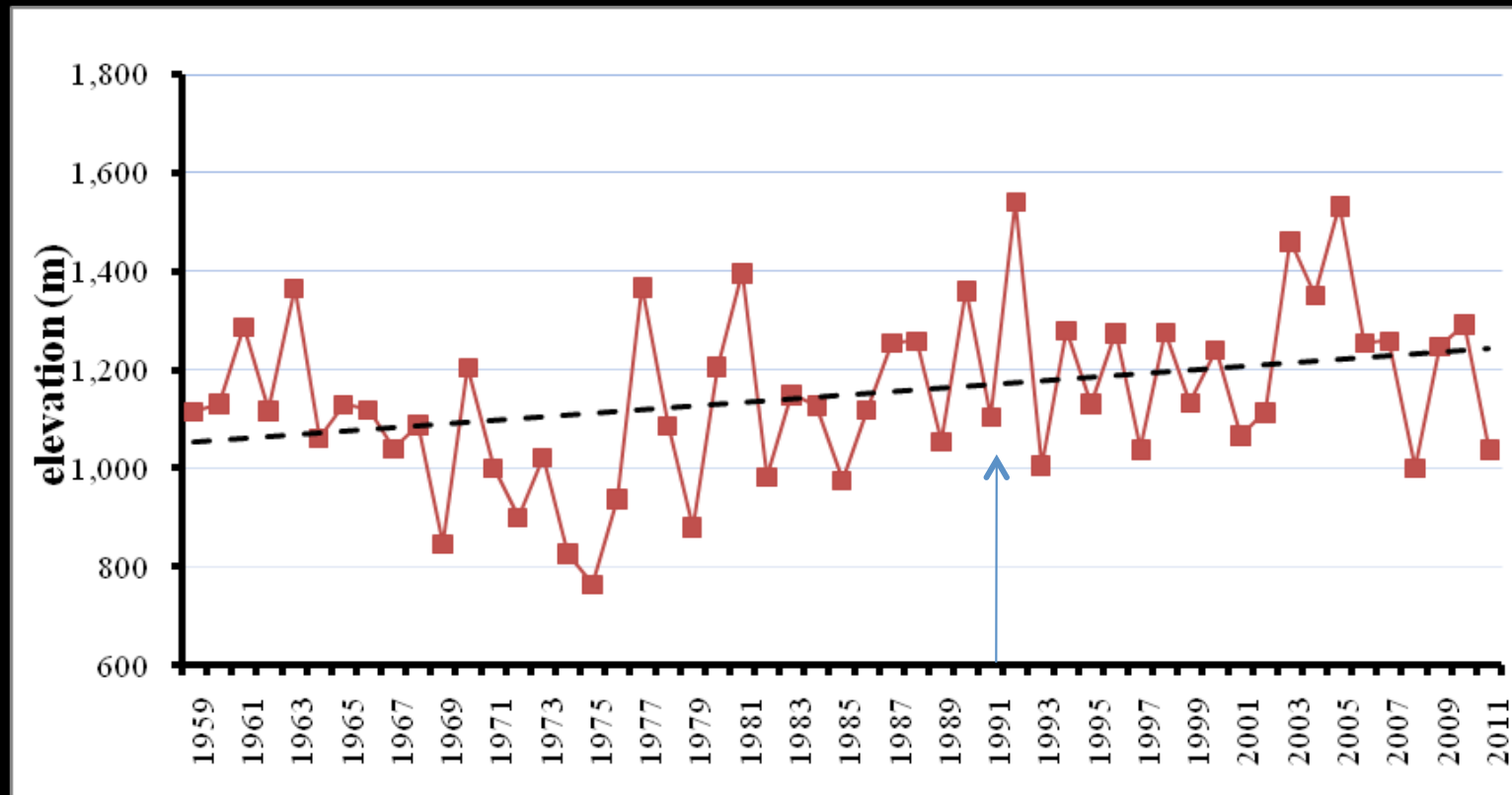


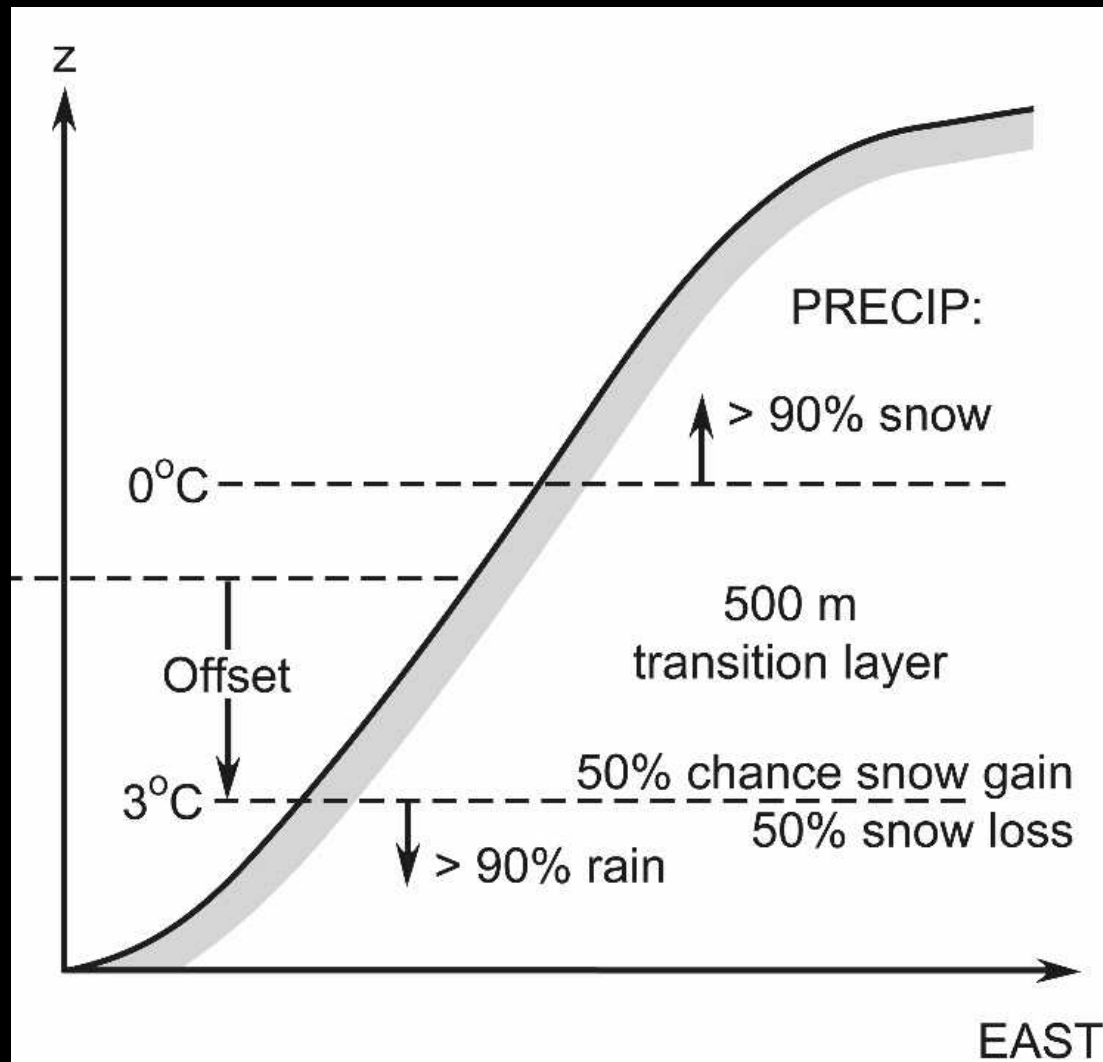
# Projected and Observed Changes in Skagit River Flooding due to Climate Change

Jon L. Riedel, Ph.D.





Average winter (November-April) elevation of the freezing level in the North Cascades. Dashed line is trend, which has risen ~650 ft since 1959 (NOAA, 2012).



Source: Lundqvist et al. 2007

## **Approach to estimating impact of warmer winters on flooding:**

- 1- Use existing ROS model (1991) to fix boundaries of winter precipitation form (rain, rain-on-snow, and snow).
- 2- Take CIG average 2040 (+3.2°F) and 2080 (+5.2°F) temperature estimates
- 3- Apply an adiabatic lapse rate of 3.5°F/1000 ft
- 4- Raise boundaries on main winter form of precipitation 900 and 1500 ft.
- 5- Use GIS to measure area changes in each zone

Projected Changes in extent of 'Precipitation Form'  
zones within Skagit Watershed

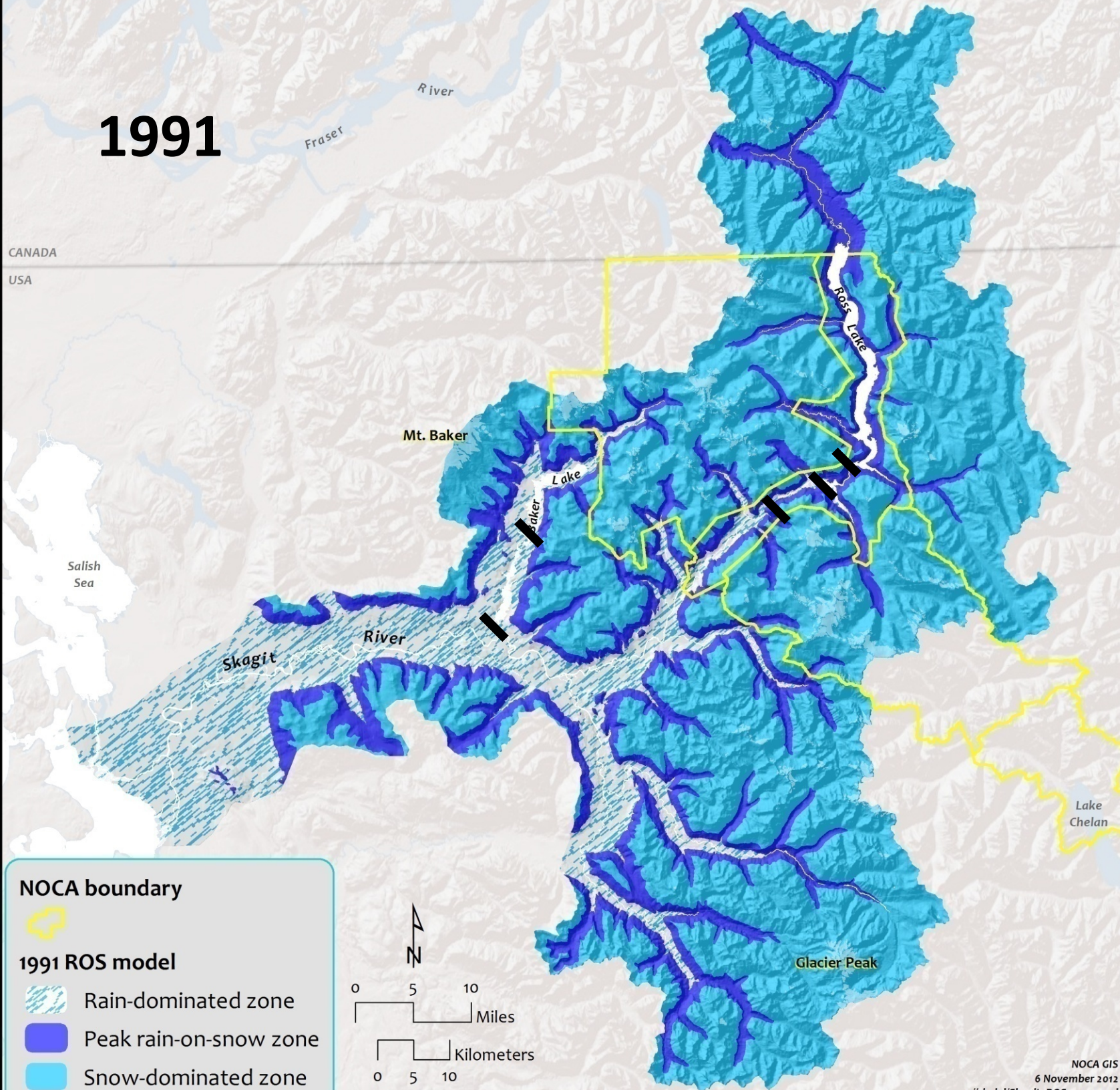
	% Rain	% ROS	% Snow
1991	17	15	68
2040 (+3.2 °F - + 900 ft)	27	19	54
2080 (+5.3 °F - + 1500 ft)	35	22	43

	Acres Rain	Acres ROS	Acres Snow
1991	350,000	309,000	1,411,000
2040	553,000	399,000	1,118,000
2080	716,000	460,000	893,000

**Sum of additions to rain and ROS by 2080 = 517,000 acres (2.07M acres total)**



# 1991





# 2040

CANADA  
USA

Salish  
Sea

Fraser  
River

Mt. Baker

Lake

Baker

Skagit  
River

Ross  
Lake

Lake  
Chelan

Glacier Peak

NOCA boundary



2040 projection:



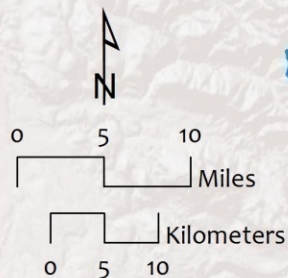
Rain-dominated zone



Peak rain-on-snow zone



Snow-dominated zone





# 2080

CANADA  
USA

Salish  
Sea

Fraser  
River

Mt. Baker

Lake

Ross Lake

Skagit  
River

Lake  
Chelan

Glacier Peak

NOCA boundary



2080 projection



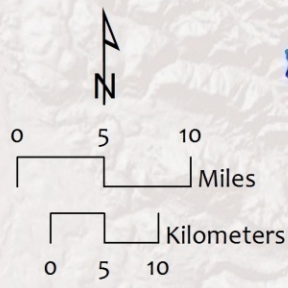
Rain-dominated zone



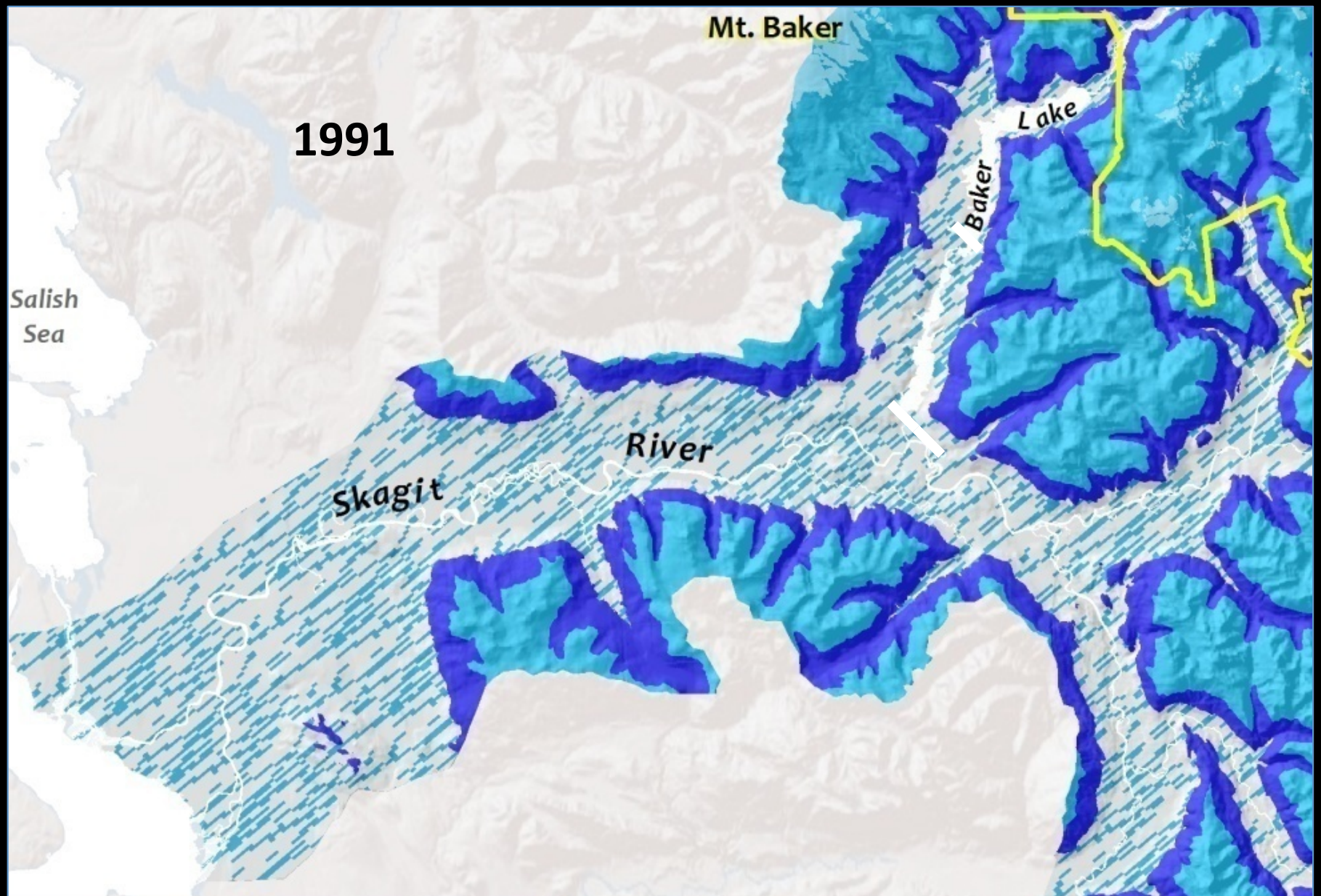
Peak rain-on-snow zone



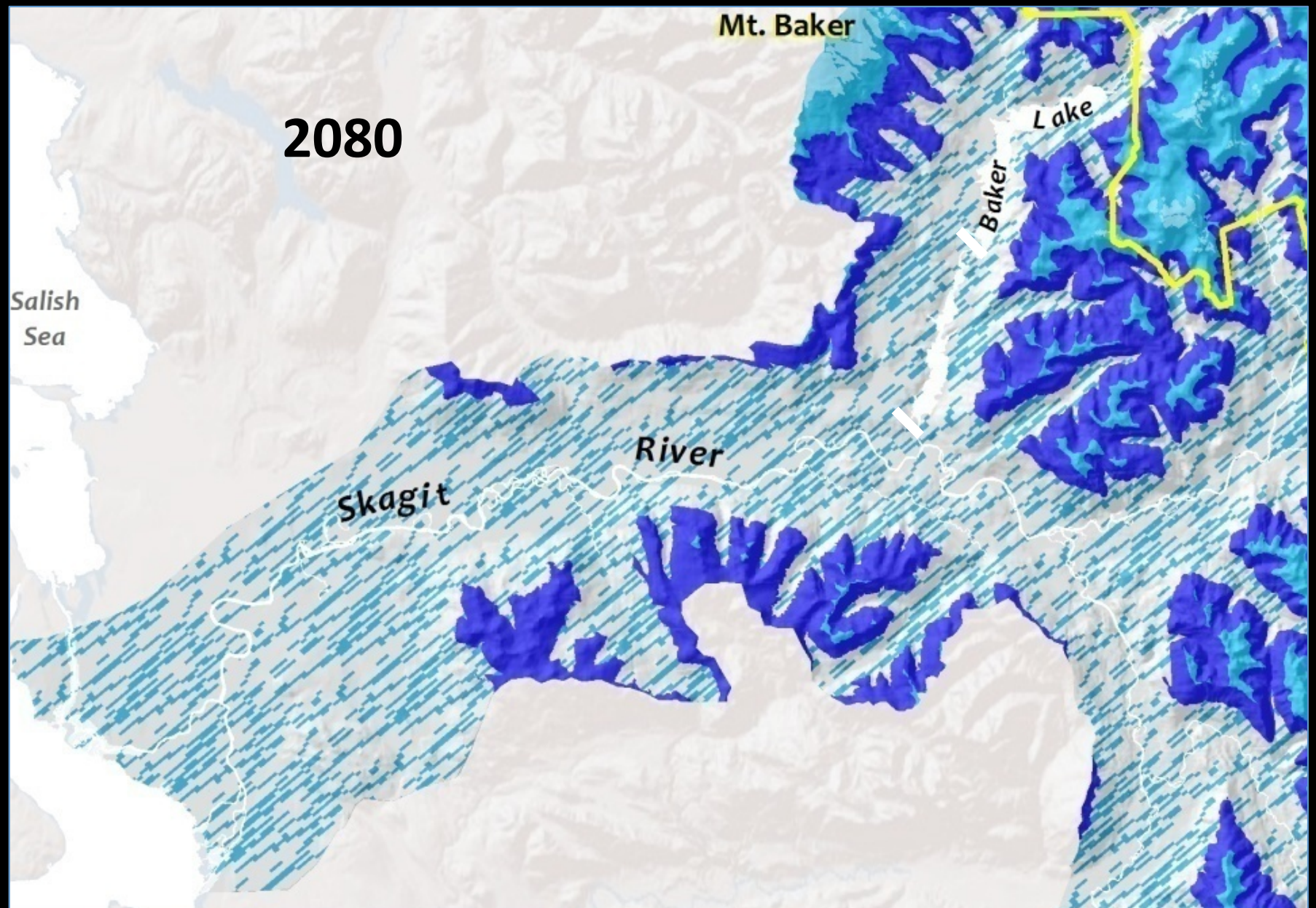
Snow-dominated zone





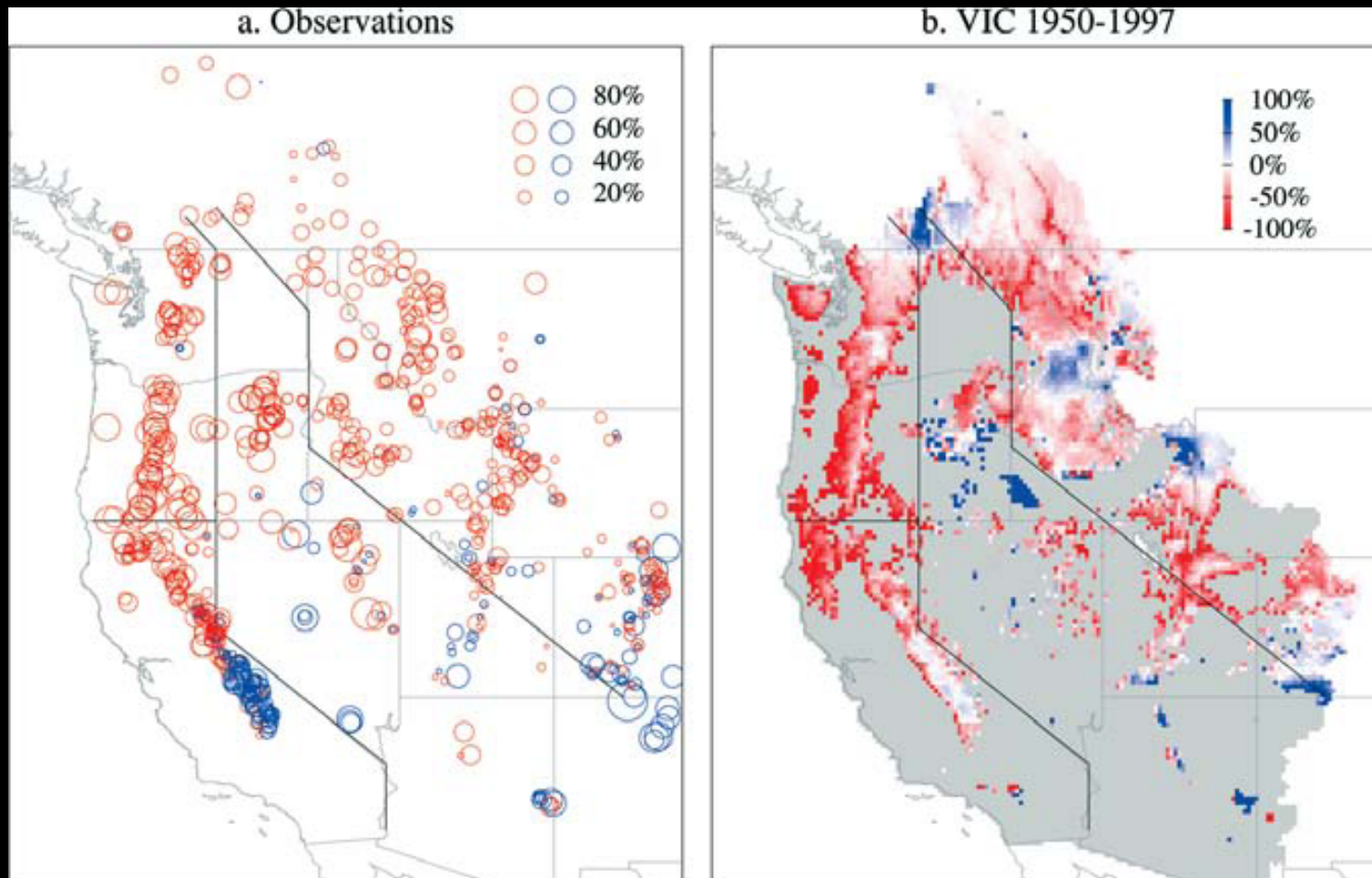




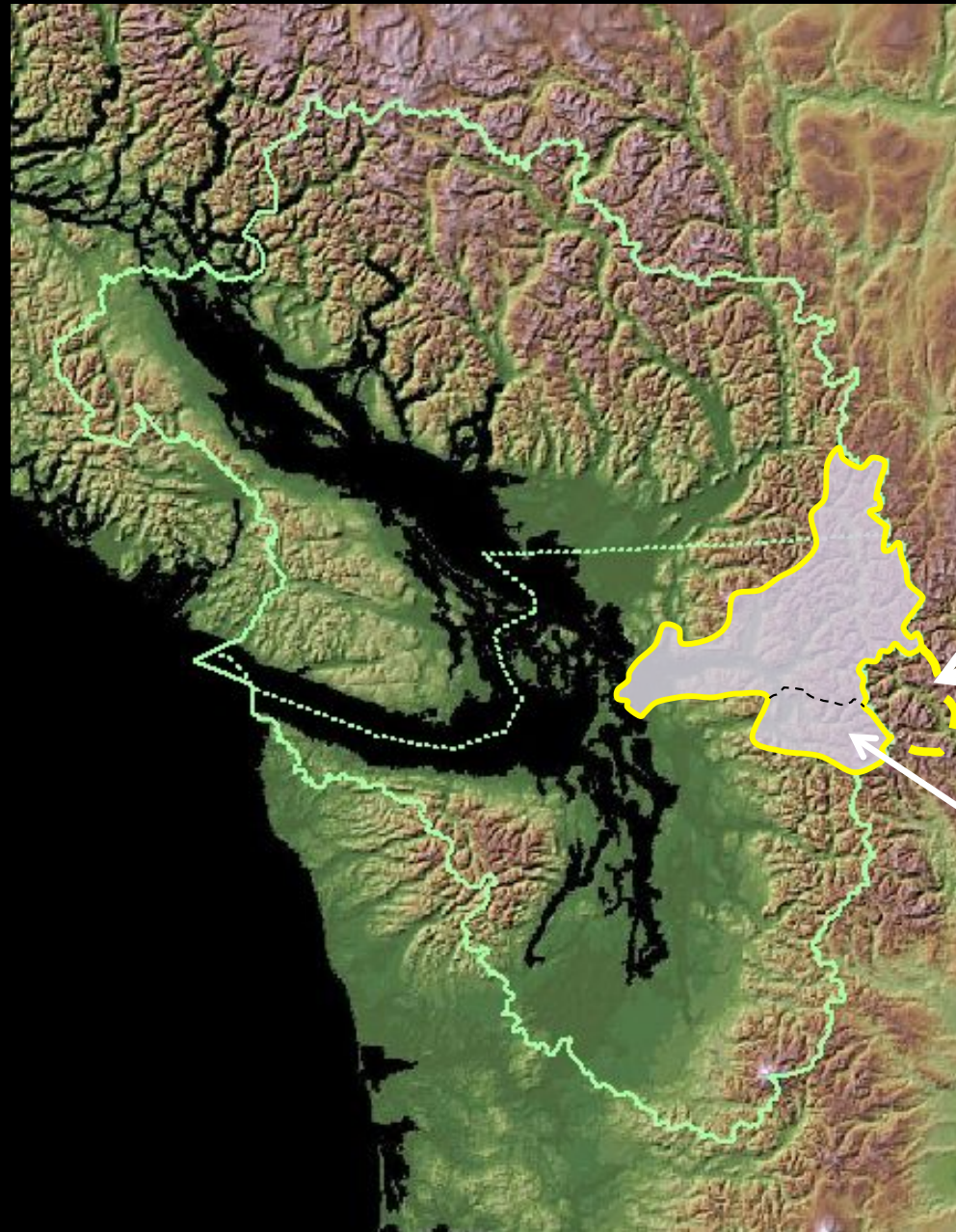




Red shows decline in snowpack in 50 years.



Source: Mote et al., 2005



Stehekin

Sauk



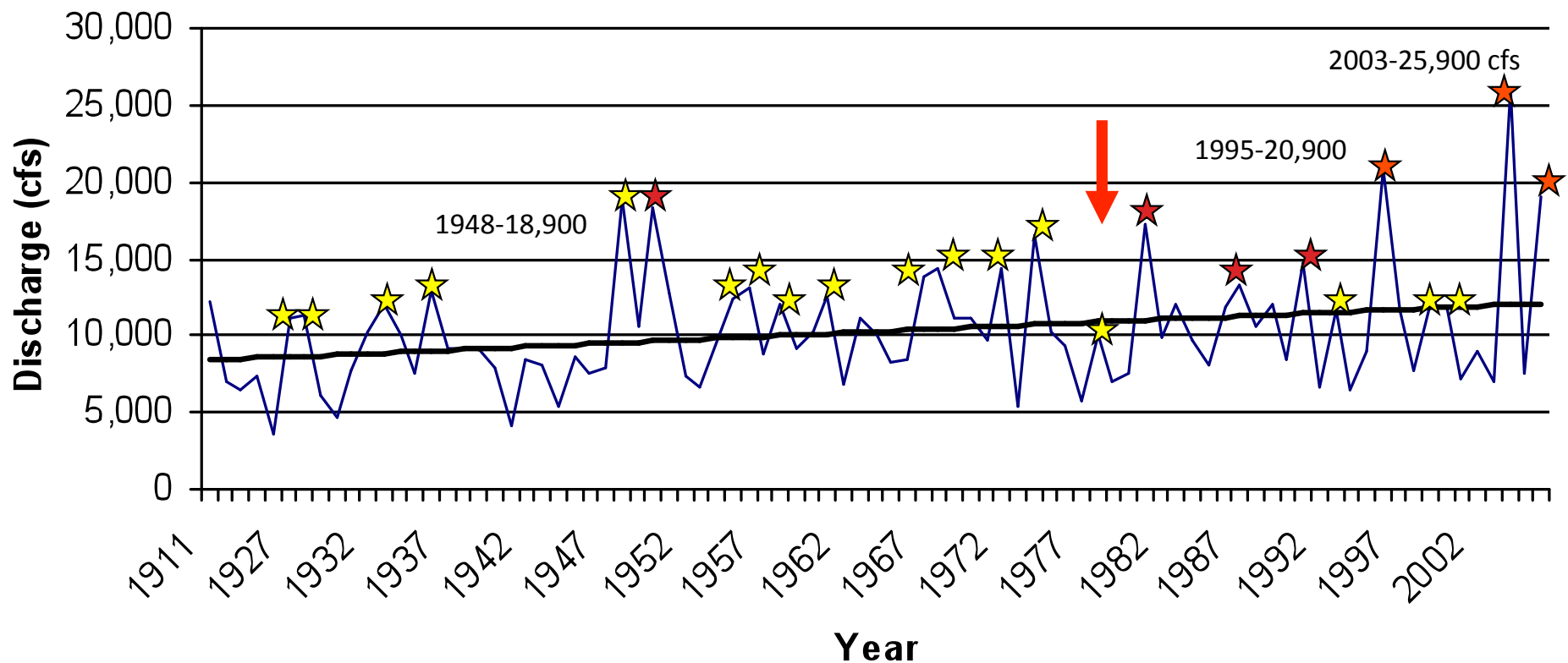
# Magnitude and Timing of the Annual Peak Flood on the Stehekin River



spring



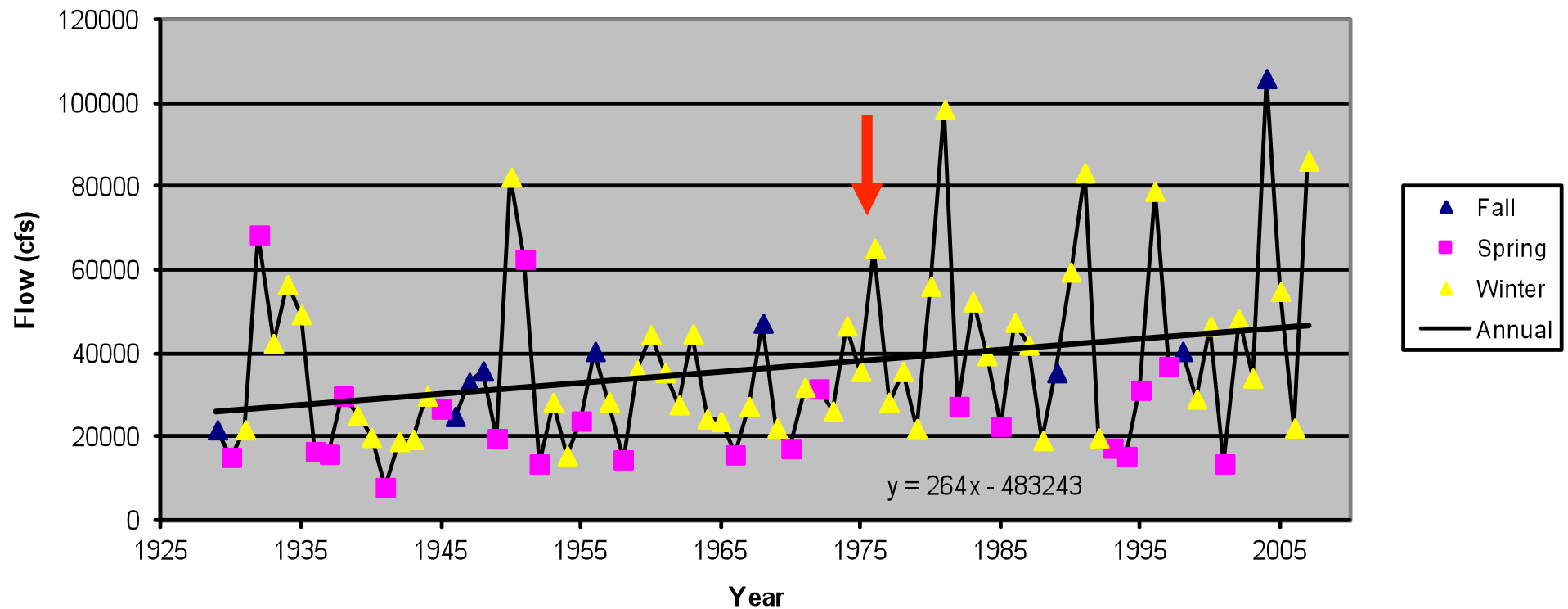
fall



Source: Jon Riedel SRCIP

# Magnitude and Timing of the Annual Peak Flood on the Sauk River

Sauk River Peak Flows



Source: Ron Tressler - SCL



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