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Does Water Flow Downhill or Towards Money? Lessons from the Western Water Assessment

CIRES Center for Science Technology Policy Research
Science, Technology and Decision Making Symposium
February 25, 2005

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Center for Science and Technology Policy Research

Cooperative Institute for Research in Environmental Sciences
CIRES

NOAA-CIRES Climate Diagnostics Center

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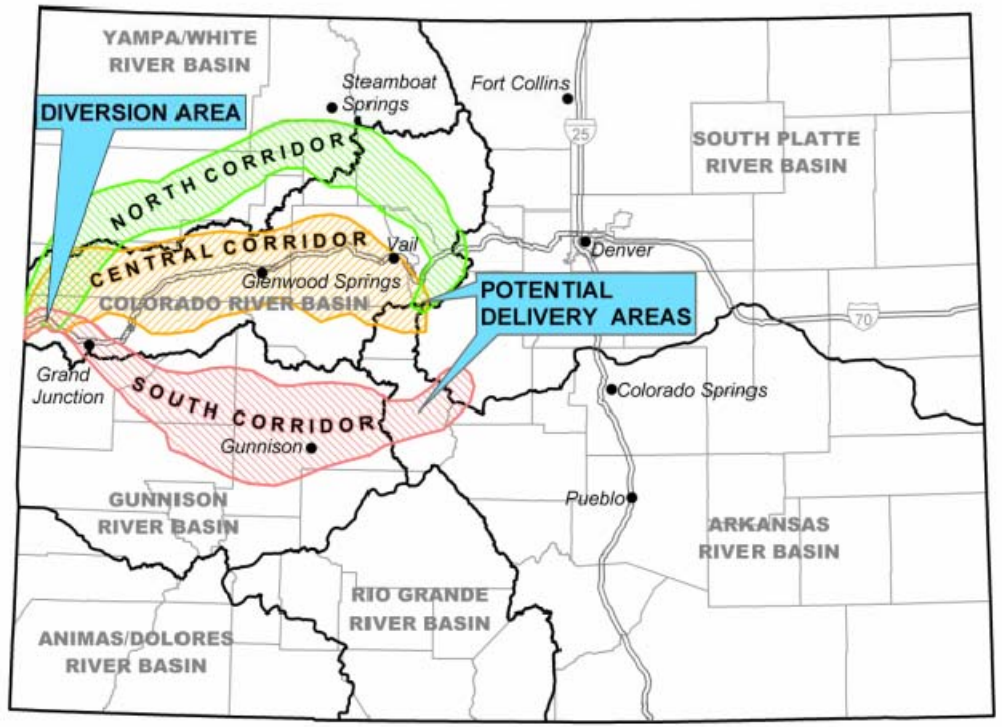
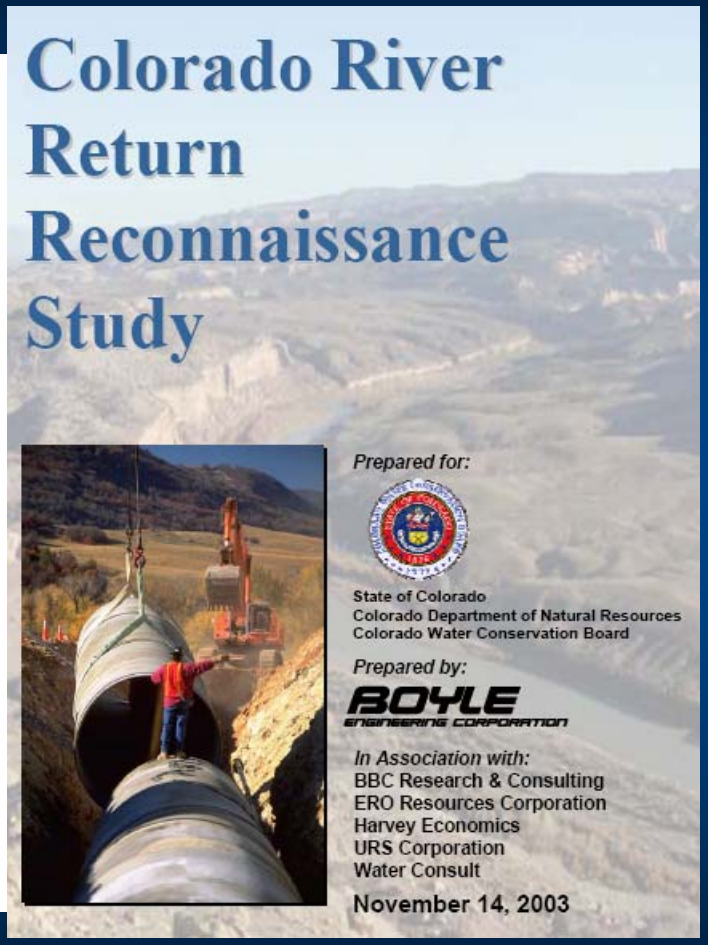
http://sciencepolicy.colorado/wwa

Downhill or Towards Money?





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Overview of Talk

Stresses on Colorado Water Supply

Basic Colorado Water Facts and a New Water Supply Era

The NOAA RISA Program

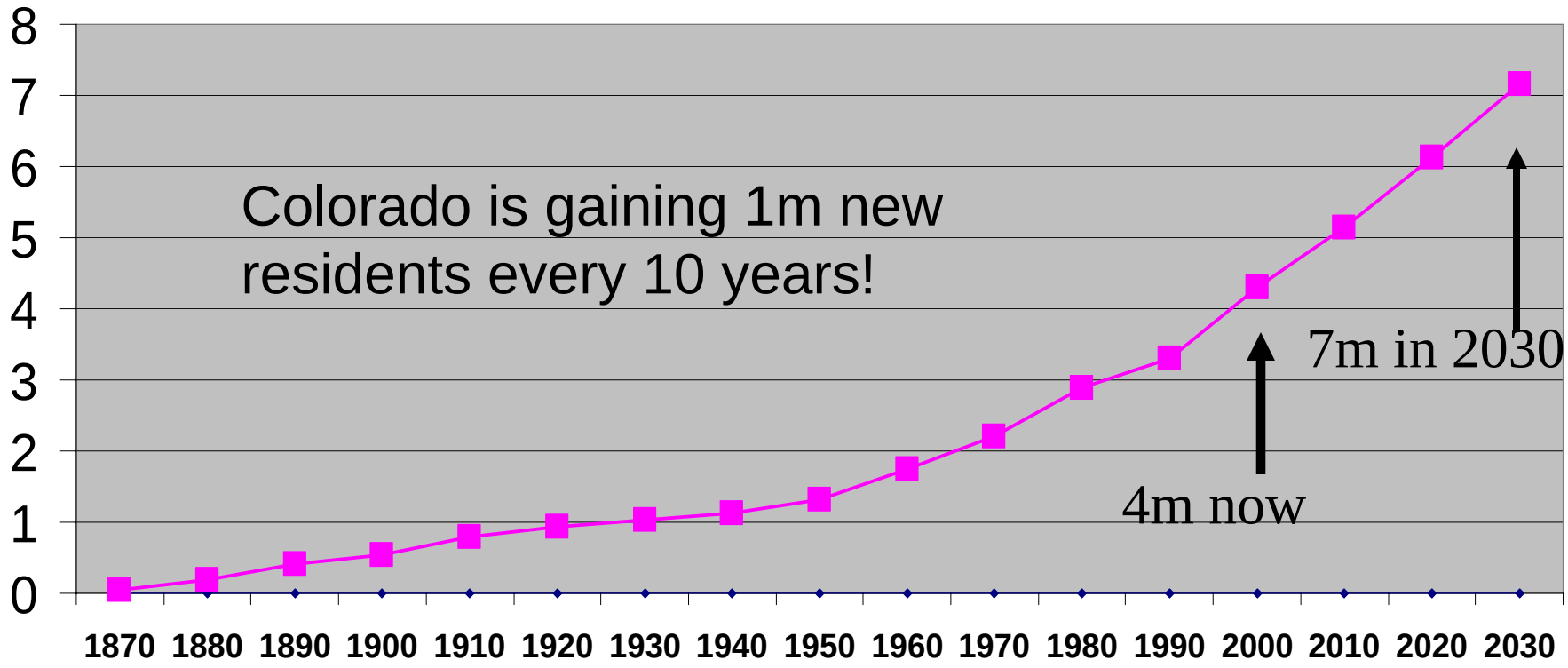
WWA in General and in Specifics

- Experimental Forecasts
- Streamflow Reconstructions

Future Work Foci

Stress: Population Growth

Colorado Population in Millions



Source: Colorado State Demographer

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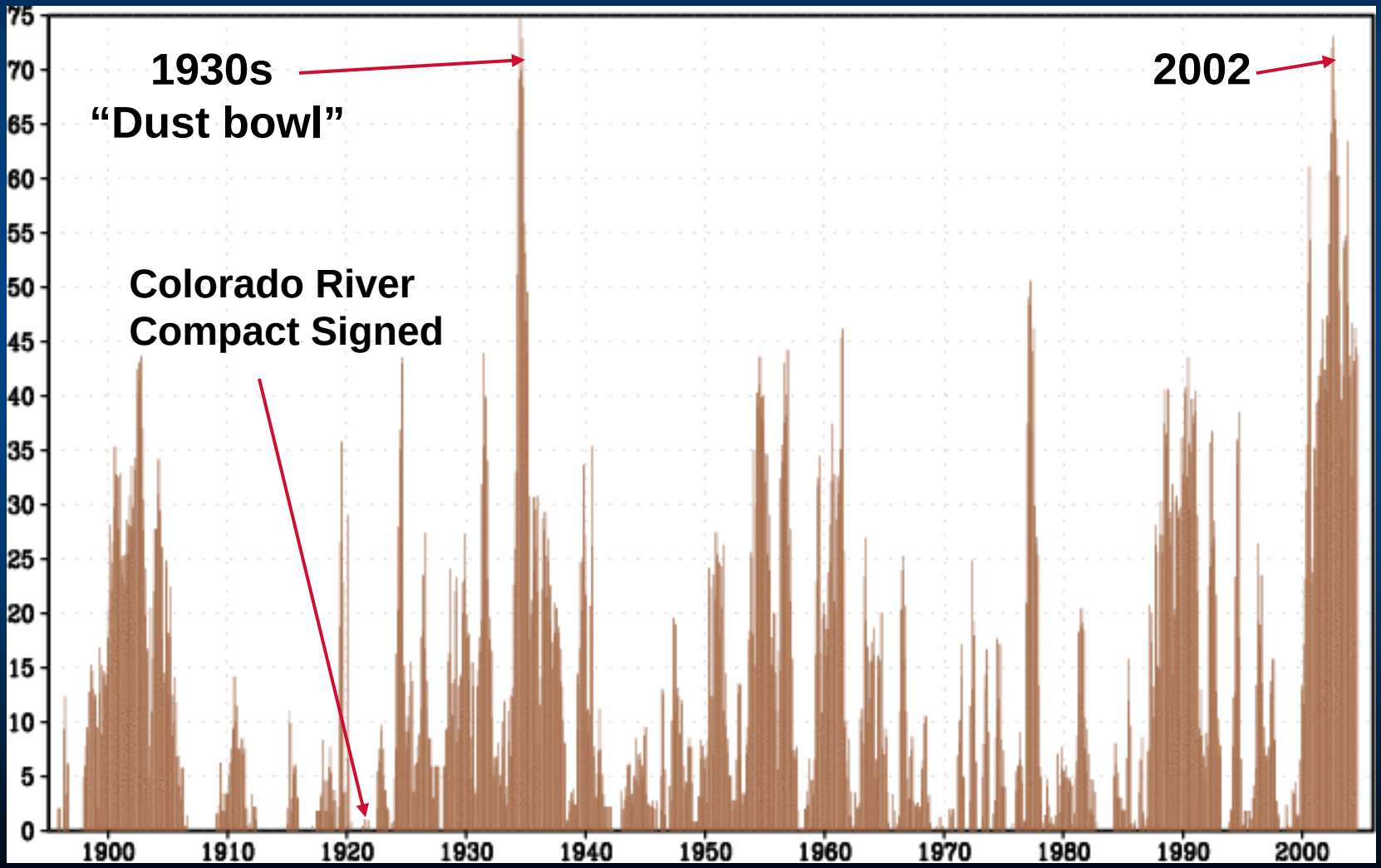
Stress: Palmer Drought Index- % of area in severe drought

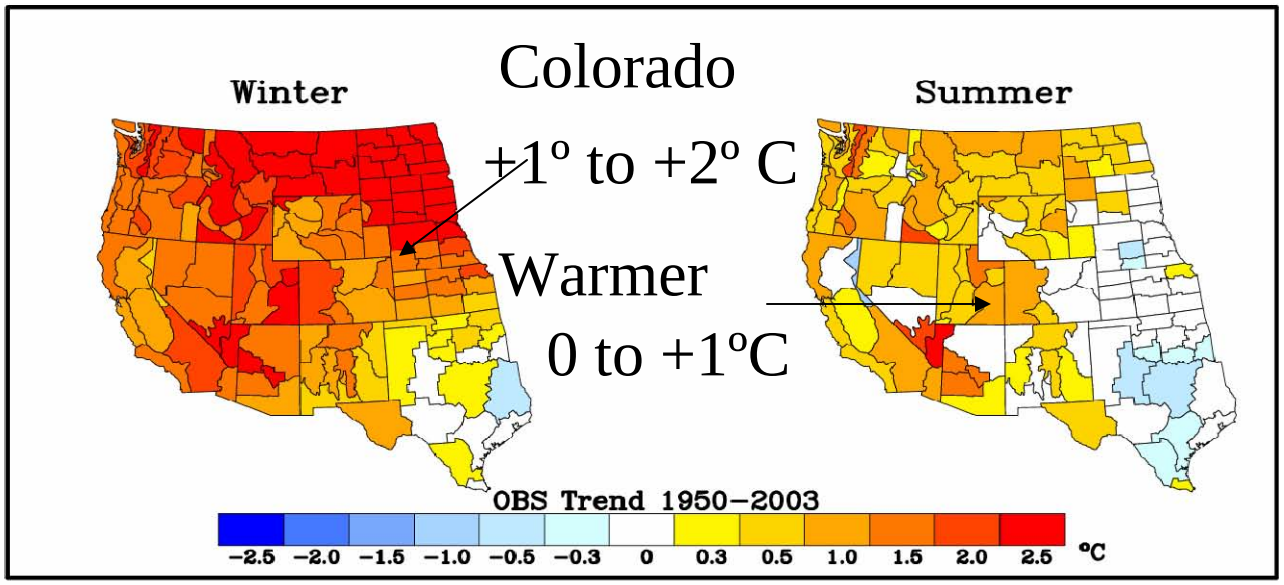


Stress: 50-Year Climate Trends

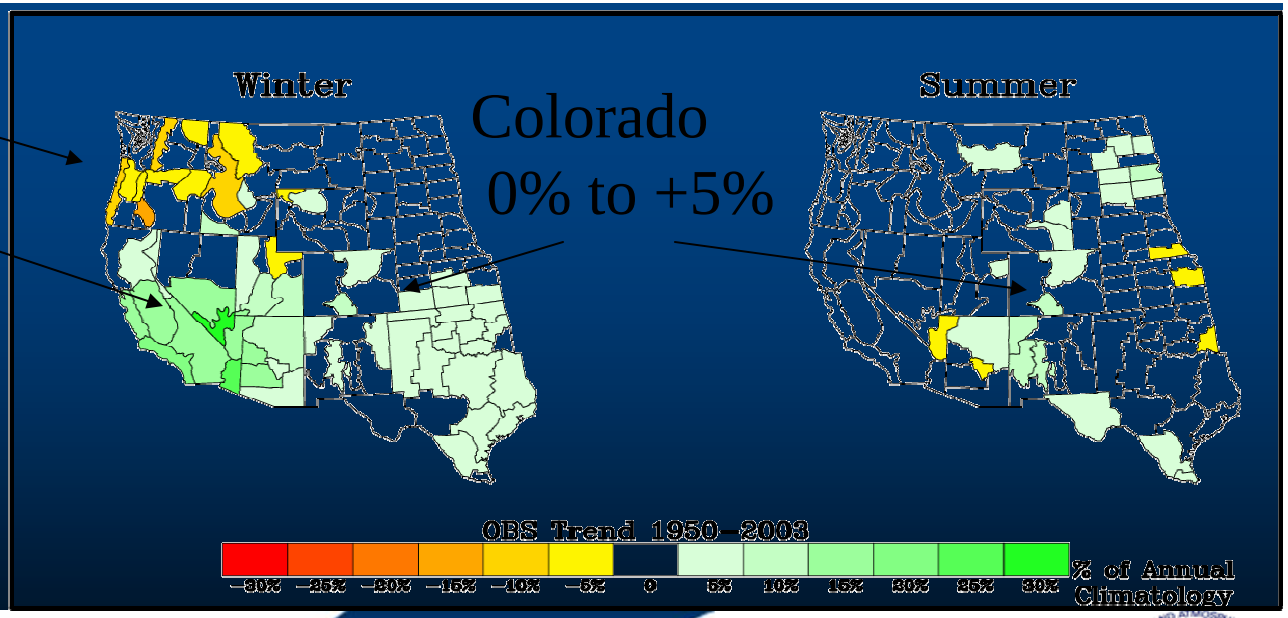
Slight Wet Trend Matches El Nino Cycle

Western U.S. Mostly Warmer and Wetter Since 1950

Temperature



Precipitation



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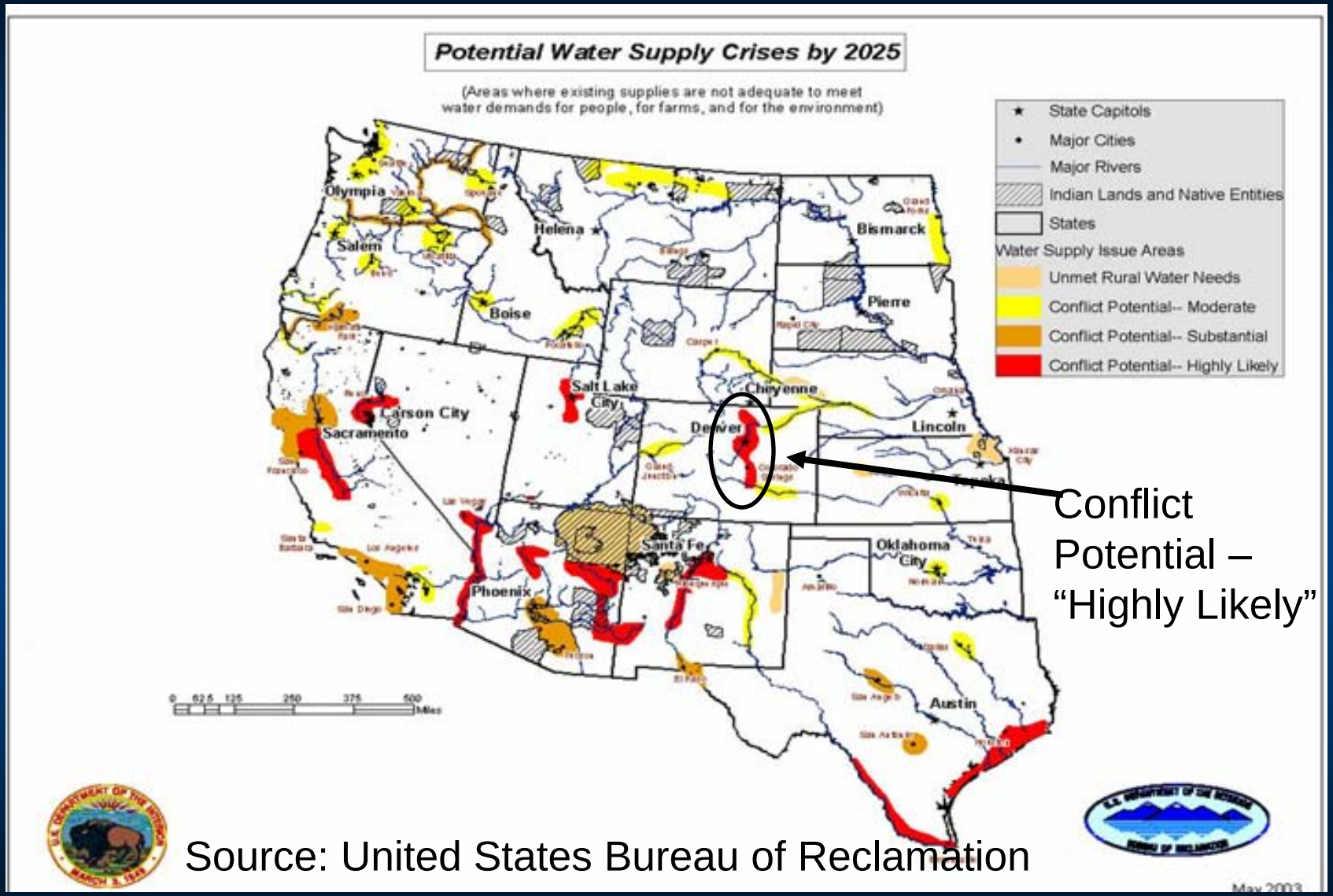
“Water 2025” - Future Supply Crises



Note: There is an underlying assumption of a statistically stationary climate.

Basic Facts: Municipal vs. Agricultural Water Use in Colorado

Table ES-1 Municipal & Industrial Gross Water Demand in 2000 and 2030

Basin	Estimated Water Demand in 2000 (AF)	Projected Water Demand with Level 1 Conservation in 2030 (AF)	Increase in Water Demand (AF)	Increase in Water Demand (%)
Arkansas	256,900	354,900	98,000	38%
Colorado	74,100	136,000	61,900	84%
Dolores/ San Juan/ San Miguel	23,600	42,400	18,800	80%
Gunnison	20,600	35,500	14,900	72%
North Platte	500	600	100	20%
Rio Grande	17,400	21,700	4,300	25%
South Platte	772,400	1,182,100	409,700	53%
Yampa/White/ Green	29,400	51,700	22,300	76%
TOTAL	**1,194,900**	**1,824,900**	**630,000**	**53%**

M&I = 1.2 maf/year 2000, 1.8 maf/year 2030

Table ES-2 Irrigated Acres by Basin

Basin	Estimated Irrigated Acres	Average Total Diversions (AF)
Arkansas	538,100	1,769,900
Colorado	237,700	1,986,900
Dolores/San Juan	255,000	902,200
Gunnison	263,500	1,736,100
North Platte	115,700	396,900
Rio Grande	632,700	1,619,000
South Platte	1,003,500	2,545,500
Yampa/White/Green	118,400	652,000
TOTAL	**3,164,600**	**11,605,000**

Ag = 11.6 maf/year 2000

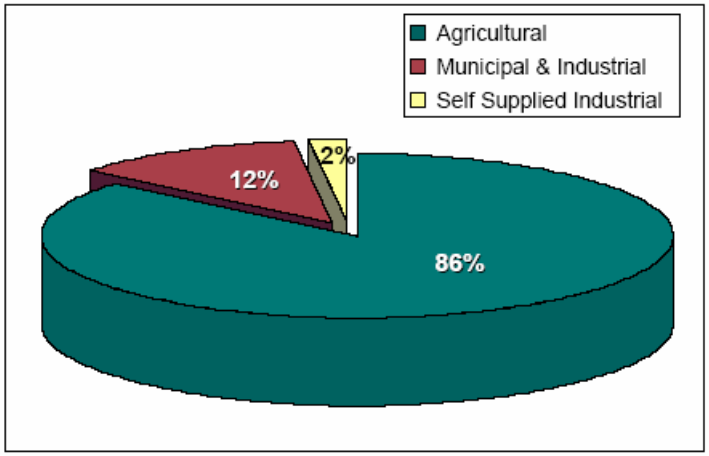


Figure ES-6
Relative Proportions of Agricultural, M&I, and SSI Gross Water Use in 2030

Source: State Water Supply Initiative

A Changing Water Supply Paradigm

- Fewer Supply-side options – 6 maf in Storage Sites Already
- Compacts, Decrees, ESA (Platte, Rio Grande, Colorado) Limit Water Availability
- Conservation reduces buffers – 'demand hardening'
- Water Law Constraints
- Water Quality an Increasing Concern
- Very Different Operational Needs – Ag vs. municipal
- Water is not a commodity, aspects of public good, externalities
- Environment and Recreational Water Needs – 'beneficial use' is changing
- Climate may not be "Stationary"
- Local Planning May no longer be enough
- New Demand-side and Supply-side Techniques…
  - Land Fallowing, Water Banks, Reverse Auctions, Reuse, Interruptible Supply Contracts, Conservation, Water Rates
- Focal Point on Colorado River Basin – from 0 to 1 maf left to develop

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What is the Western Water Assessment?

Public Mission:

The mission of the Western Water Assessment is to identify and characterize regional vulnerabilities to climate variability and change, ...and,

to develop information, products and processes to assist water-resource decision-makers throughout the Intermountain West.

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Why Western Water Assessment?

Private Mission:

Help NOAA Consider and Implement Future "Climate Services", an analog to the National Weather Service but Different…

Existing NOAA Climate-centered Activities…

River Forecast Centers – Volumetric Streamflow Forecasts
Climate Prediction Center – Long-lead T&P Forecasts
Climate Focal Points – NWS Regional Personnel
Climate Services Division

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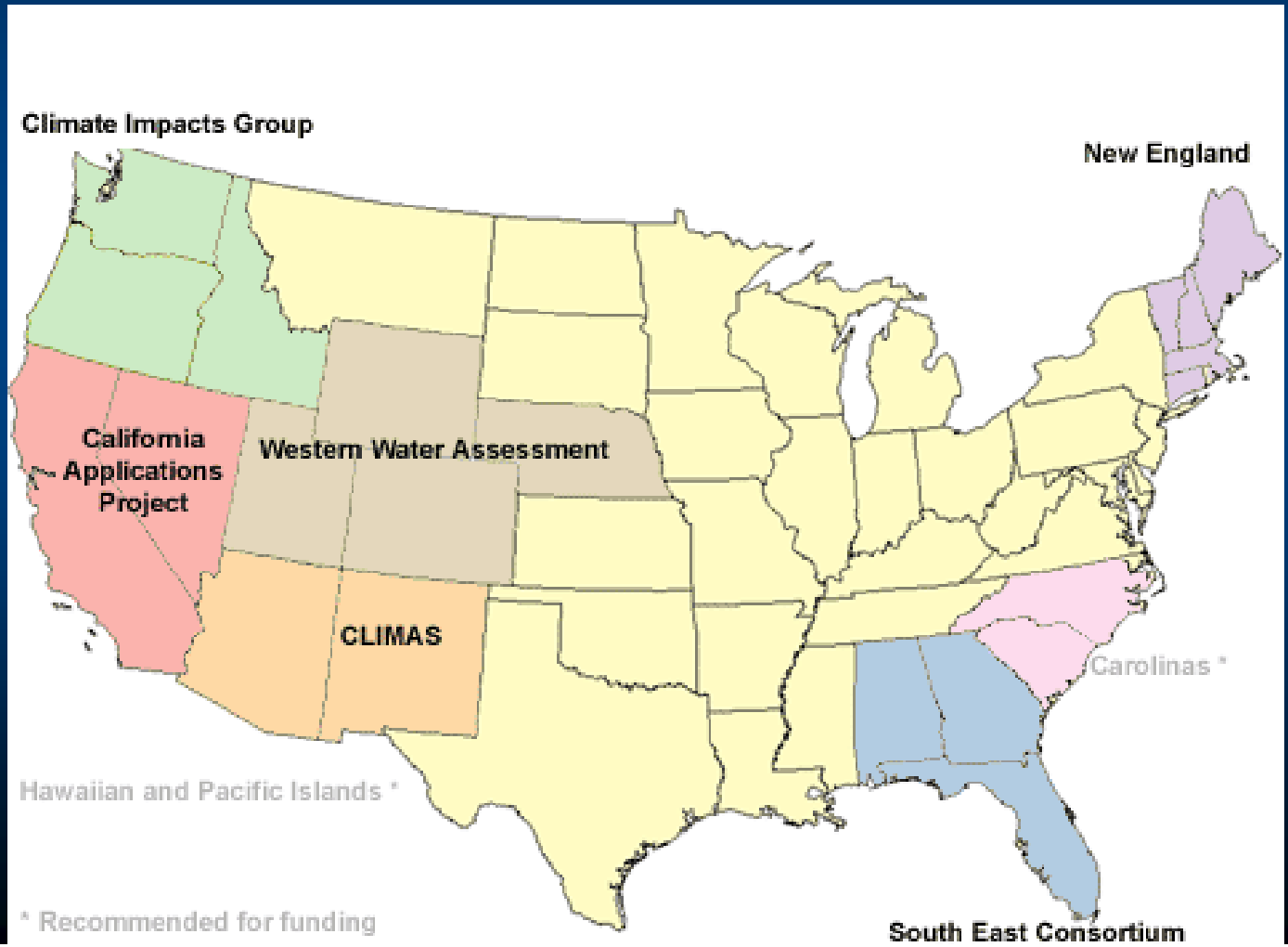
Western Water Assessment one of 8 Similar Regional Integrated Sciences and Assessments ("RISA") Programs.



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Regional Integrated Sciences and Assessments ("RISA") History, Goals and Objectives

- Arose from NOAA Office of Global Programs discussions ca. 1995

- Characterize the state of knowledge of climate variations and changes, and their social, economic, and ecological interactions, impacts, and projections at appropriate scales of interest within a region

- Assess regional and local resources, capacity, and decision-support dialogs needed in responding to environmental variability and change

- Identify knowledge gaps in selected critical climate-environment-society problems in a region and develop experimental decision support products and services to bridge these gaps as needed

- Carry out research focused on realizing the benefits of integrated knowledge and forecasts in different contexts and provide an informed basis for place-based decision support and services.

Source: Pulwarty, NOAA OGP

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Who is WWA ?

(A Cast of Thousands…)

Principal Investigators: Susan Avery, Randy Dole

University of Colorado Scientists

Legal and Policy – Doug Kenney, Bobbie Klein, Roger Pielke, Jr.

Snow and Hydrology – Martyn Clark, Balaji Rajagopalan

Water Quality – Jim Saunders

Economics – Chuck Howe, Chris Goemans

NOAA-CIRES Climate Diagnostics Center Scientists

Policy – Andrea Ray, Roger Pulwarty, Jessica Lowrey

Climatologists – Klaus Wolter

Snow Scientists – Shaleen Jain, Jessica Lundquist

Paleoclimatologists – Connie Woodhouse, Robin Webb, Jeff Lukas

Colorado State University Scientists

John MacKenzie, Reagan Waskom, Dan Smith, John Wilkin-Wells

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WWA Activity Matrix…

Evaluation Matrix 1 for WWA Activities		RISA Means, Current					
		Links to Decision Makers	Links to NOAA Operations	Integrated Research	Synthesis Research	Self Evaluation	Training New Leaders
RISA Ends	Assessments						
	Information, Products & Processes						

Evaluation Matrix 2 for WWA Activities		Temporal Scale			
		Paleo	Seasonal to Interannual	Decadal	Global Change
RISA Ends	Assessments				
	Information, Products & Processes				

Stakeholder Research Partners

- Municipal
  - Denver Water Department – M&I
- Combined Ag and M&I
  - Northern Colorado Water Conservancy District – Ag, M&I
- Federal
  - United States Bureau of Reclamation – Ag, M&I
- Non-governmental
  - Ditch and Reservoir Company Alliance – Ag
- State Chartered Planning Entities
  - Colorado River Water Conservation District
  - Colorado Water Conservation Board

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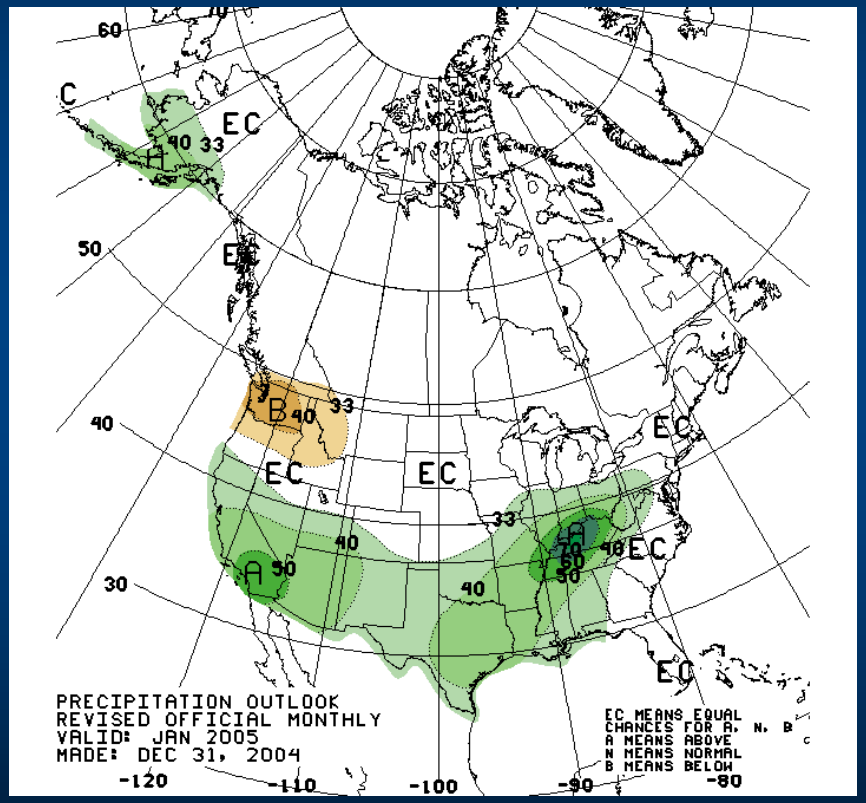
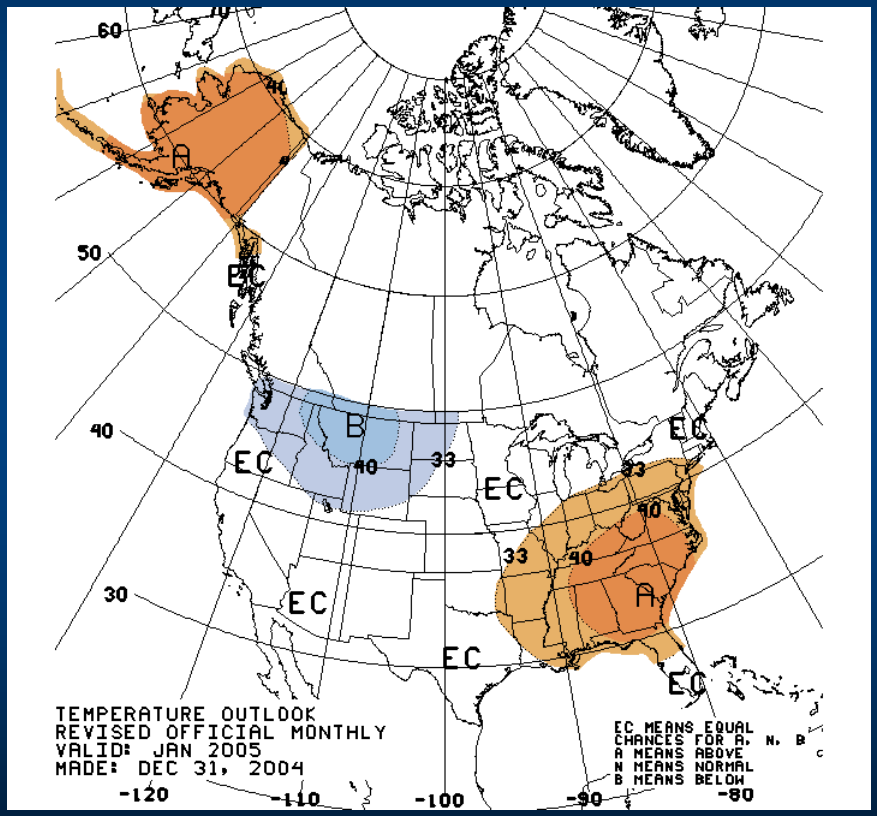
Some Current Projects…

1. South Platte Regional Assessment Tool
2. Streamflow Reconstructions using Tree-Rings**
3. Climate Services Clearinghouse
4. Improved “Week 2” Streamflow Forecasts
5. Seasonal Forecasts for Drought Task Force**
6. DARCA Use of Climate Forecasts
7. Intermountain West Climate Outlook

Hot off the Press: June 8-10, 2005 Conference: “Hard Times on the Colorado River: Drought, Growth and the Future of the Compact”, CU Law School, Boulder.

NOAA Climate Prediction Center ("CPC") Seasonal Precipitation and Temperature Outlooks





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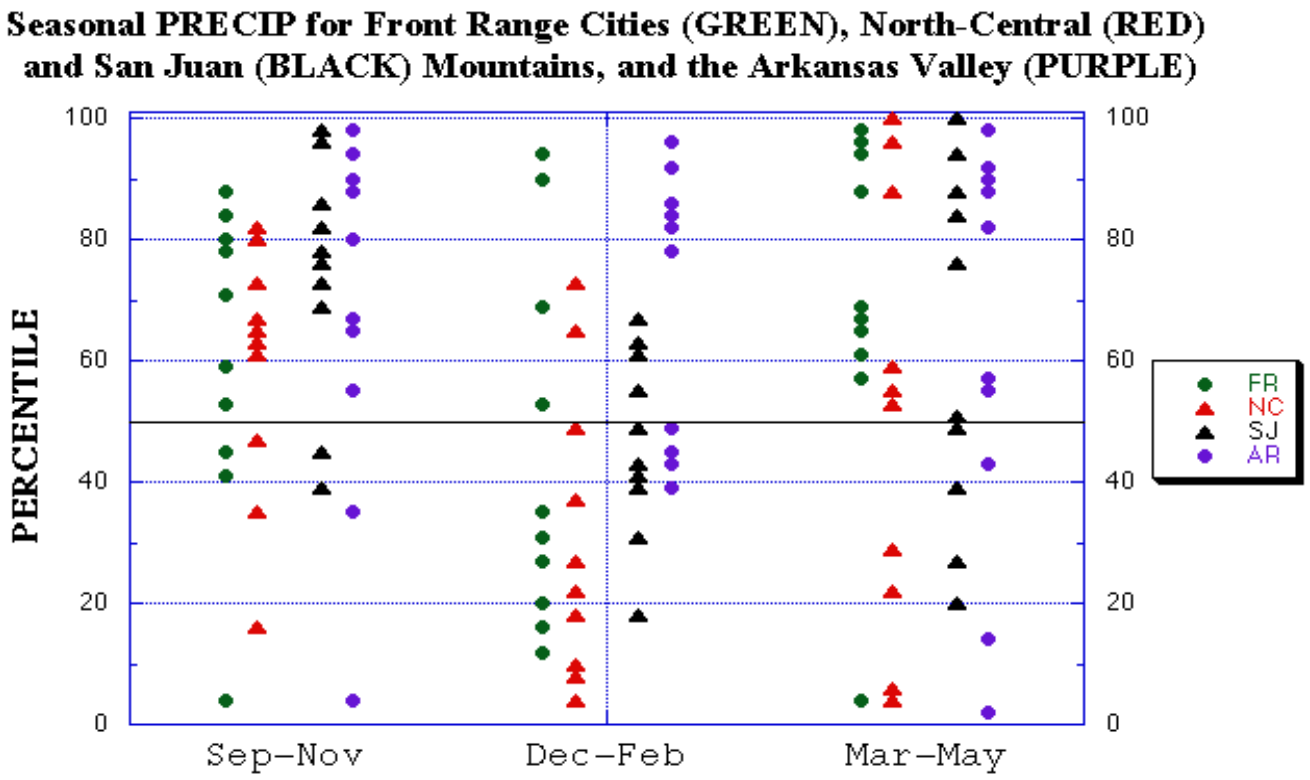
Predicting Climate Variability in Colorado – ENSO–Based Experimental Seasonal Forecasts



Source: Wolter Website, 2004

http://www.cdc.noaa.gov/people/klaus.wolter/SWcasts/index.html

Sample Experimental Forecast

Colorado (and Interior Southwest) forecasts - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites

Address http://www.cdc.noaa.gov/people/klaus.wolter/SWcasts/ Go

Links

Google wolter forecast Search Web 1316 blocked AutoFill Options wolter forecast

Colorado (and Interior Southwest) forecasts

- 1. Current status of the El Niño/Southern Oscillation (ENSO) phenomenon and prospects for the next six to nine m
- 2. Regional climate variability and El Niño composites
- 3. Most recent Climate Prediction Center forecasts for February through June 2005
- 4. Most recent experimental forecasts for January through June 2005
- 5. Discussion of forecasts
- 6. Executive summary

Outline for latest forecast webpage (updated on January February 24th, 2005)

This webpage consists of six parts:

1. Status and Outlook for ENSO (El Niño/Southern Oscillation), the most important global climate variability factor on

6. Executive summary (updated on January 2

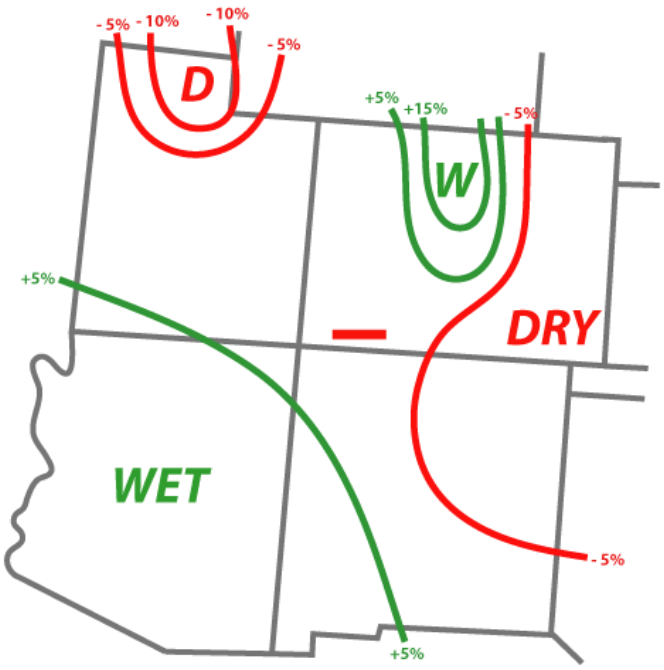
1. The 2004-05 El Niño event continues to limp along, with large-scale SST anomalies that barely exceed 1C (2F). Neverthe precipitation anomalies have been consistent with typical El Niño-associations (for instance, a failed summer monsoon in In in the southwestern (northwestern) U.S.).

3. Executive summary of this webpage:

The most recent forecasts are based on data through December 2004. This website will remain online until further notic

Internet

EXPERIMENTAL CDC JAN-MAR 2005 PRECIPITATION FORECAST
(issued: January 18, 2005)



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Lessons from Experimental Regional Forecasts

- CPC National Forecasts lack spatial scale needed by water managers.
- Active (email) contact provides new forecast reminder.
- Experimental Forecast has multiple sections – map, discussion, summary, skill.
- CPC “Equal Chances” forecast confusing.
- 2002 Prompted interest and attention.

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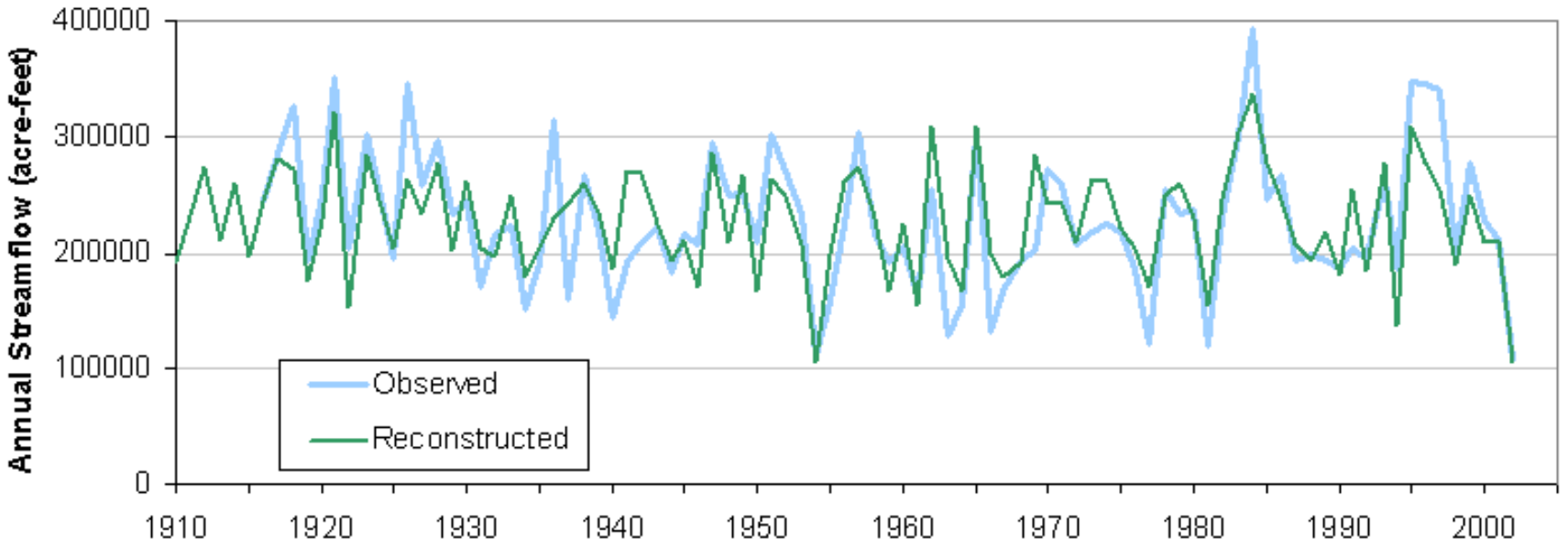
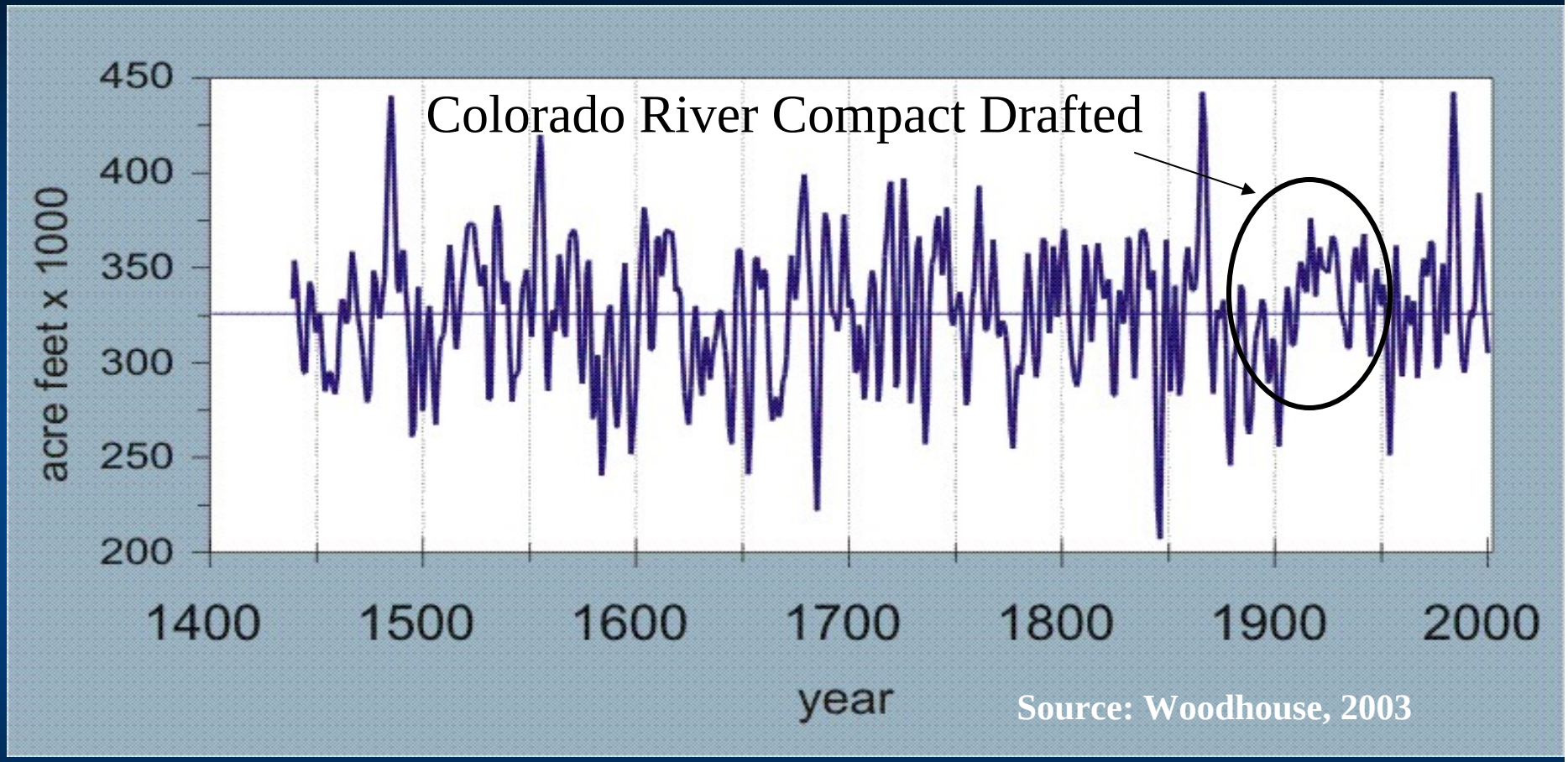
Blue River at Dillon Streamflow Reconstruction



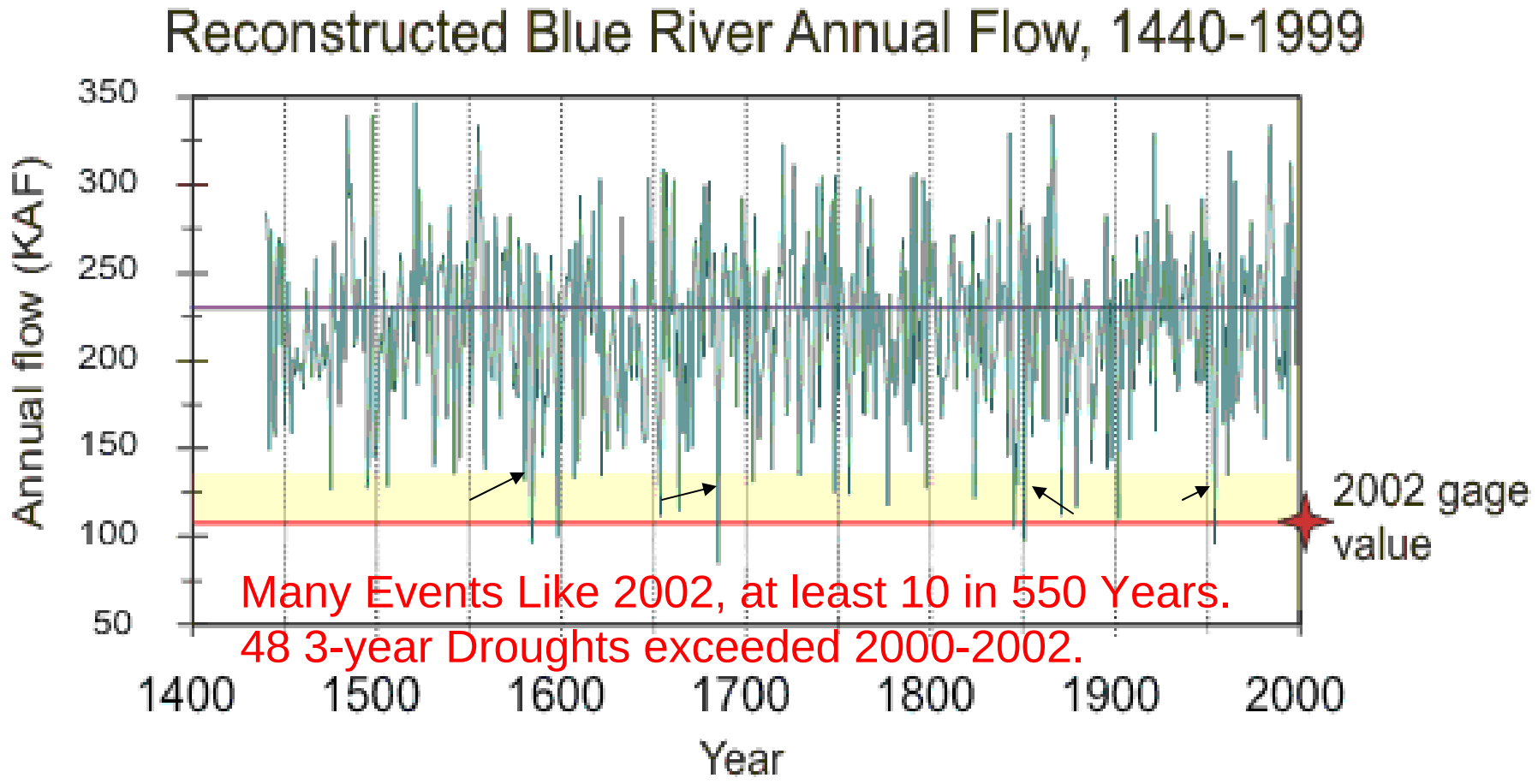
http://www.ngdc.noaa.gov/paleo/streamflow/background.html

Reconstructed Upper Colorado River Streamflow, 1437-2002

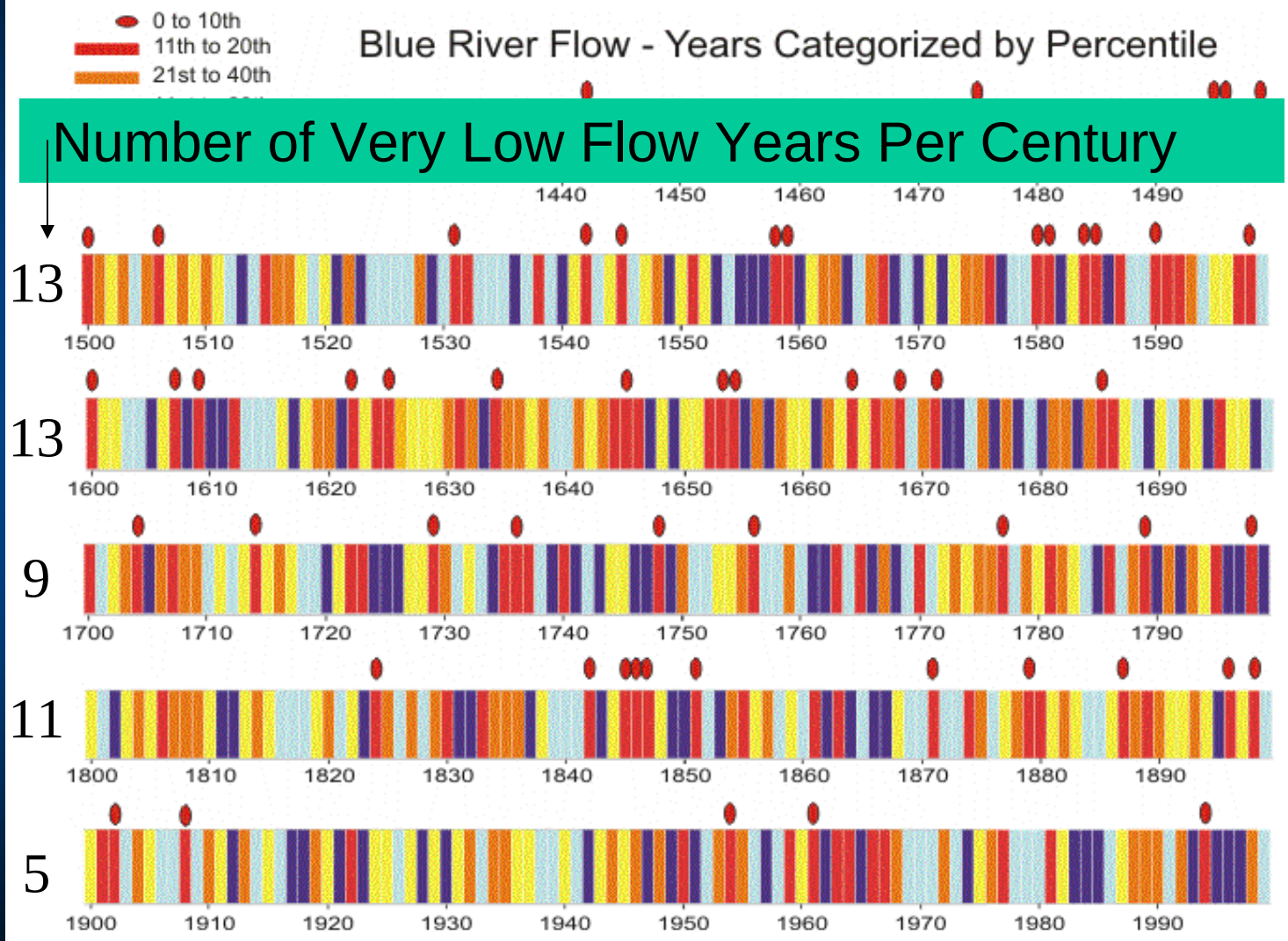
smoothed with a 5-weight filter



The early 20th century wet period does not appear matched in prior centuries. However, drought similar to the 1950s drought have occurred.



Source: Woodhouse, 2003



Source: Woodhouse, 2003

Lessons from Streamflow Reconstructions

- Take advantage of event-related windows of opportunity. Tree-ring data could answer the question that gage data could not: how rare was this event?
- Collaborative work with decision makers is essential. Sustained communication allowed us to explore the development of reconstructions and analyses useful for planning and management.
- Be open willing to address user-based questions. Updating tree-ring collections from 1999 to 2002 or ensemble reconstructions would not have been undertaken otherwise.
- Do not wait to develop collaborative partnerships with decision makers until there is an impeding crisis and they are too busy to figure out how new climate information might be of use.

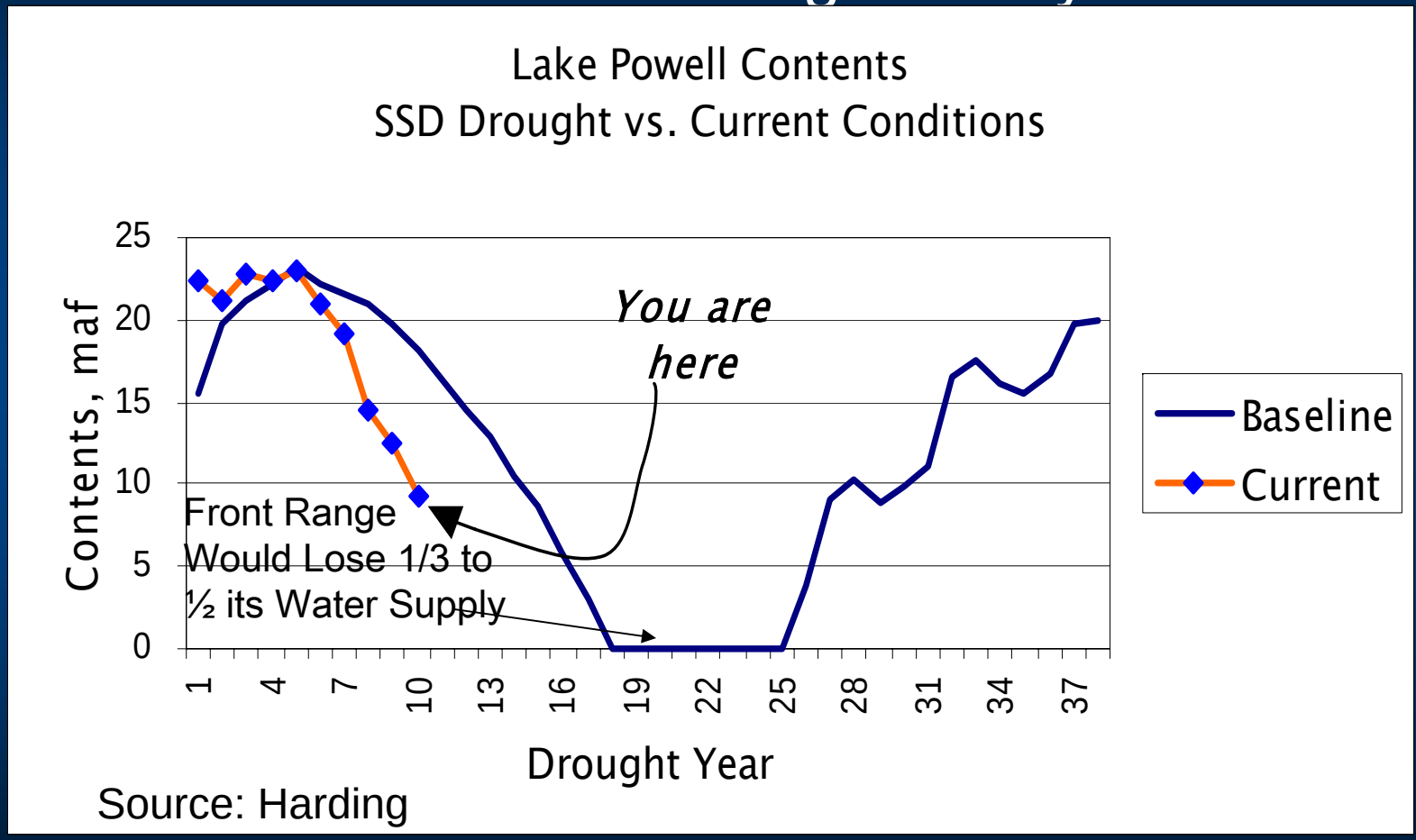
Future Work Foci

Continued Product Development
- Paleo, Seasonal, Streamflows, Others

Continued Assessments
- SPRAT, Demand, Others

New Initiatives
- Global Change Work with Local Provider
- Colorado River Compact
- NOAA Climate Services Feedback

Lake Powell: Current vs. 1995 Severe Sustained Drought Study



Source: Harding