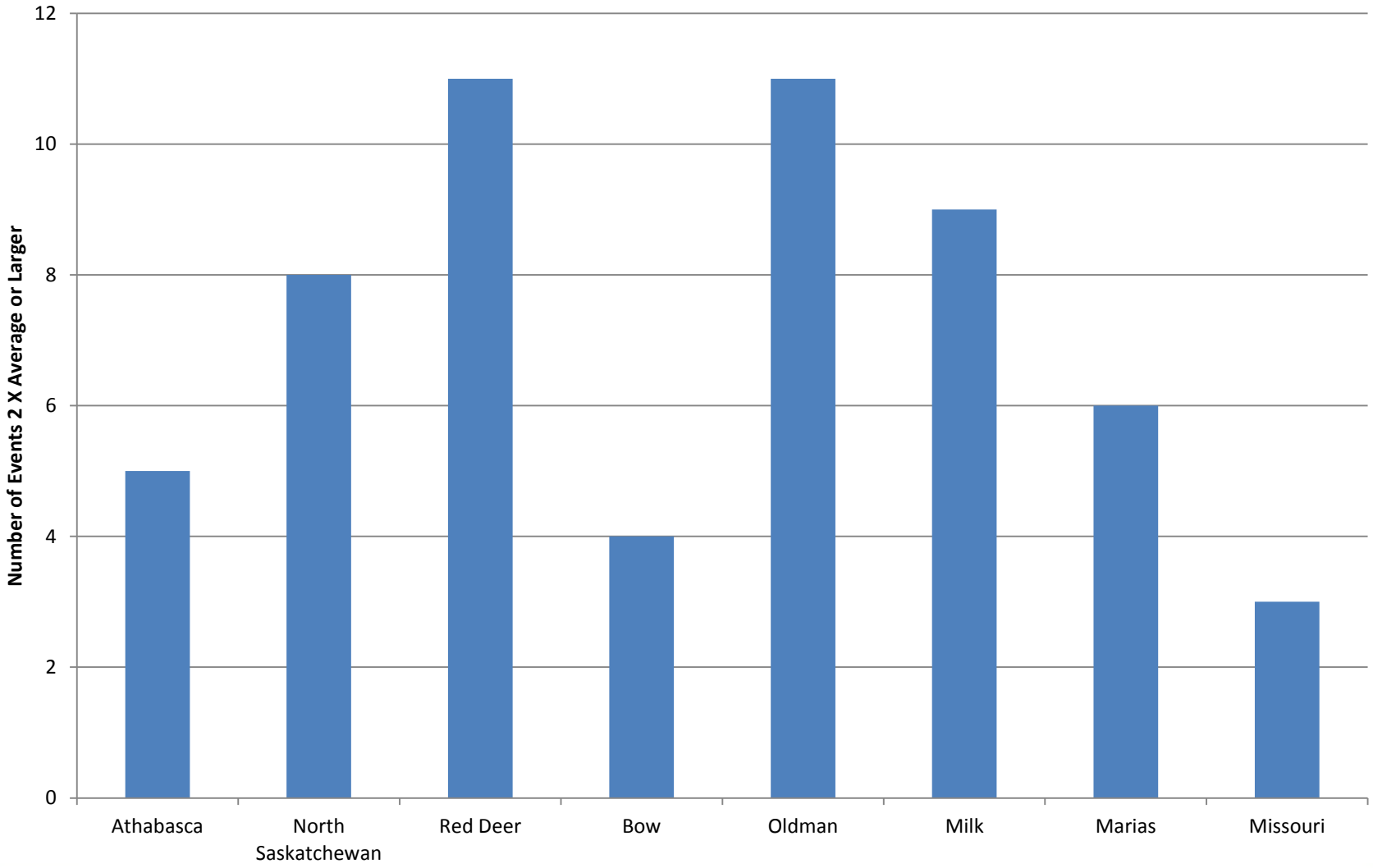
Approach

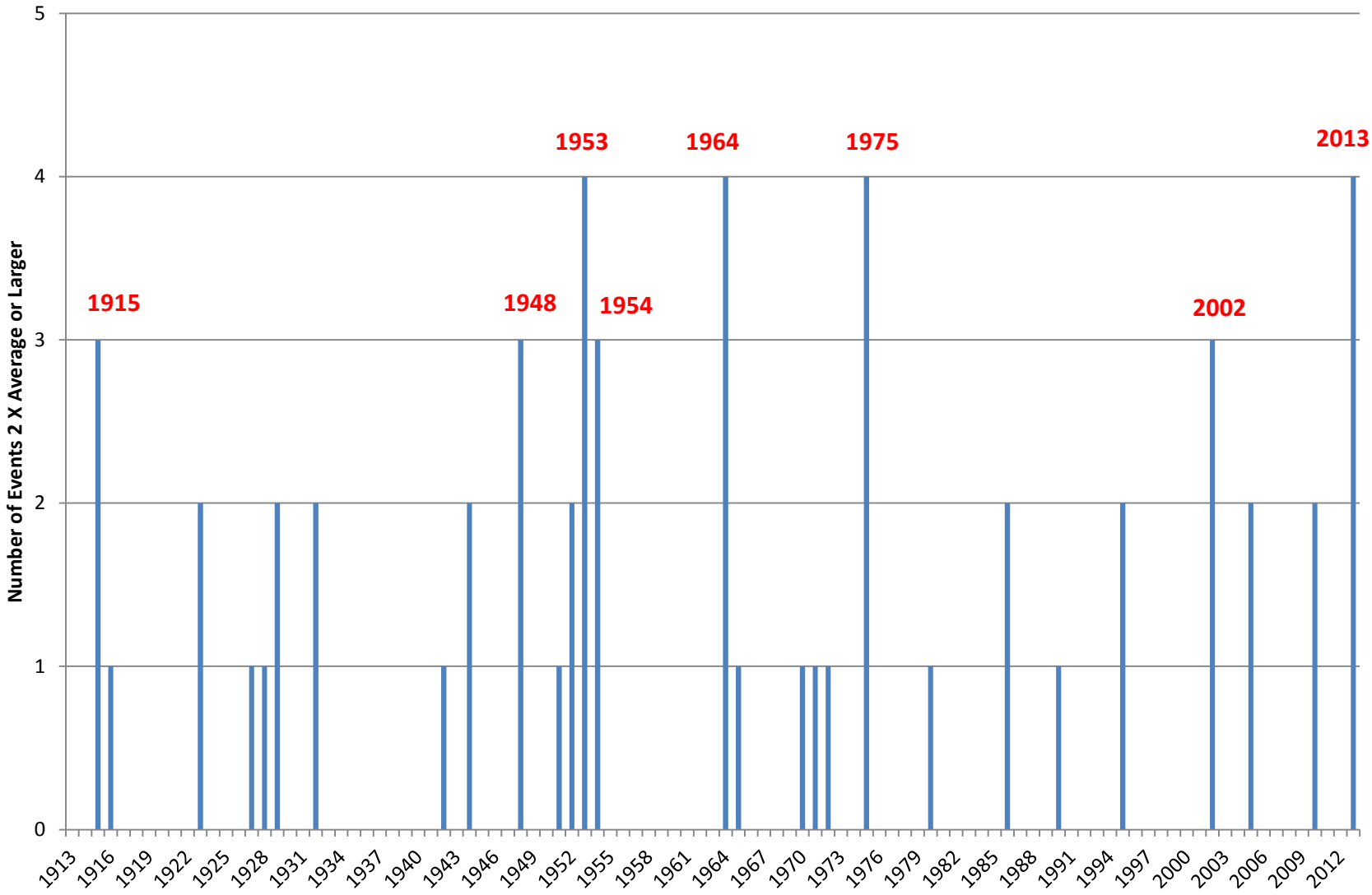
- Used recorded data – no attempt to adjust for regulation
- Comparison period = 1913 – 2013
- Used daily average peak flow; not all stations have instantaneous peaks
- Calculated average of recorded annual flood peaks at each station
- Identify all floods:
  - 2 x Average or larger
  - Exclude Ice Jam events
- Looked for event commonality

How Big is 2 X Average?

Recent High Flow Events

Athabasca River at Athabasca	2011	(1.9)
North Saskatchewan River at Edmonton	2013	(2.2)
Red Deer River at Red Deer	1990	(2.2)
(2005 & 2013 around to 3.0)		
Bow River at Calgary	2005	(1.5)
Oldman River near Lethbridge	2010	(2.3)
Milk River at Milk River	2010	(2.5)
Marias River near Shelby	2002	(2.0)
Missouri River at Fort Benton	2011	(1.8)

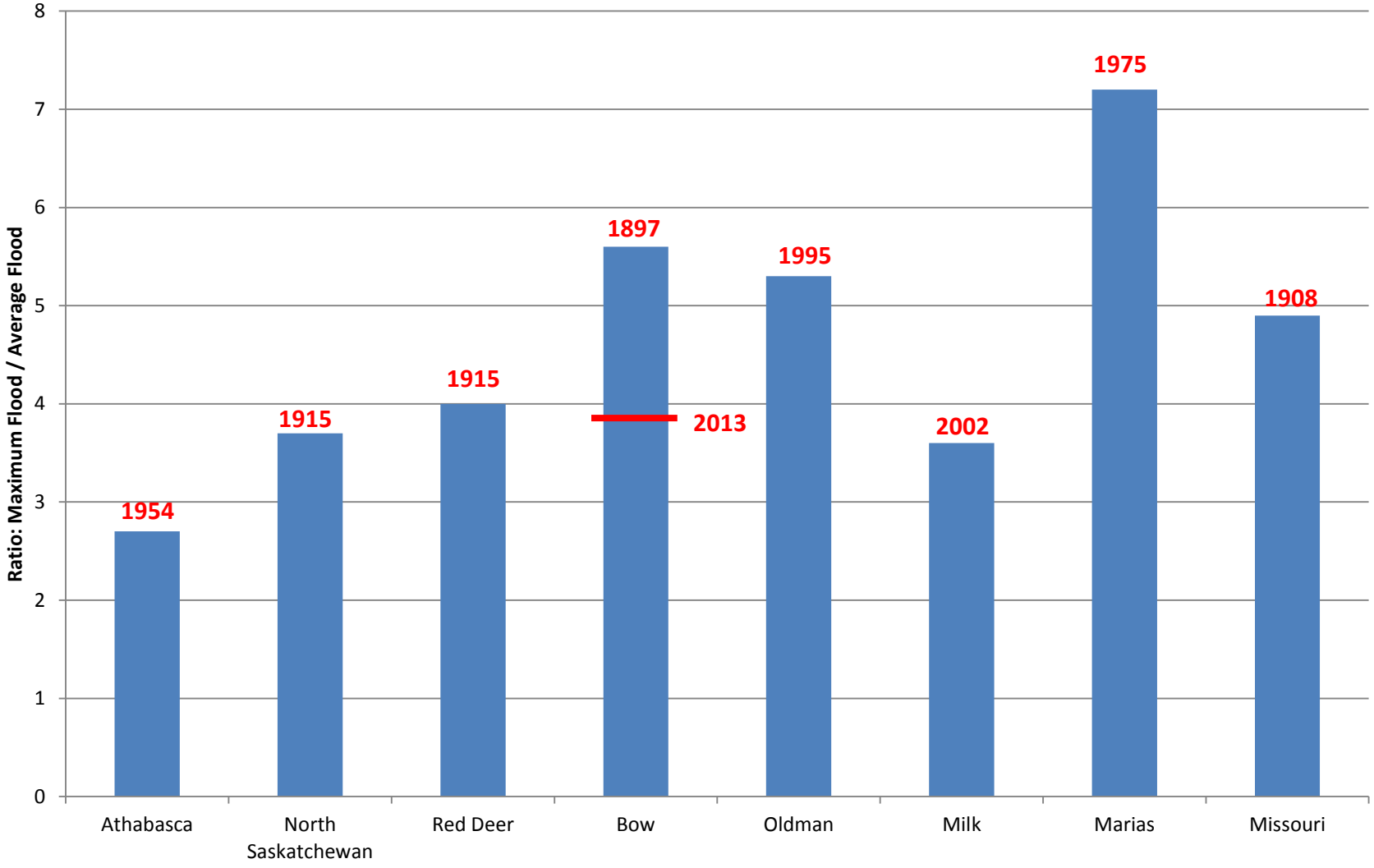

Flood Occurrence by River Basin, 1913 - 2013
Number of Events 2 X Average or Larger
12
10
8
6
4
2
0
Athabasca
North Saskatchewan
Red Deer
Bow
Oldman
Milk
Marias
Missouri


Flood Occurrence by Year, 1913 - 2013
Number of Events 2 X Average or Larger
0
1
2
3
4
5
1915
1948
1953
1954
1964
1975
2002
2013
1913
1916
1919
1922
1925
1928
1931
1934
1937
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012

Interesting Observations

- 57 Events in 101 Years: One Event Every Other Year
- 1951 – 1954: 10 Events in 4 Years

Largest Flood by Basin



More Interesting Observations

- Largest Floods by Basin are Distributed Across Period of Record
- Ratio of Largest Flood / Average Flood can go Significantly Higher than Experienced in 2013
- Basins With Back to Back High Flow Years
  - Bow River: 1915, 1916 (both just under 2 X average)
  - Red Deer River: 1915, 1916 (4.0, 1.8)
  - Red Deer River: 1928, 1929 (both ~2.4)
- Basins With 2 High Flow Events in 3 Years
  - North Saskatchewan River: 1952, 1954 (2.8, 2.4)
  - Red Deer River: 1952, 1954 (2.7, 3.0)
  - Milk River: 1951, 1953 (2.0, 2.8)

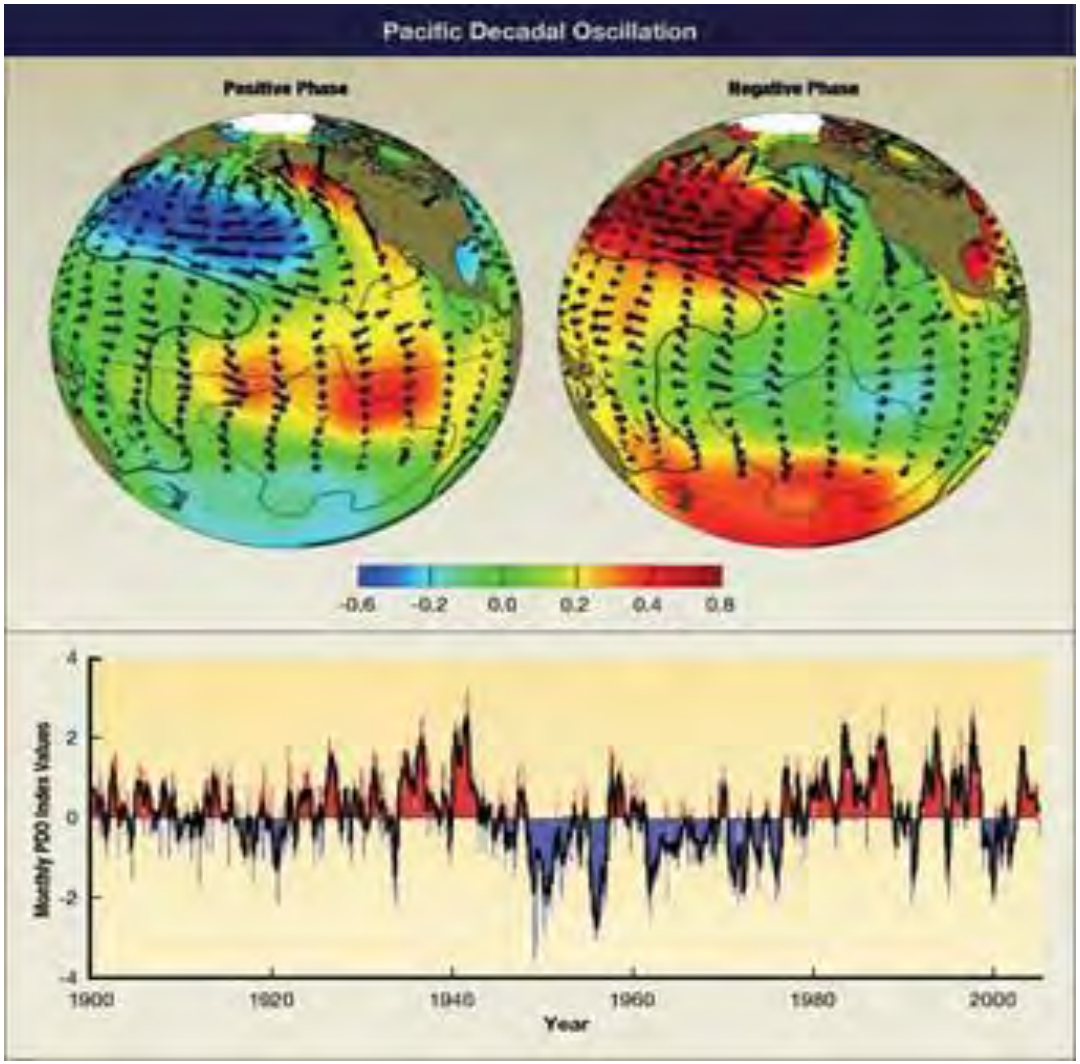
Flood Event Commonality – Selected Years

River Basin	1915	1929	1932	1948	1964	1975	1986	1995	2002	2005	2013
Athabasca	30-Jun						21-Jul				around 23 Jun
North Saskatchewan	**29-Jun**	5-Jun	4-Jun				**19-Jul**			21-Jun	around 22 Jun
Red Deer	**27-Jun**	4-Jun	3-Jun				19-Jul	8-Jun		**20-Jun**	around 21 Jun
Bow	26-Jun	**3-Jun**	**3-Jun**					8-Jun		19-Jun	**21-Jun**
Oldman	27-Jun	4-Jun	3-Jun	**18-Jun**	**10-Jun**	21-Jun		**8-Jun**	11-Jun	**9-Jun**	around 21 Jun
Milk	26-Jun	3-Jun		18-Jun	9-Jun	21-Jun		8-Jun	**11-Jun**	8-Jun	around 21 Jun
Marias		3-Jun		18-Jun	9-Jun	**20-Jun**		8-Jun	11-Jun		
Missouri		2-Jun			10-Jun	21-Jun		8-Jun	12-Jun		

Date of Peak Annual Flow – Red Font Shows Where Storm Center Occurred

Pacific Decadal Oscillation

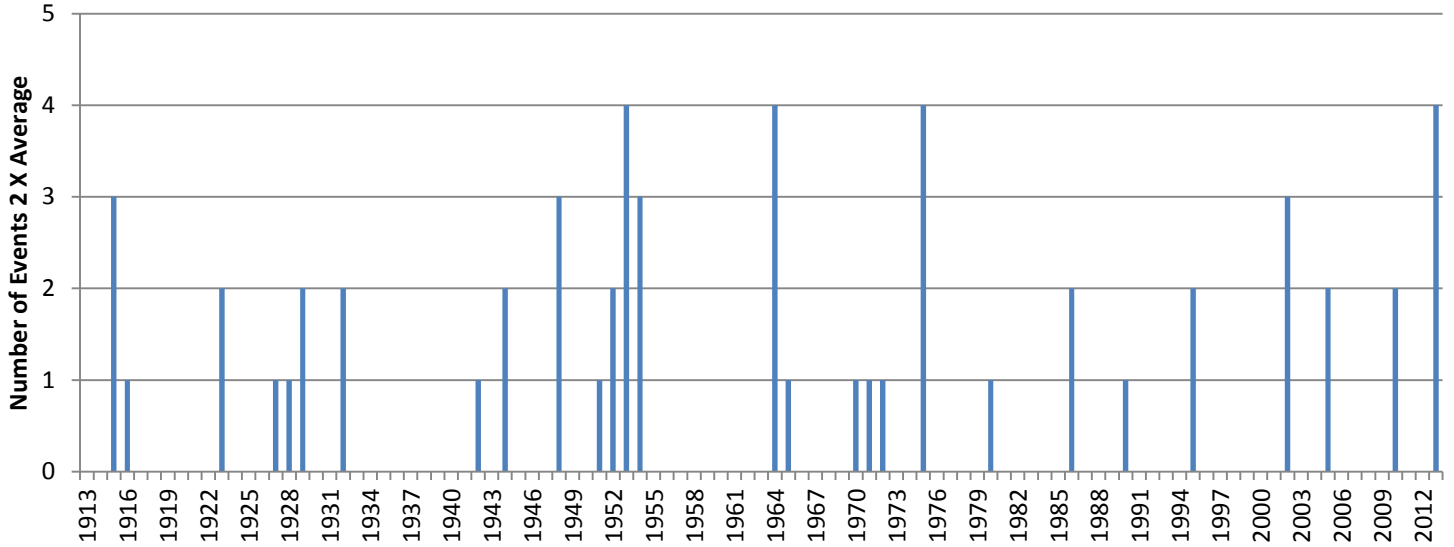
Cool Phase

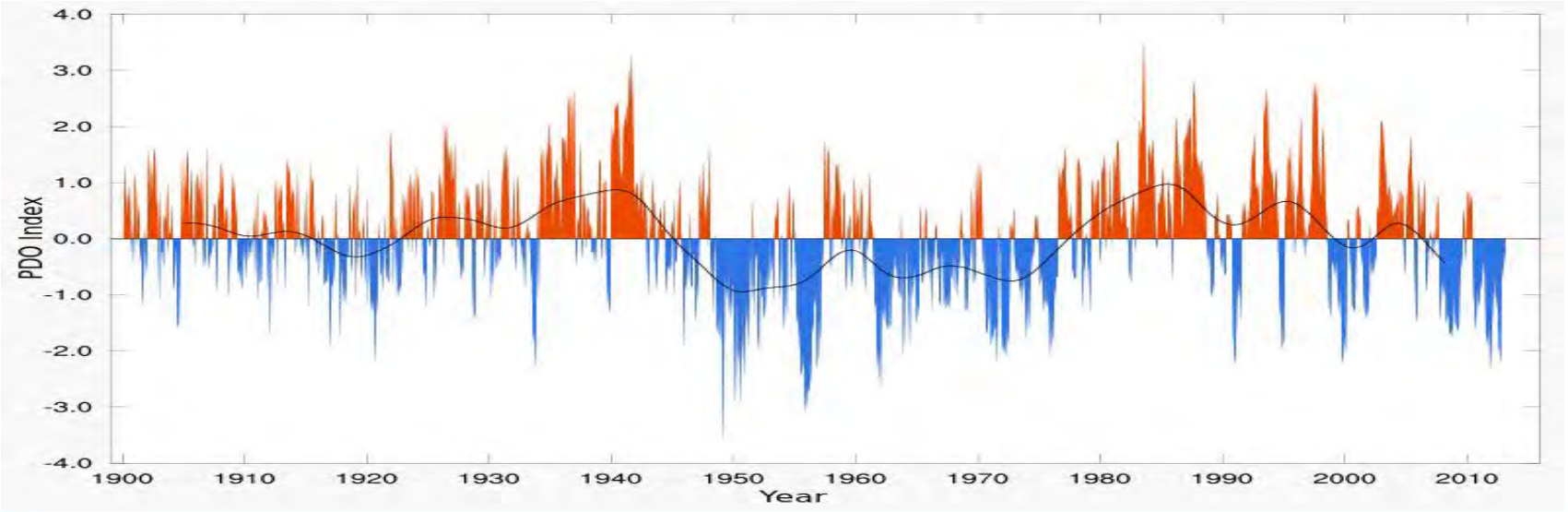


Warm Phase

From: Hare & Mantua, University of Washington

Frequency of Large Floods vs. Pacific Decadal Oscillation Cycle

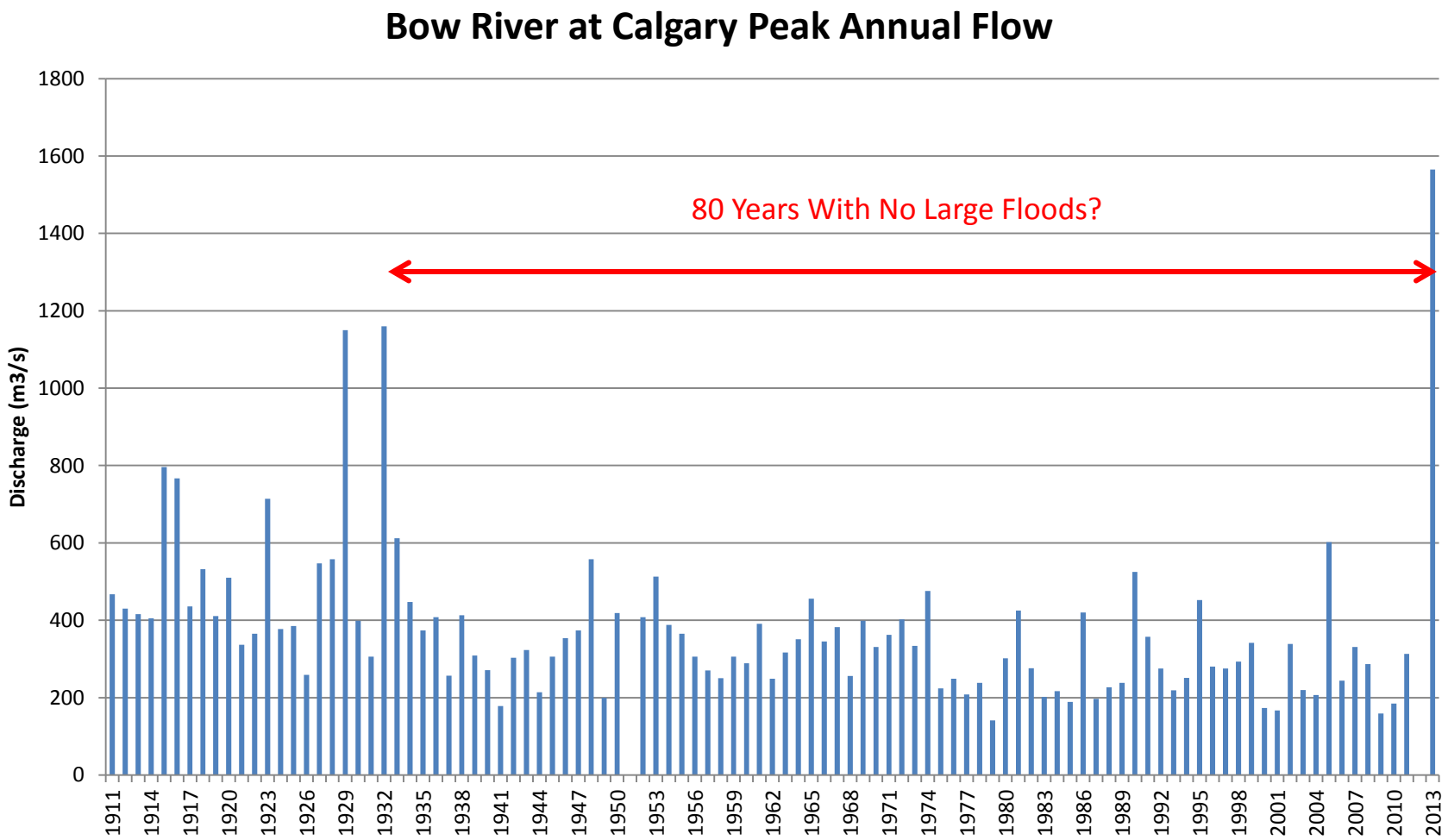




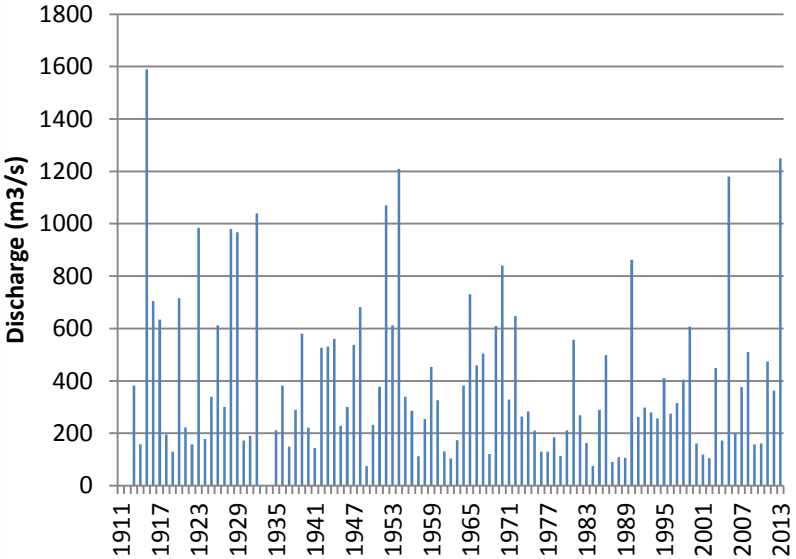
Preliminary Conclusions & Observations

- Large floods occur frequently along the Rocky Mountain East Slopes
- These storm events impact several basins at one time
- Not uncommon to have back to back events
- Potentially a correlation between frequency of Cold Low events and the cycle of the Pacific Decadal Oscillation
- Need to consider a regional approach to flood frequency analysis rather than looking at Basins independently

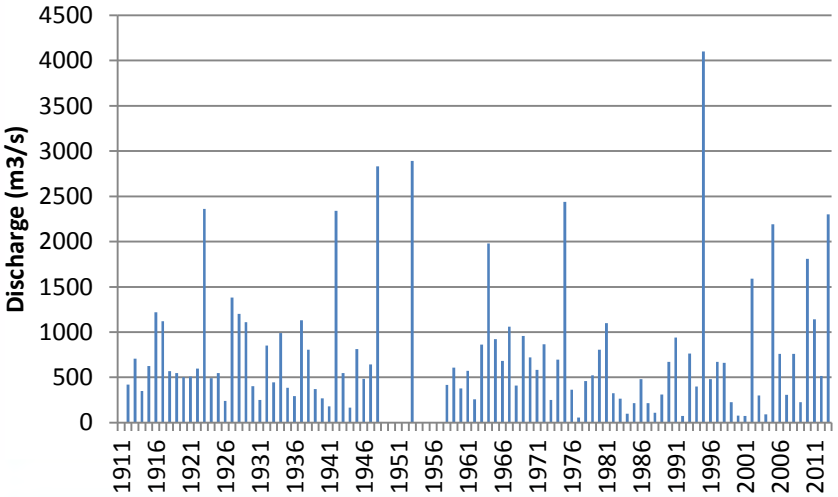
Bow River Conundrum



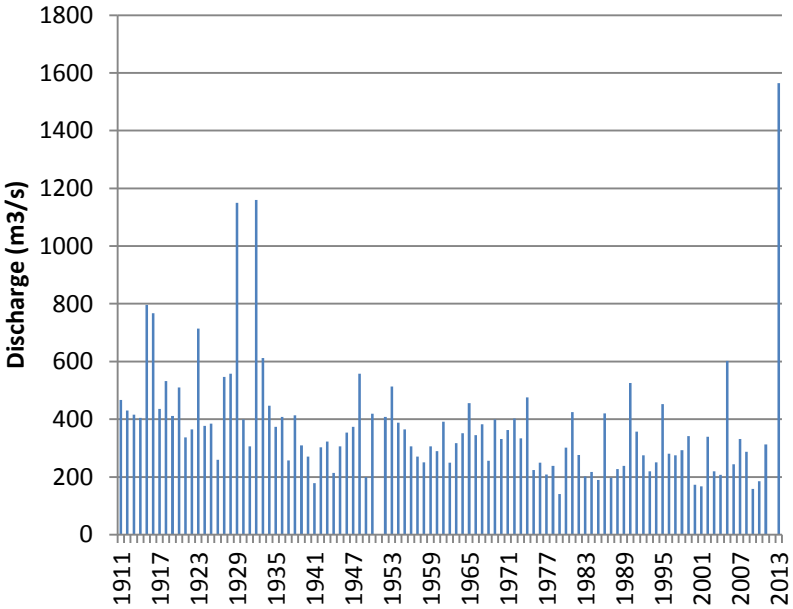
Red Deer River at Red Deer



Oldman River near Lethbridge



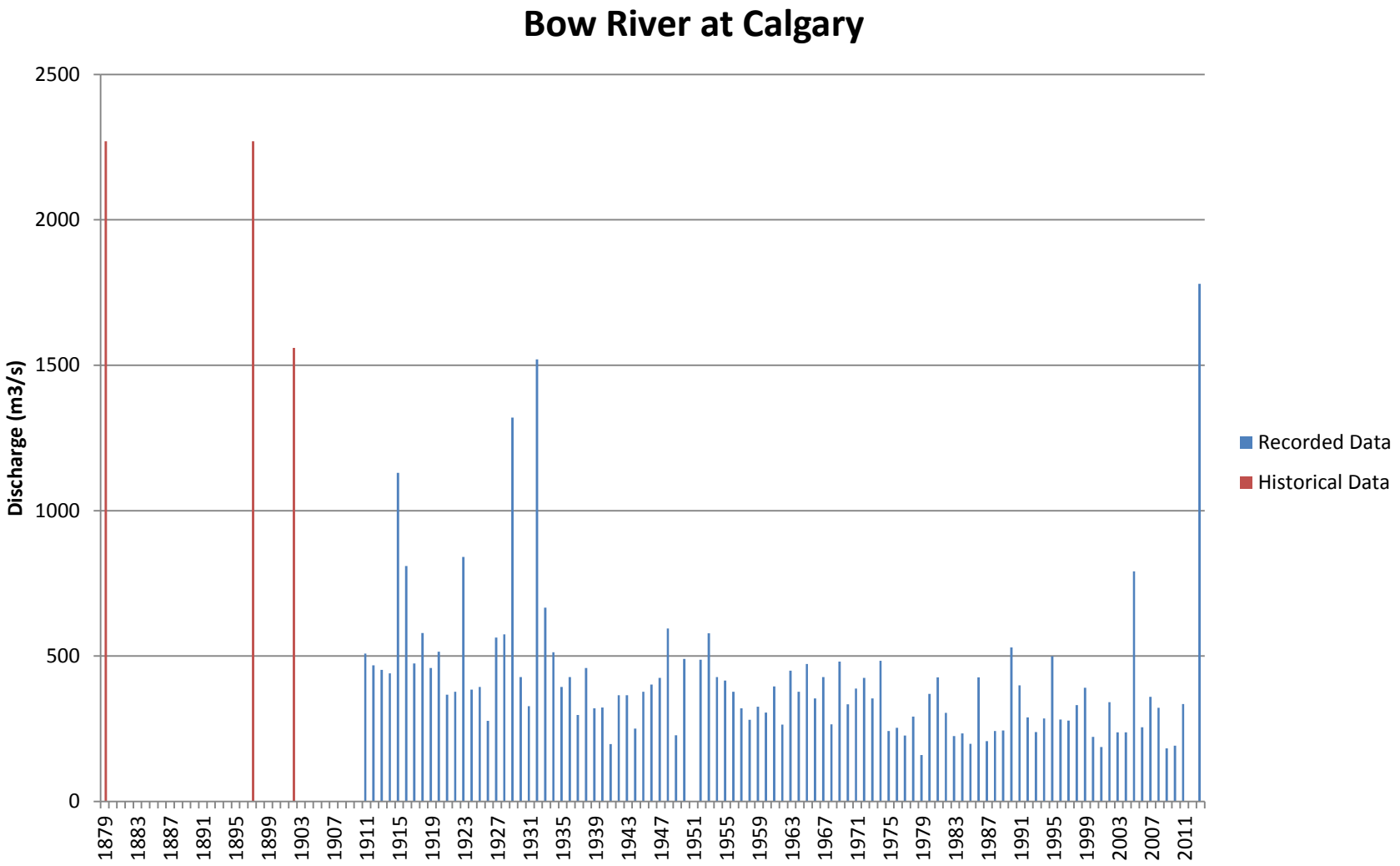
Bow River at Calgary



Question

- Is the lack of floods in the Upper Bow River pure chance?
- Or are there other factors?

Value of Historical Data



QUESTIONS?