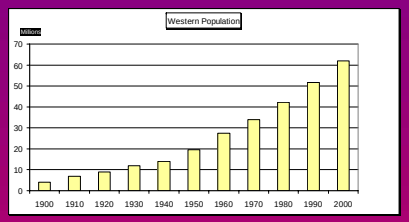
Recent Effects of Climate Variability on Western Water Supplies

Natural Resources Conservation Service – National Water and Climate Center

Portland, Oregon

Western Water: A Critical Juncture

- **Recent Observations and Trends**
  - Increased climate variability
    - More extremes, more often
  - Population growth continues
    - Most growth in the driest states
  - Reservoir infrastructure is 50 – 100 yrs old
  - Municipal water supply impacted by climate extremes
    - Medium and long-term planning impacts
  - Energy demands increasing
  - Endangered species legislation
    - Klamath Basin, Rio Grande, others soon…
    - Proposed Snake River dam removal



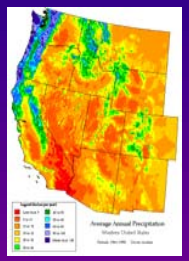
Western Water History

- Settlement began about 150 years ago
- Drought genesis of the largest westward migration – 1930s
- Reservoir construction, 1930 – 1970
- No significant reservoirs built in the last 25 years, actual removal discussed
- Irrigated agriculture 25.5m acres, $51.1b in market value (Source: Ag. Census, 2002)

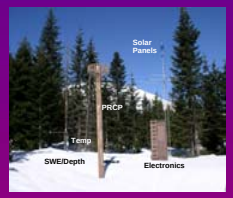
Center Pivot Irrigation System, Northern California, Mount Shasta in the background. (NASA Photo)

Tracking Western Climate

Western climate is three-dimensional. The mountains trap up to 80% of the winter snowpacks that melt into spring and summer streamflow critical to agriculture, power generation, municipal water supplies and species management. Annual precipitation ranges from less than 4 inches in the Nevada desert, to over 180 inches in the Washington Olympics.



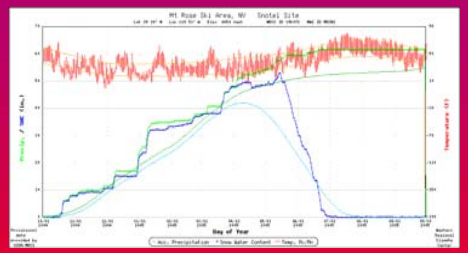
SNOTEL Communications Schematic



Typical SNOTEL Remote Station

SNOTEL uses meteor-burst communications technology to collect and communicate data in near real-time. VHF radio signals are reflected at a steep angle off the ever present band of ionized meteorites existing from about 50 to 75 miles above the earth. Satellites are not involved. The NRCS operates and controls the entire system.

The 704 station SNOTEL (SNOw TELemetry) network provides snow water equivalent, snow depth, precipitation and temperature data required for snowpack and climate assessments necessary to produce Snow Survey, Water Supply Forecasting and drought products year-round.



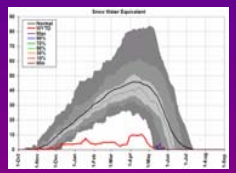
SNOTEL data plot showing a full season of climate information; snow water equivalent, accumulated precipitation and maximum/minimum temperatures for Mt. Rose Ski Area, Nevada. (Courtesy Western Regional Climate Center)

Phil Pasteris and Dr. Tom Pagano
USDA – Natural Resources Conservation Service
National Water and Climate Center
Portland, Oregon
phil.pasteris@por.usda.gov; tom.pagano@por.usda.gov
www.wcc.nrcs.usda.gov

Recent Snowpack Extremes

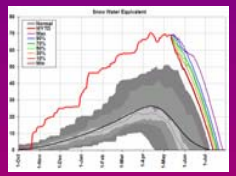
The PNW has experienced two extremely low snowpacks in the past 5 years (2001, 2005). The Southwest experienced a 6-year drought, then record snowpacks in spring of 2005.

Mt. Rainier, WA, 9/8/2005

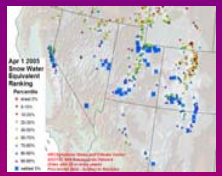


Stampede Pass, WA SNOTEL

Record Low PNW Snowpacks

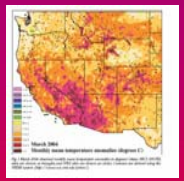


Midway Valley, UT SNOTEL



Record High SW Snowpacks

Rapid Snowpack Changes



Rapid snowpack reduction. Record warmth and dryness combine in March 2004. (Pagano, Pasteris, EOS)

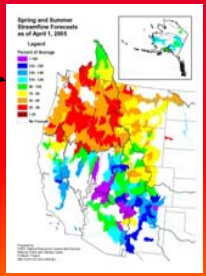
Impacts on Water Supply Forecasts

Before 1965 this map had 3 categories

1965-2001
had 5 categories
(<70% to >130%)

2002-2004
had 7 categories
(<50% to >150%)

2005
Now has 9 categories
(<25% to >180%)



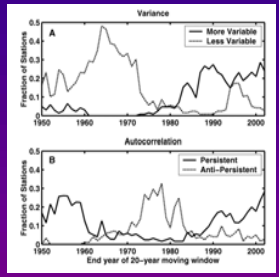
Recent Streamflow Variability and Persistence

1930s-1950s: Low variability, high persistence.

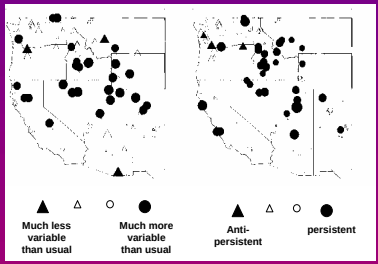
1950s-1970s: low variability, anti-persistence.

1980s-present: High variability and high persistence>

(Pagano, Garen, 2005, Journal of Hydrometeorology)

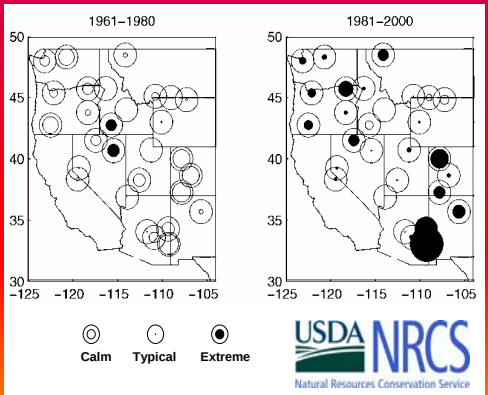


Variance '83-02 **Persistence '83-02**



Potential Impacts on Western Water Management

- Not varying on the same time scales or coincidentally
- Increases in variability have preceded increases in autocorrelation by approximately 5-10 years
- Increased autocorrelation preceded increases in skewness by another 5 years
- Triple alignment is greatest threat to water mgmt.
- Consecutive wet years inflate expectations
- Extended dry stretch exhausts reservoirs
- Most impact on smaller reservoirs, no annual carryover

Where is spring precipitation more irregular?

Now, especially in PNW and Southwest, whereas before it was very calm