

*From Fishing to Farming -
How Climate Trends are
affecting the Bitterroot*

Snowpack and Stream Hydrology

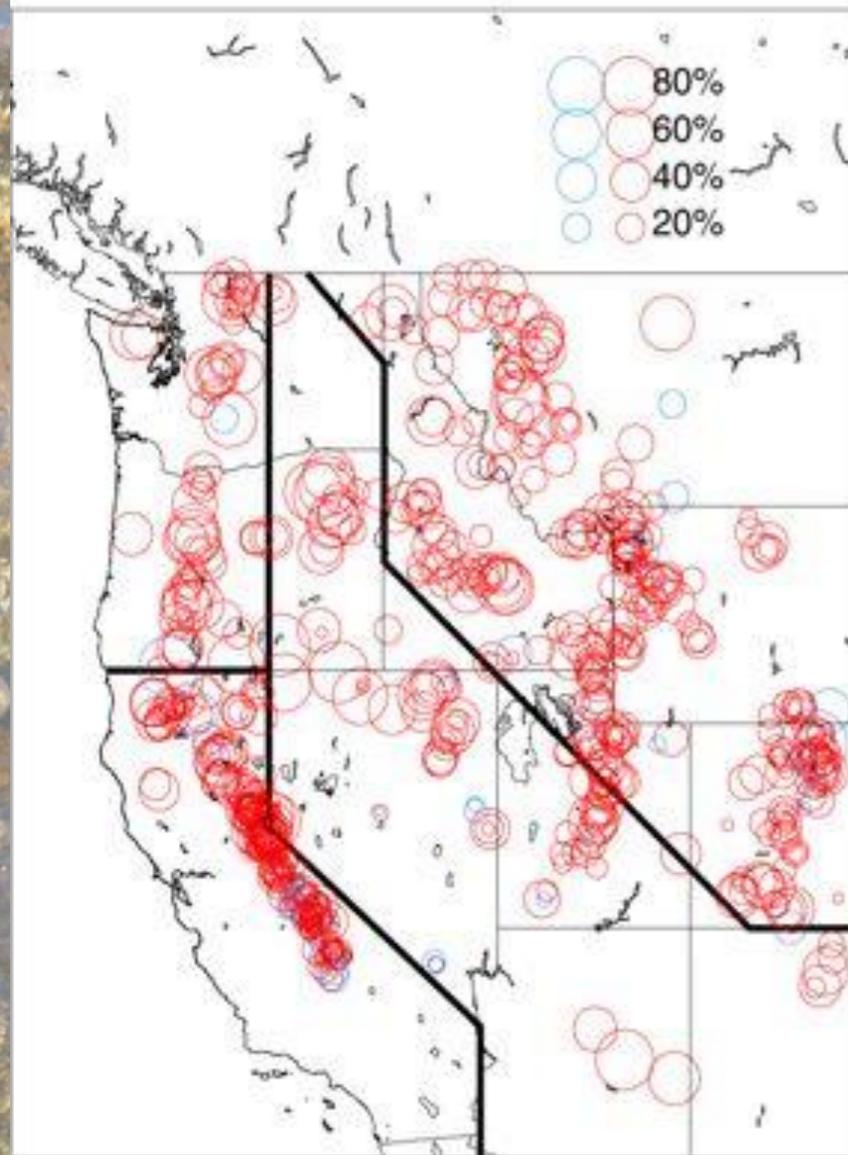
Ed Snook

- 23 years USFS Hydrologist in Wyoming and Montana
- MA Water Resources, University of Wyoming

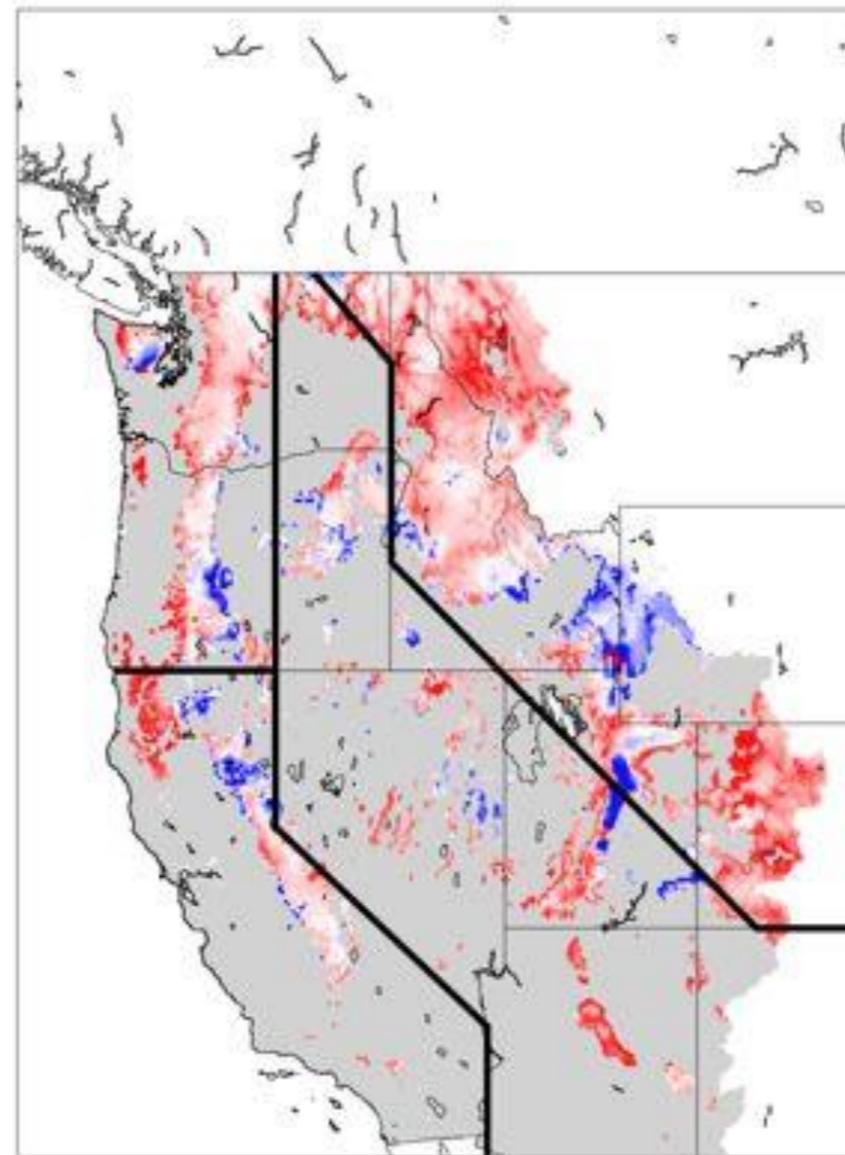
Dramatic declines in snowpack in the western US

Philip W. Mote, Sihan Li, Dennis P. Lettenmaier, Mu Xiao and Ruth Engel (2018)

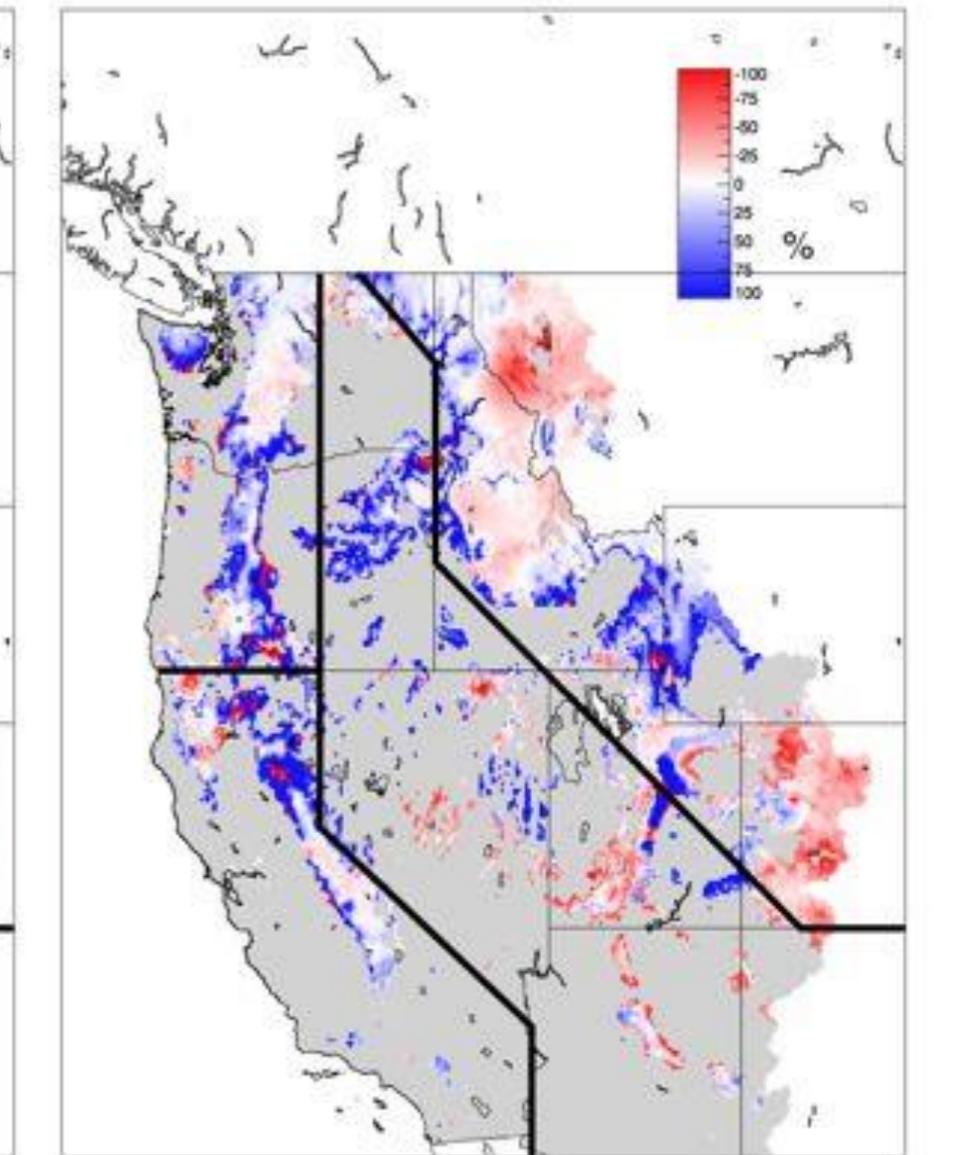
a) April 1 Observed SWE Trends 1955-2016



b) April 1 VIC SWE Trend 1955 to 2014

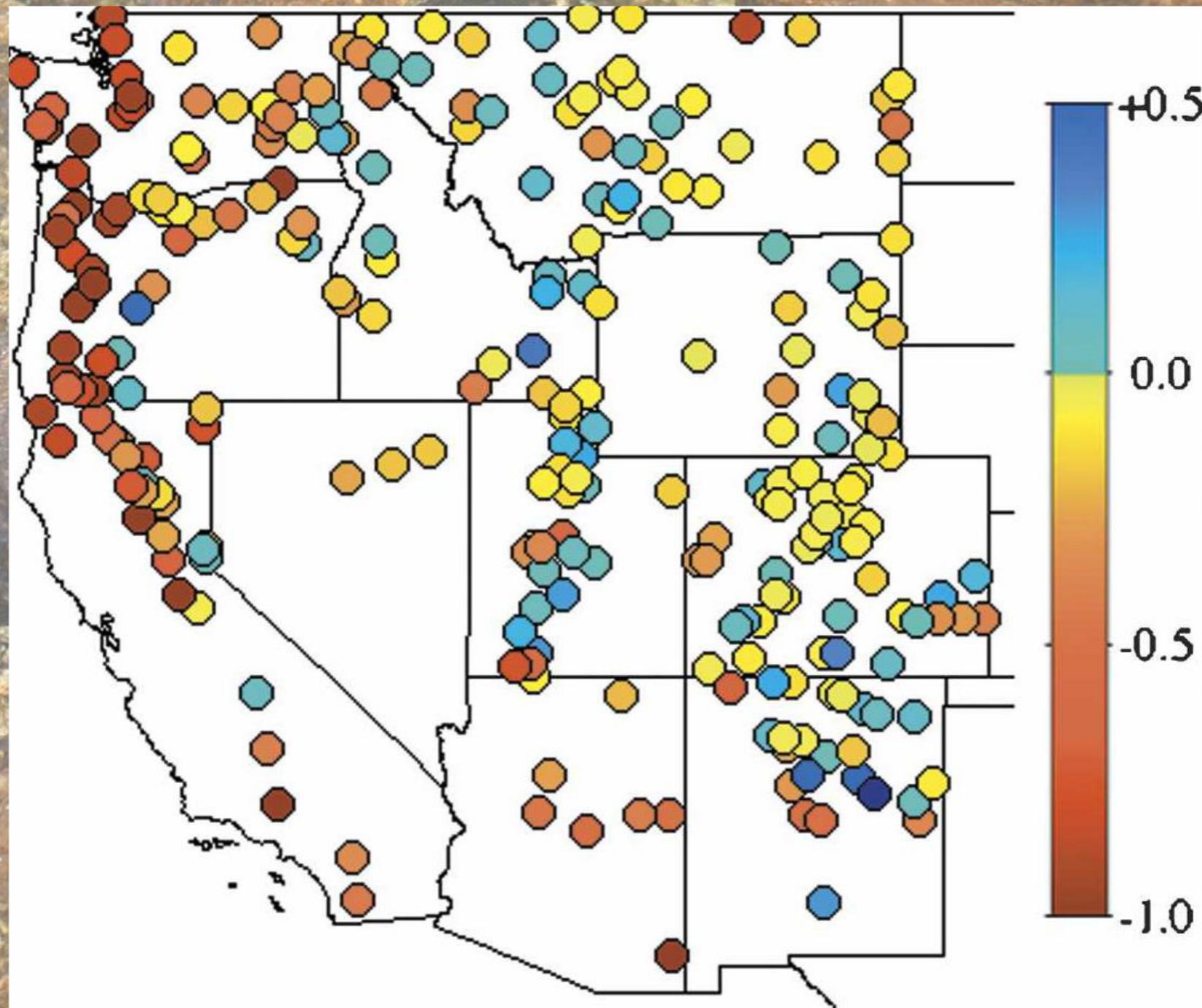


c) April 1 VIC SWE Trend (Detrended) 1955 to 2014



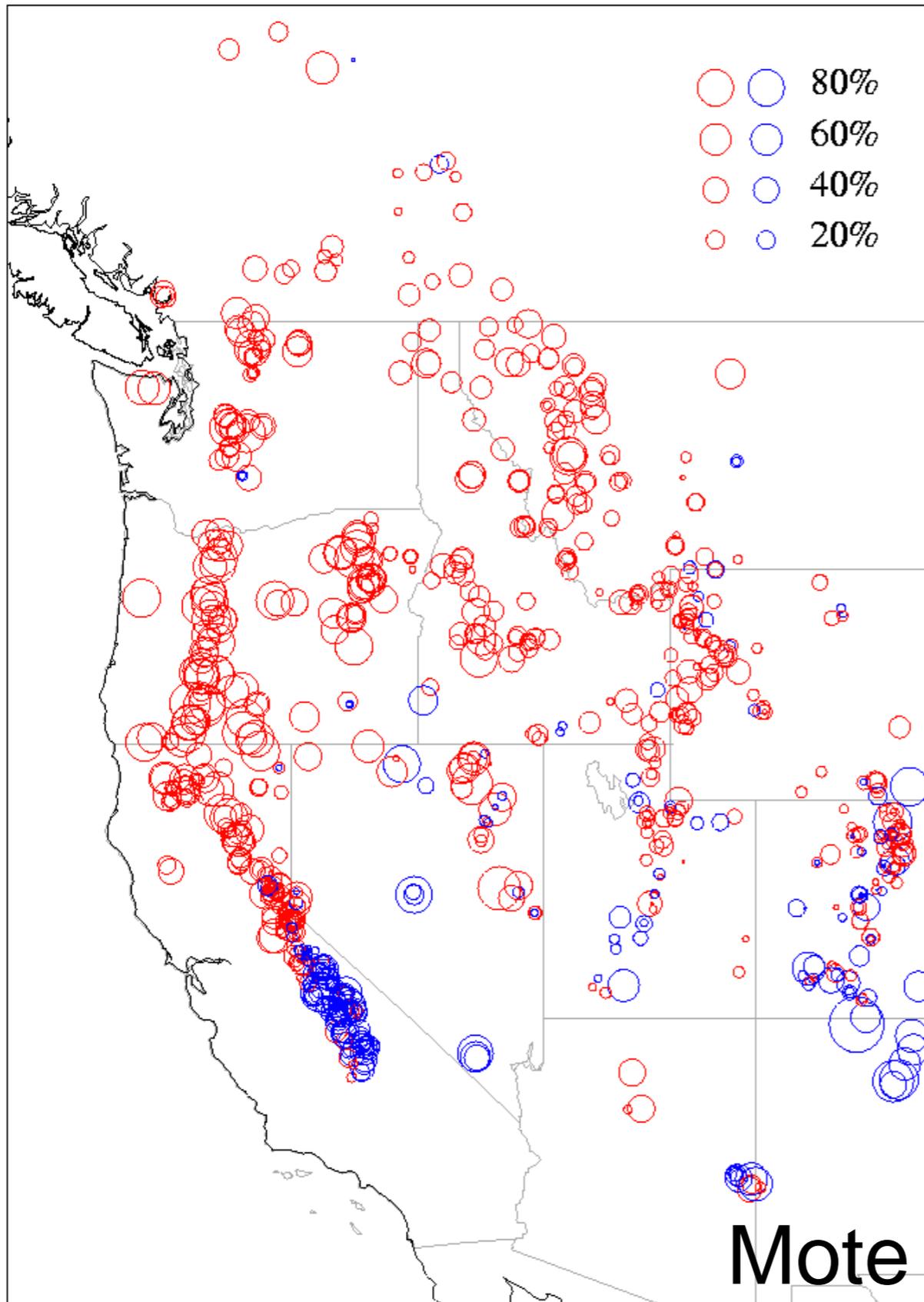
Trends in Snowfall versus Rainfall in the Western United States

Knowles, Dettinger and Cayan 2005

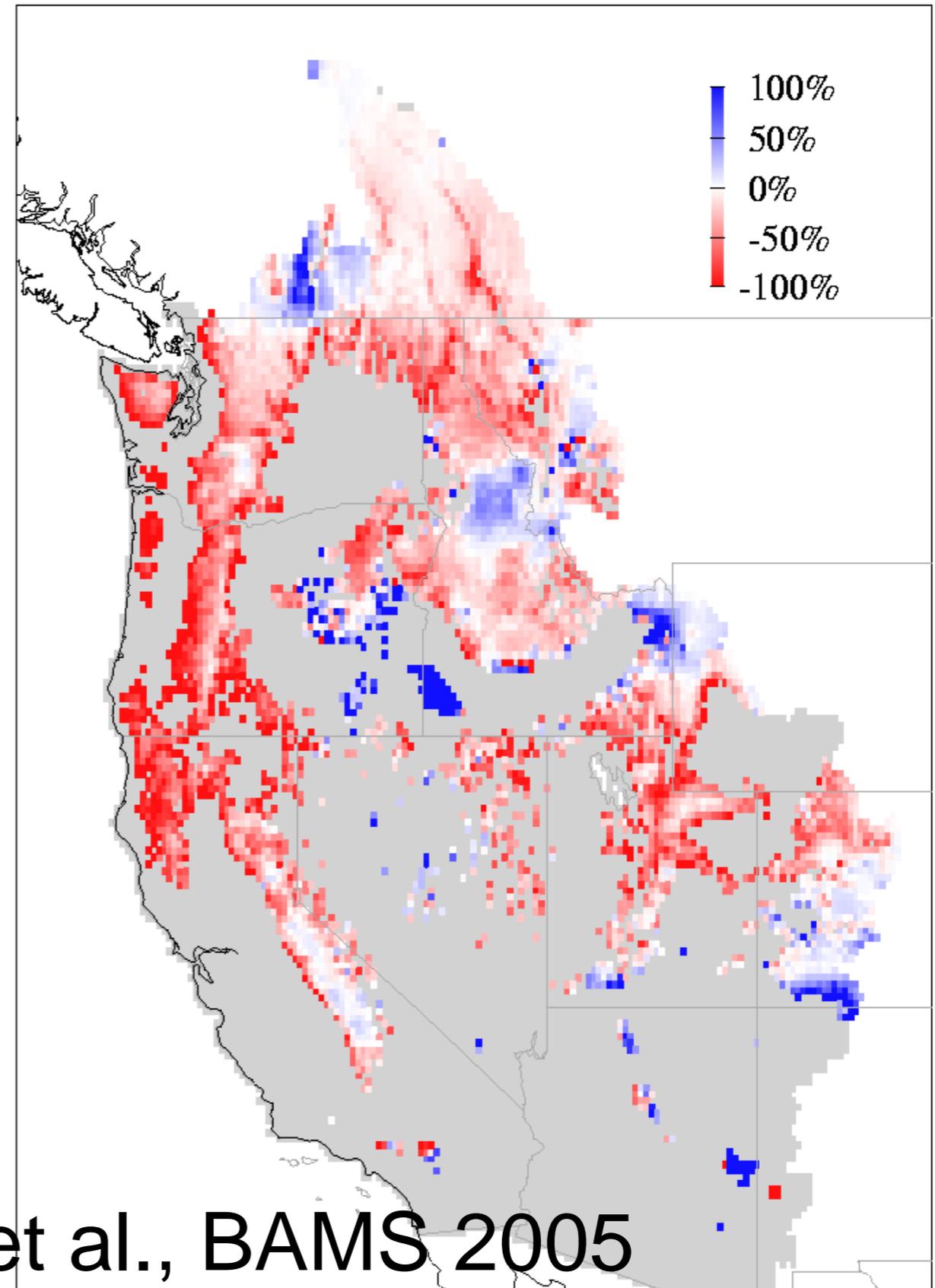


Declining April 1 snowpack, 1950-1997

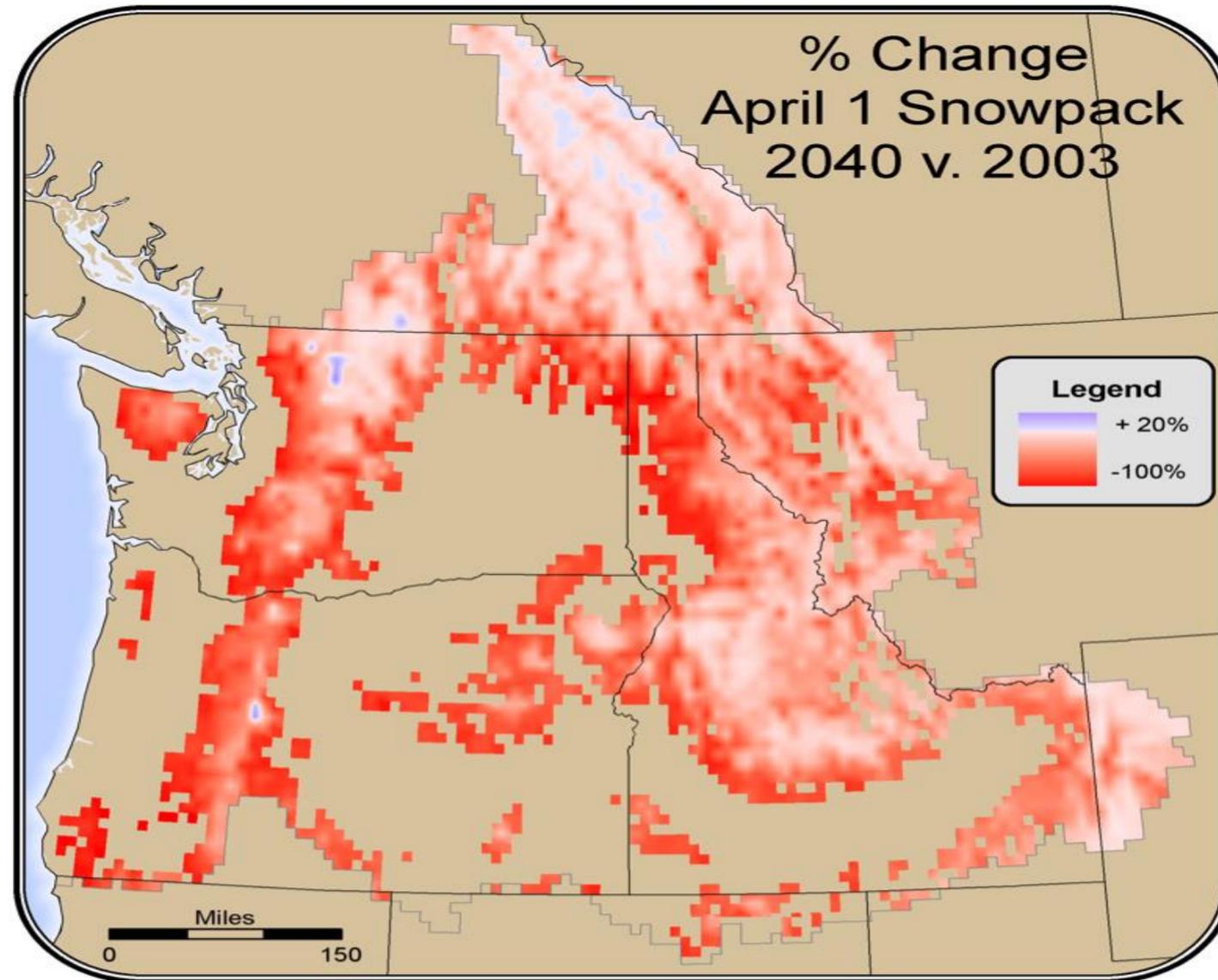
a. Observations



b. VIC

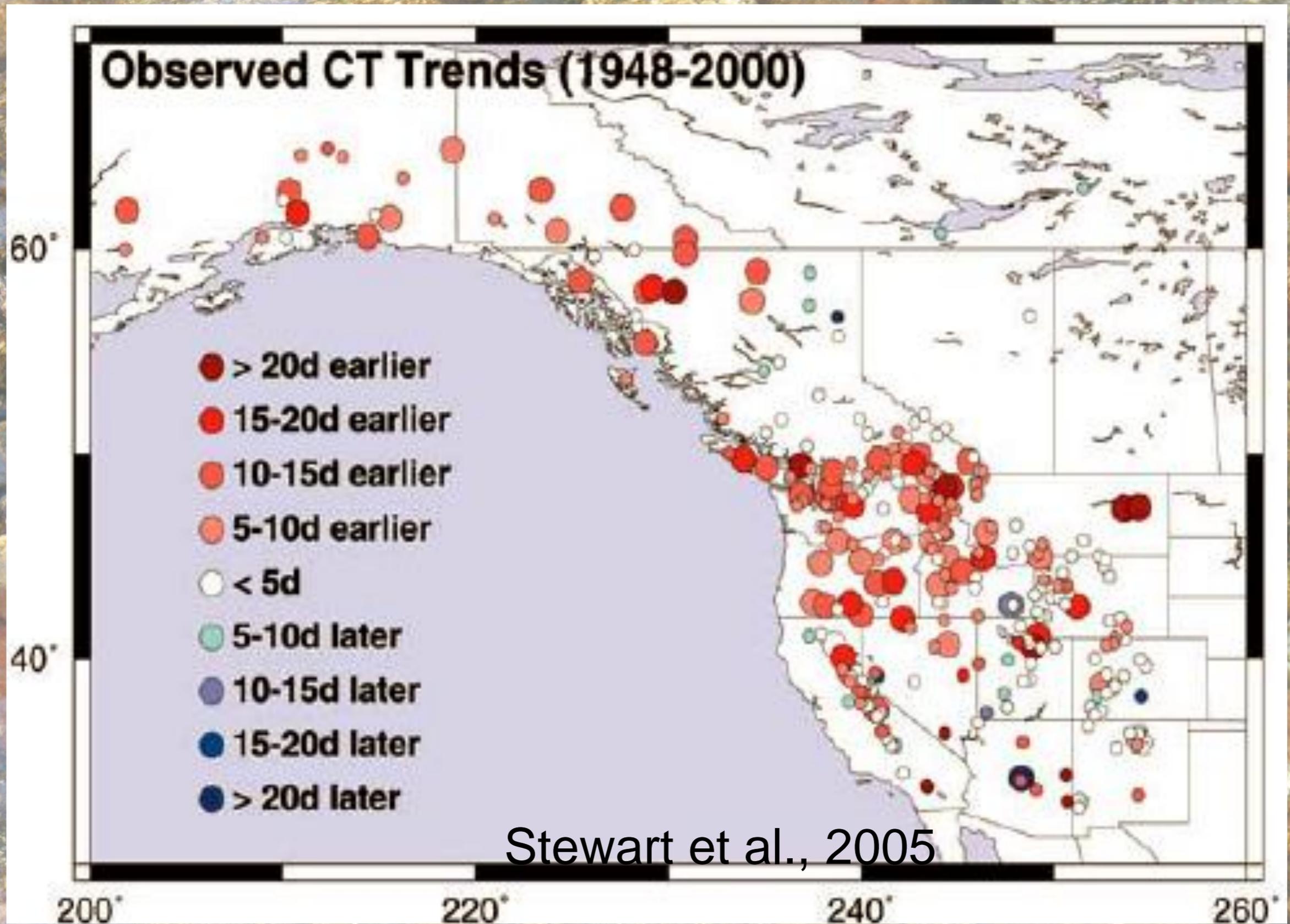


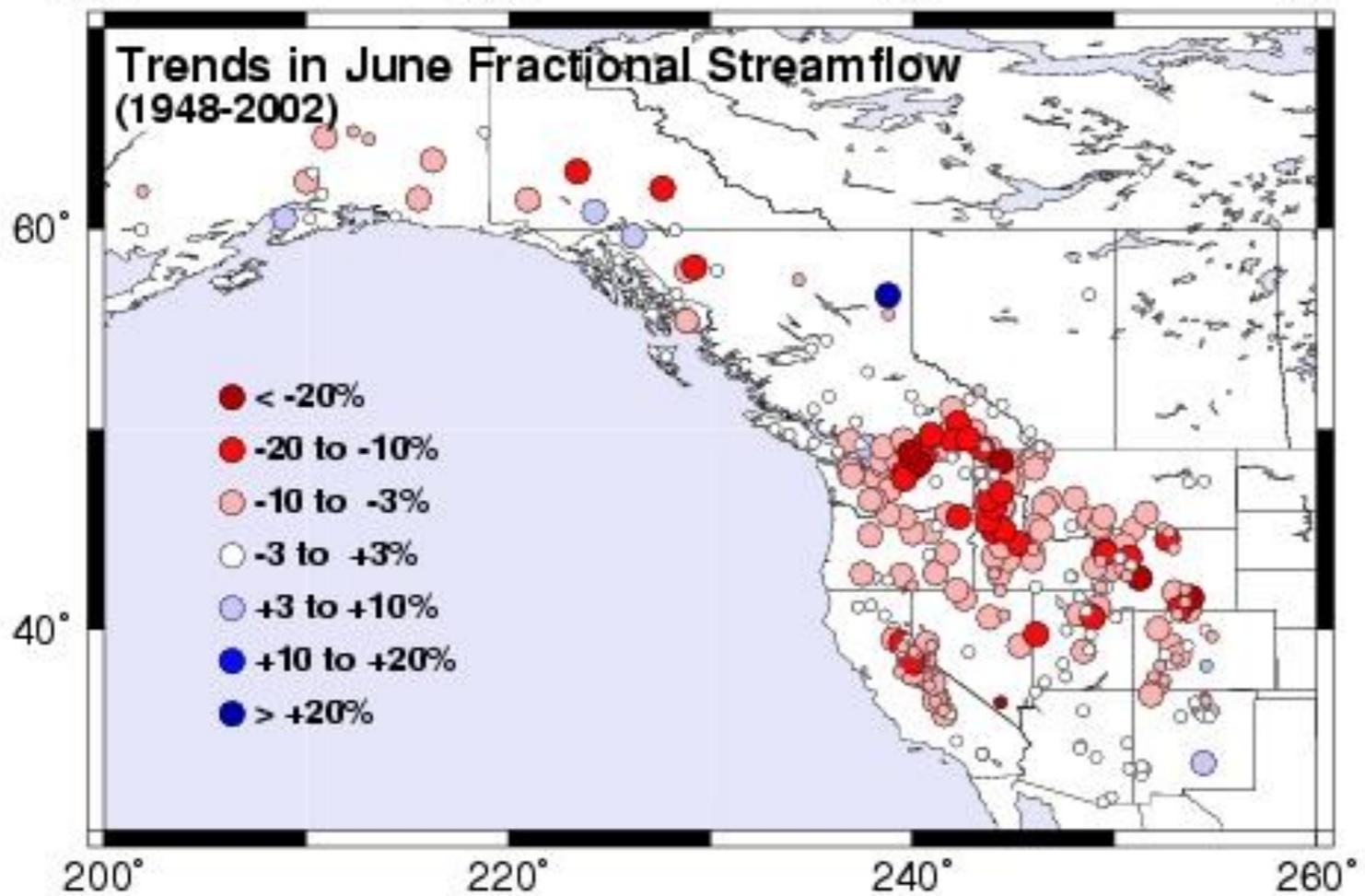
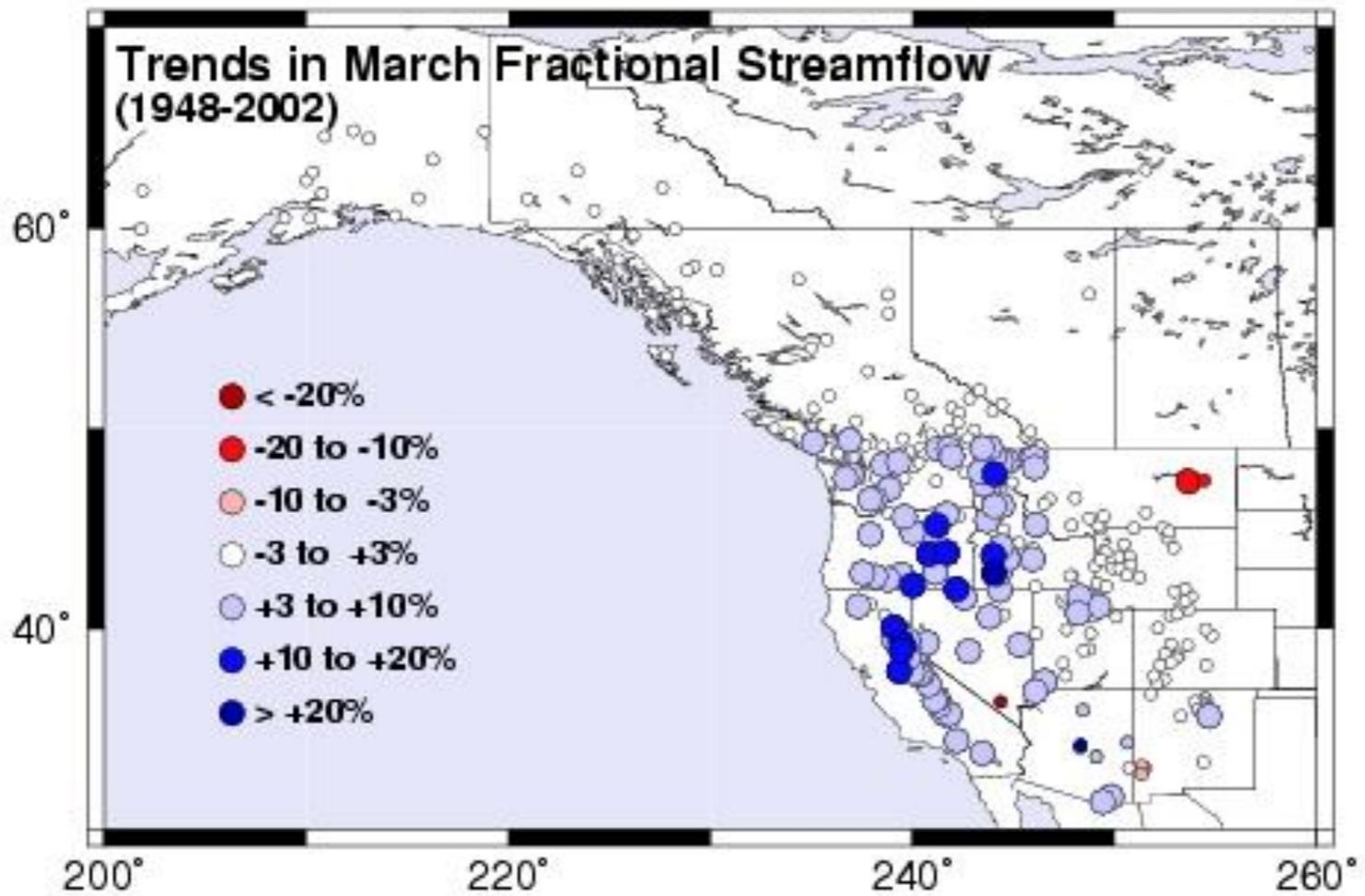
Mote et al., BAMS 2005



UW
Climate Impacts
Group

Streamflow Timing

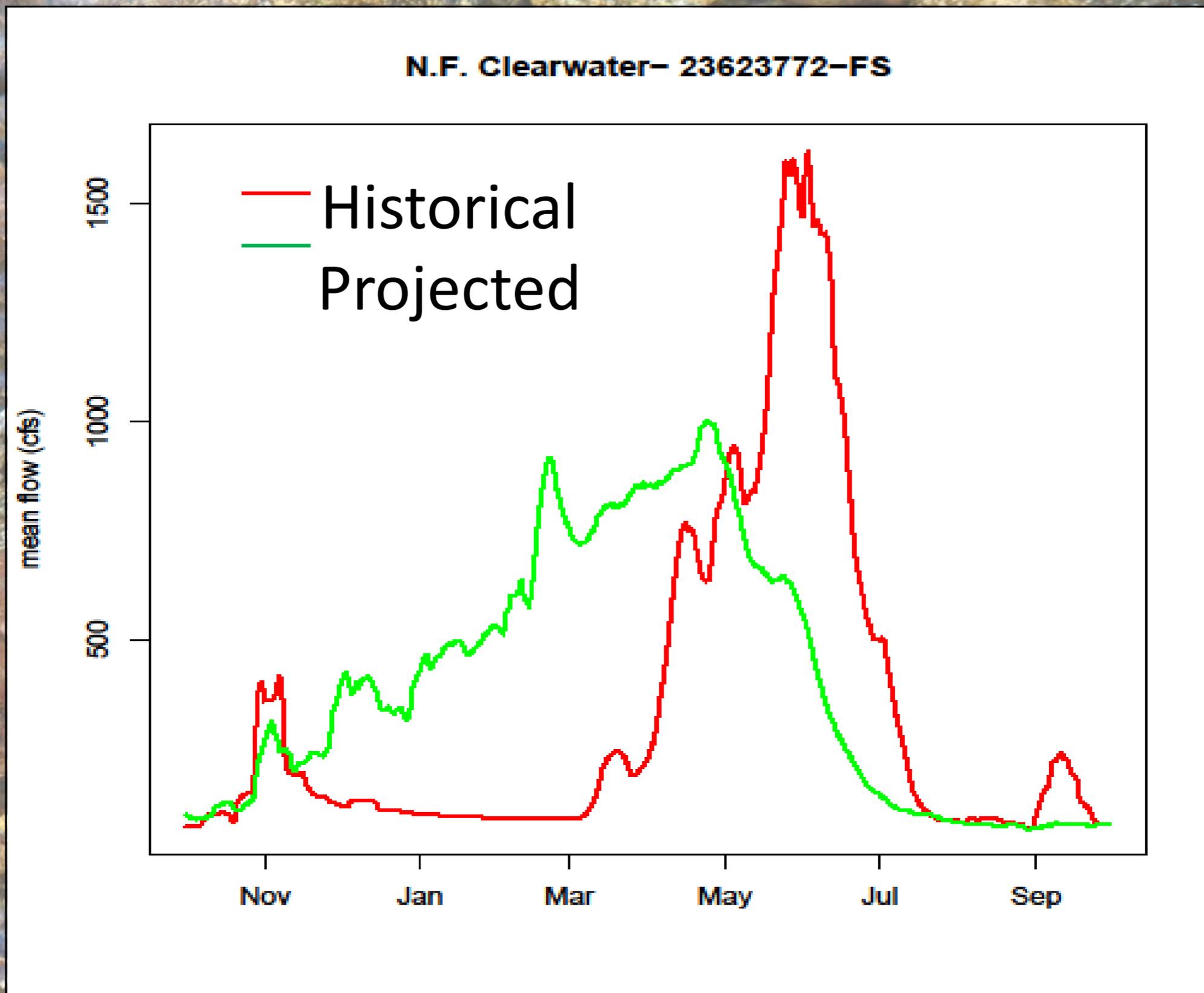




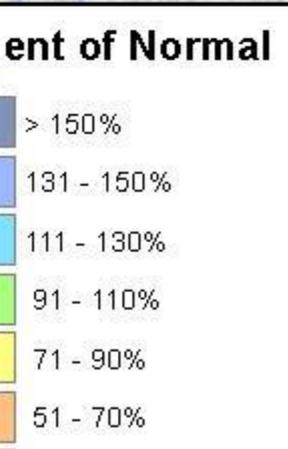
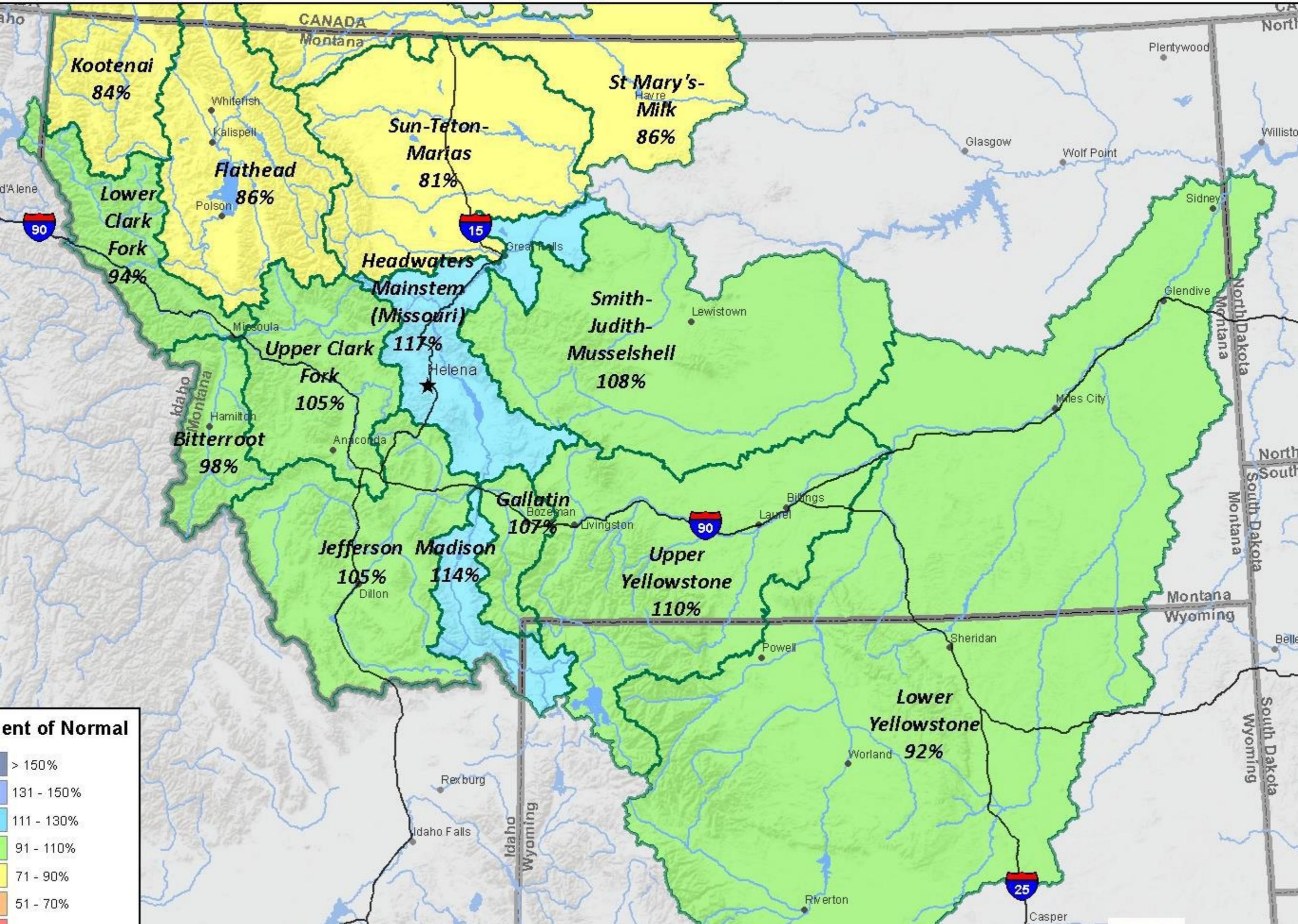
As the West warms, winter flows rise and summer flows drop

Stewart et al. J Climate 2005

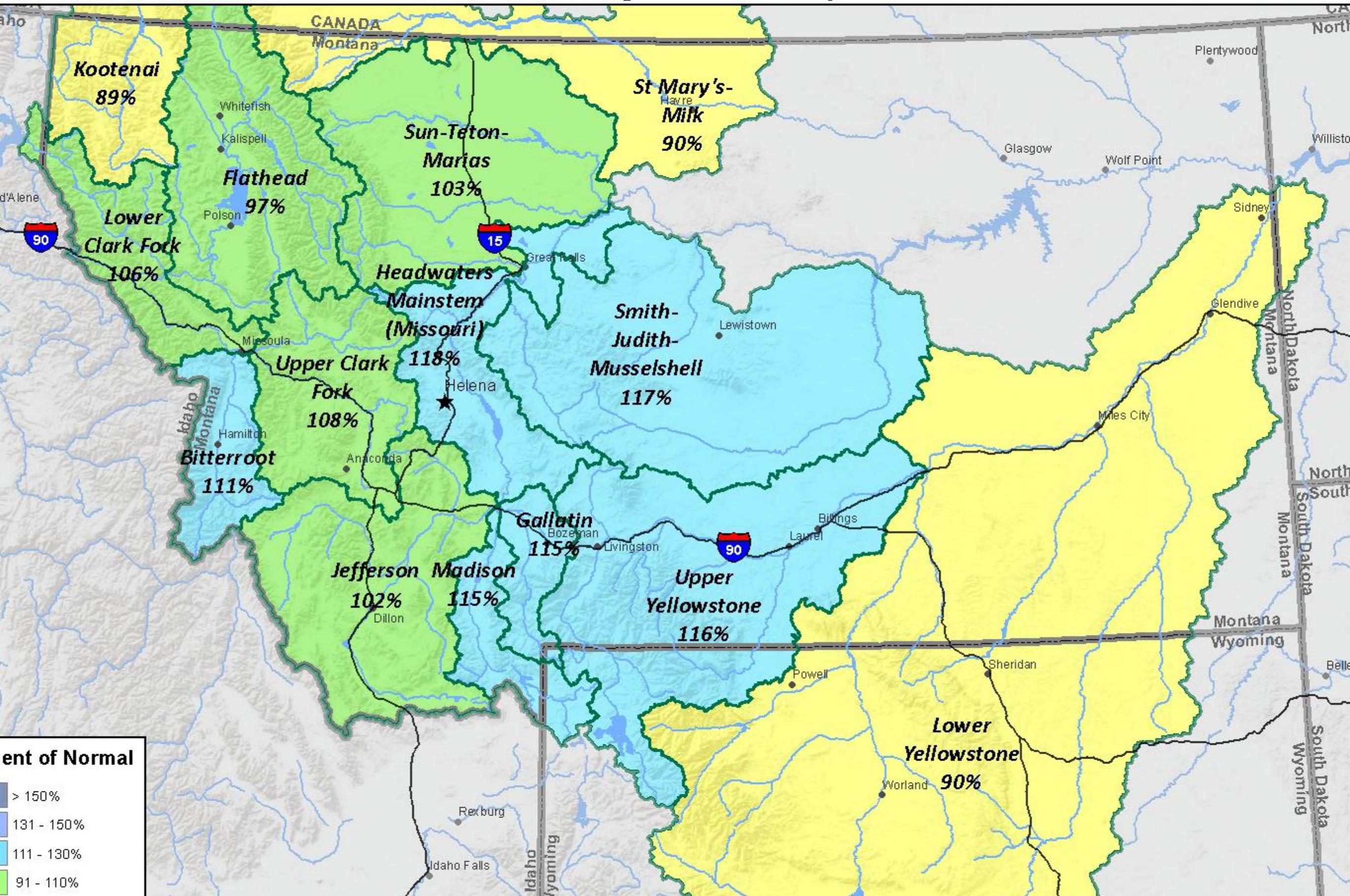
Past and 'Future' Hydrographs



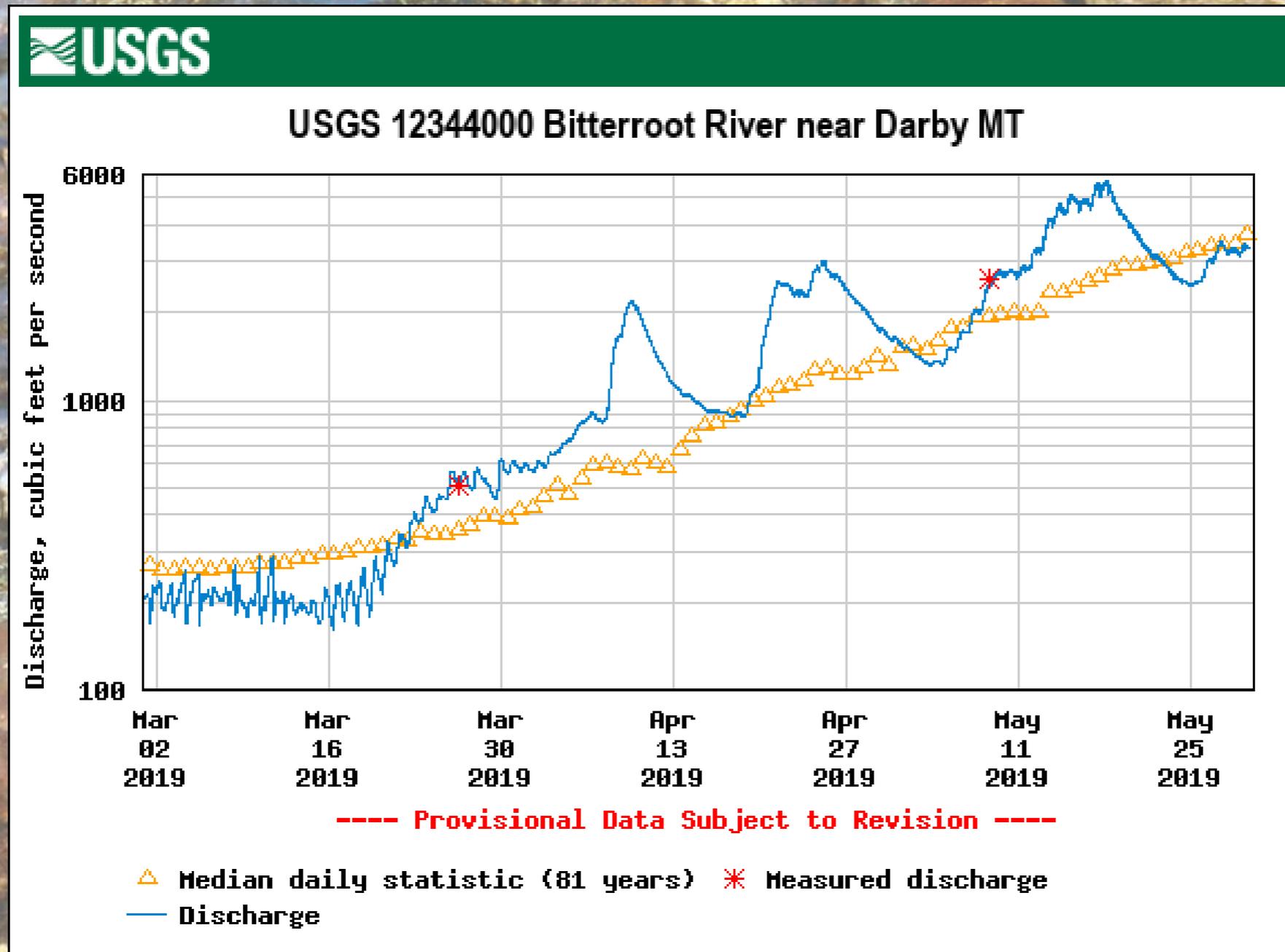
Current Snow Water Equivalent Basin Percentage of Normal - April 1, 2019



Montana Data Collection Office
 Current Snow Water Equivalent
 Basin Percentage of Normal - May 1, 2019

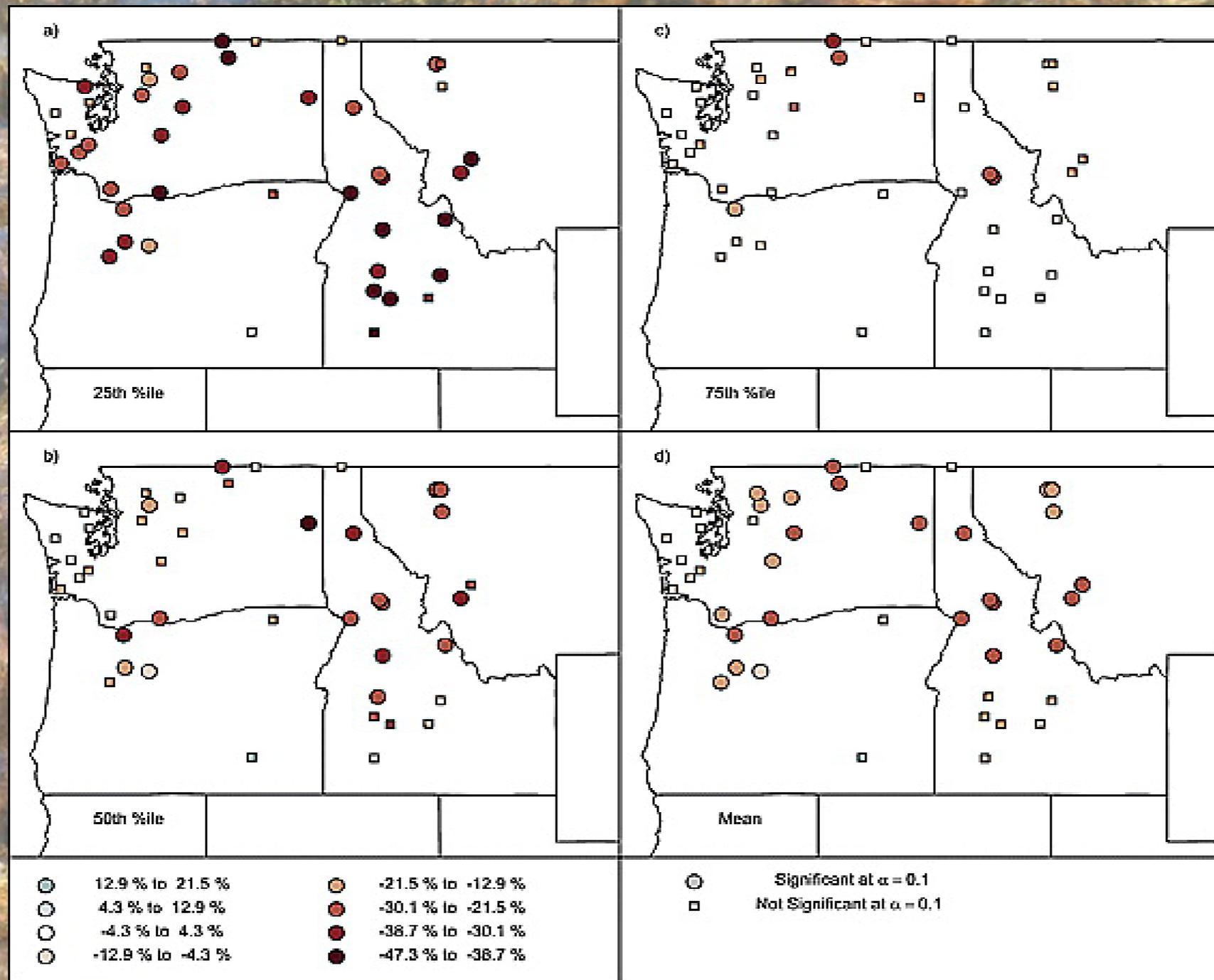


This spring's flows at Hwy 93 Bridge S. of Darby



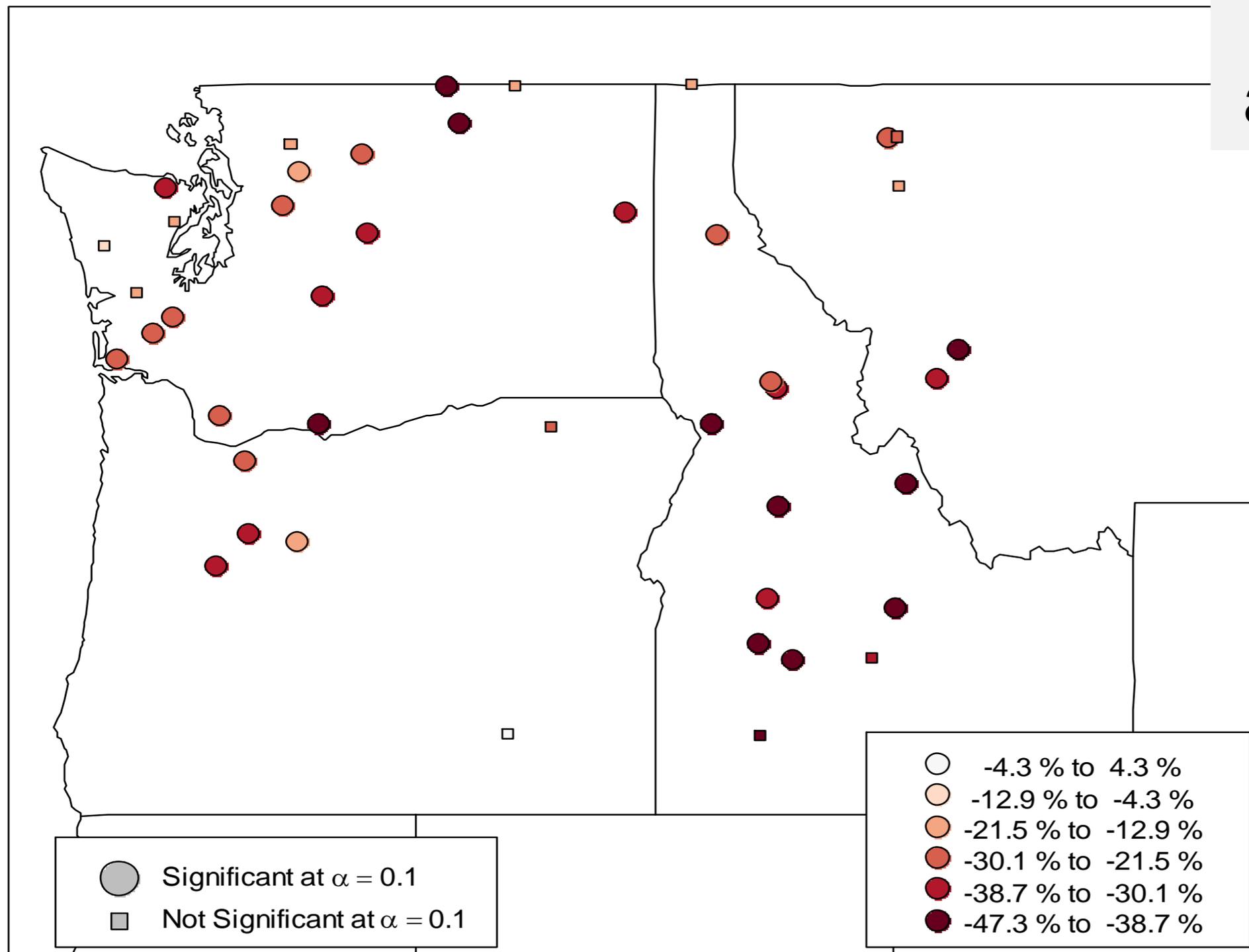
Declining annual streamflow distributions in the Pacific Northwest United States, 1948–2006

Luce and Holden 2009



Which flows most important?

Change in
25th %ile
annual flow



Low Flow Hydrologic Trends

Recent Research

- Hydrologic drought is more sensitive to precipitation amount than air temperature in the Pacific Northwest
- Hydrologic drought has generally intensified from 1948 to 2013 in the Pacific Northwest
- Mean annual streamflow has declined and the streamflow center of timing has occurred earlier
- “Warm” sites more sensitive to temperature changes than “cold”, high elevation sites.
- “Dry years getting drier” – Low flows more intense.