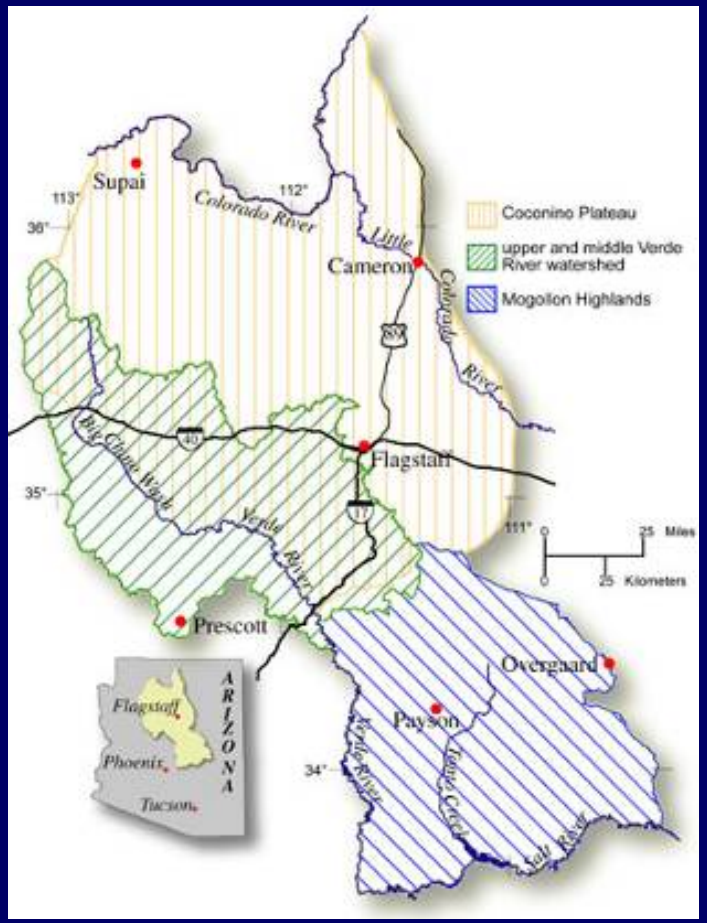
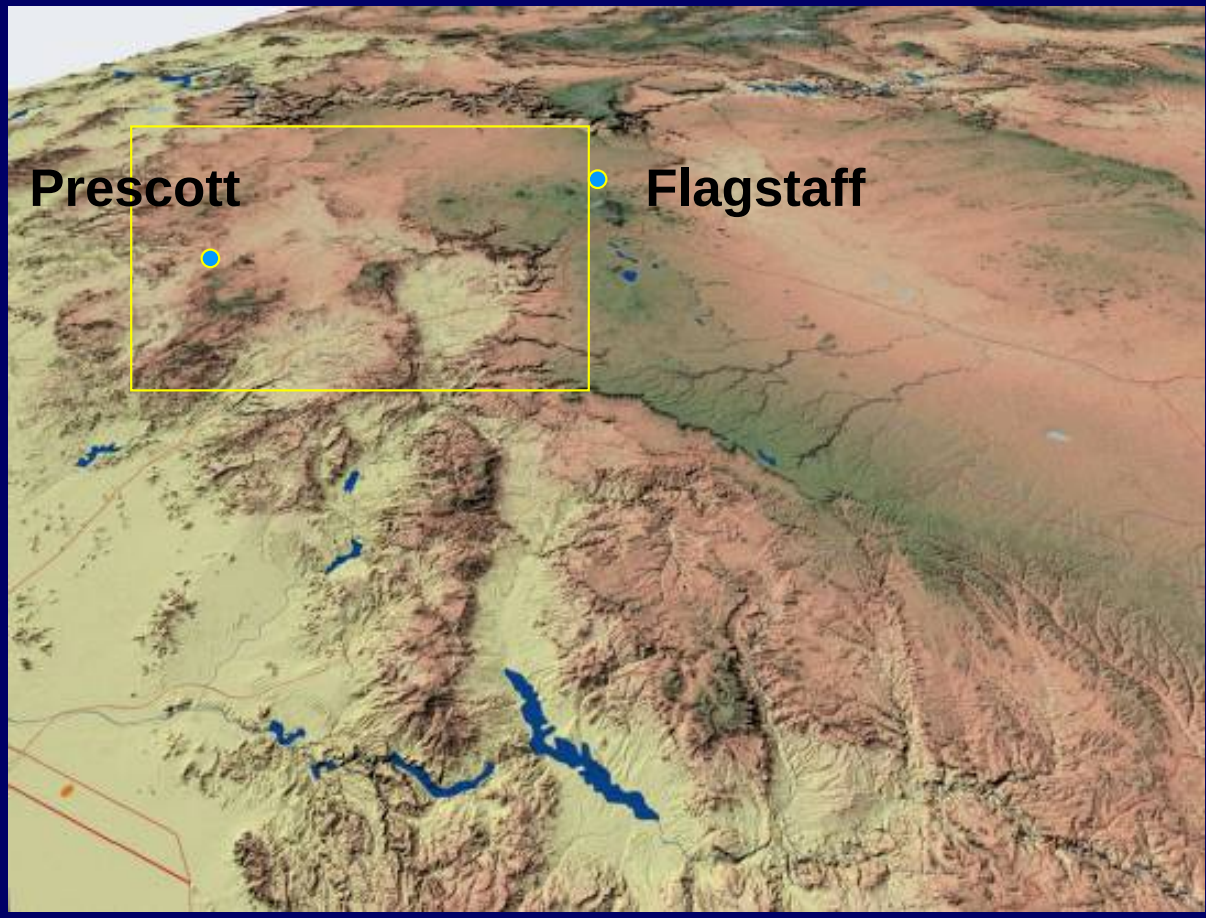
**This presentation has not been approved for publication by the Director of the USGS*

# Hydrologic Investigation of the upper and middle Verde Watersheds




Kyle Blasch, John Hoffmann, Jeannie Bryson, USGS
Leslie Graser, ADWR

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SECURING ARIZONA'S WATER FUTURE

# Program Goals and Objectives

- Regional database
- Hydrogeologic framework
- Conceptual model
- Numerical model

Improve the understanding of the regional ground-water system



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# Ecosystem Restoration Support?

Improve understanding of

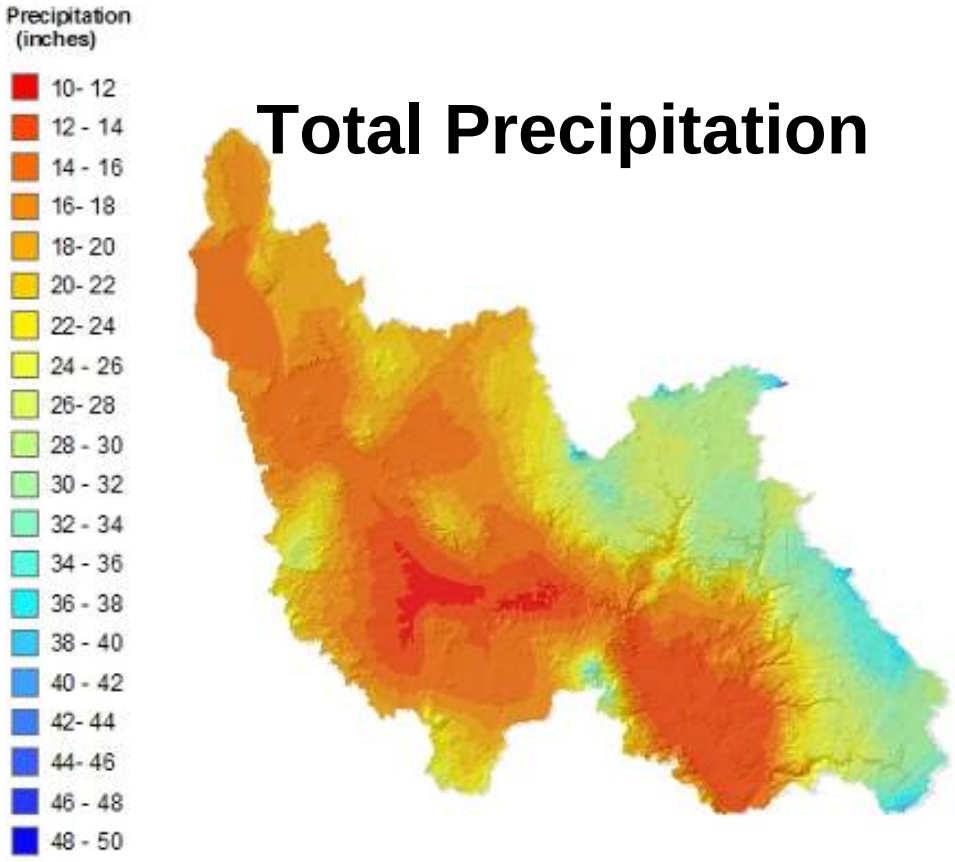
- Predevelopment hydrologic system
- Current hydrologic system
- Natural variations in hydrologic processes
- Anthropogenic changes to the system
- Future scenarios - Planning - Impacts

Significant Impacts of Concern

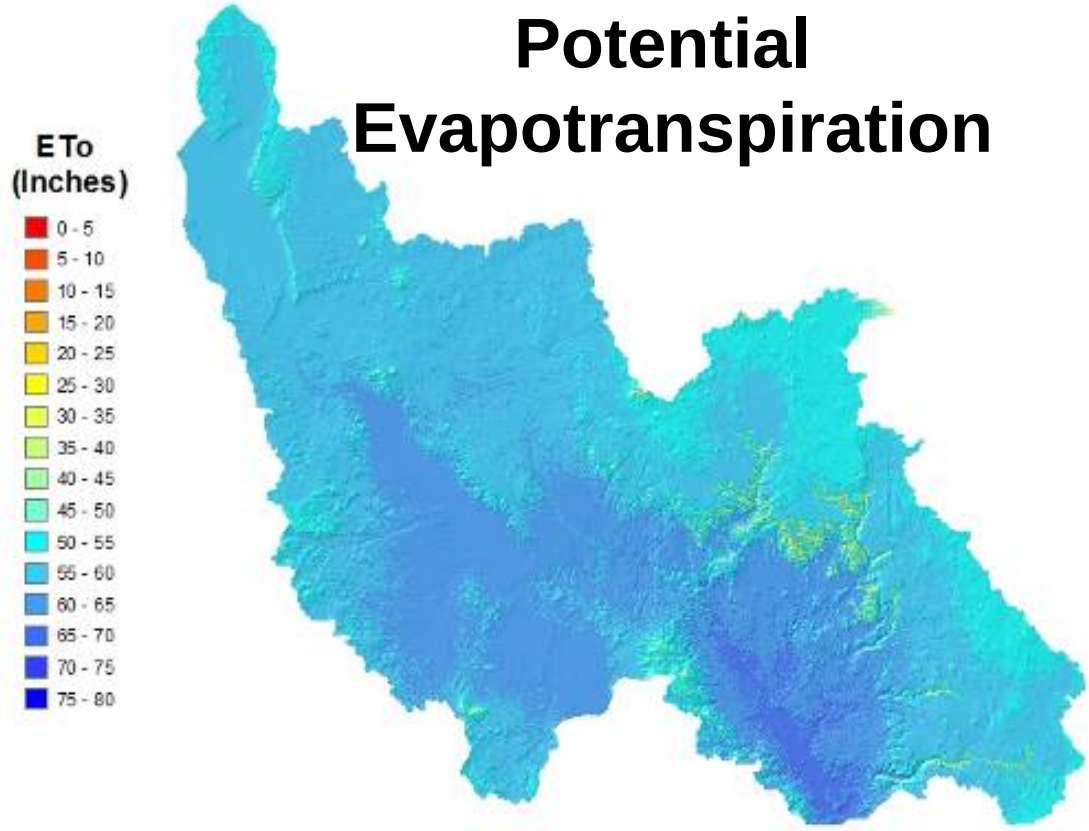
- Water Quantity
- Water Quality


Introduced Species

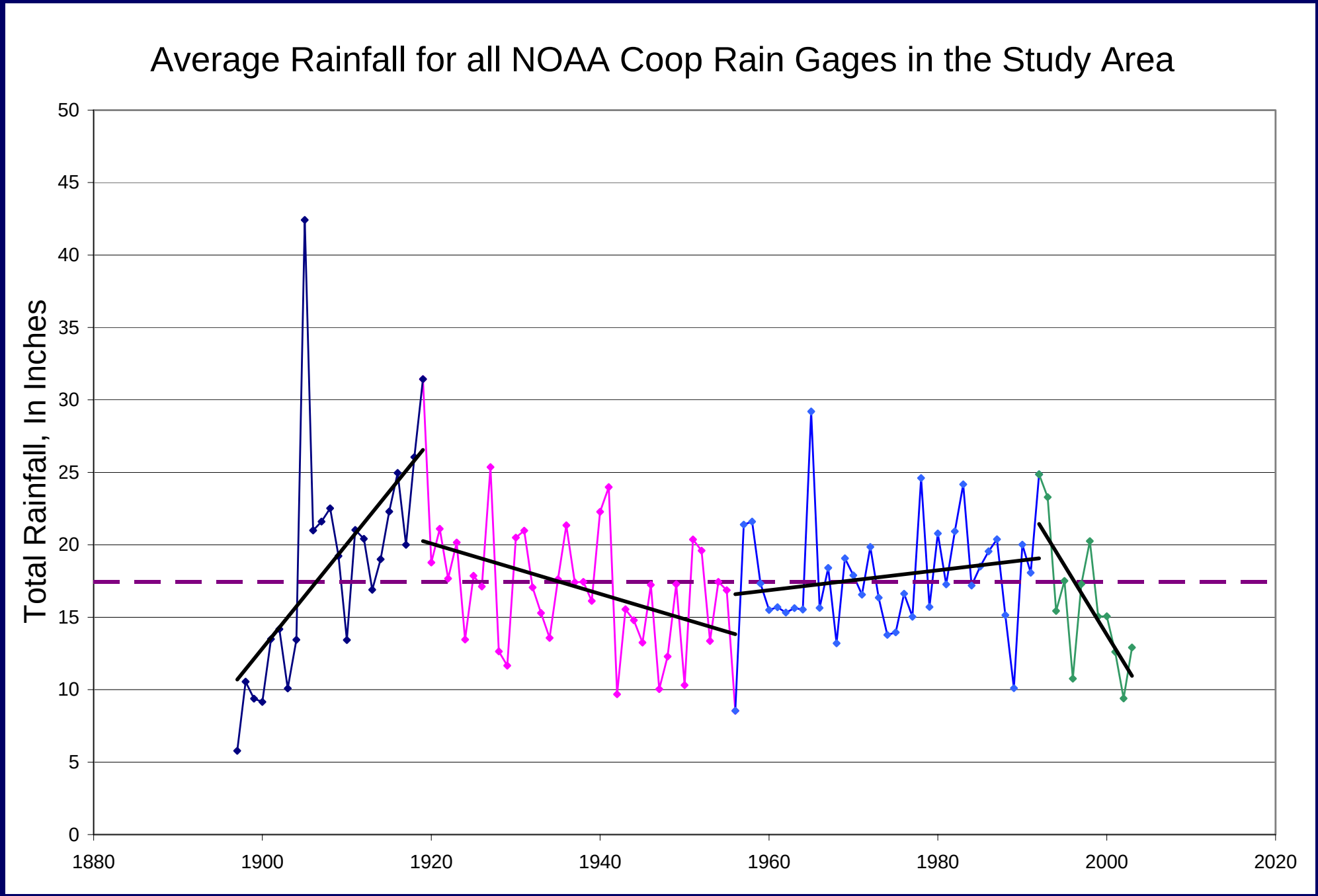
# Total Precipitation



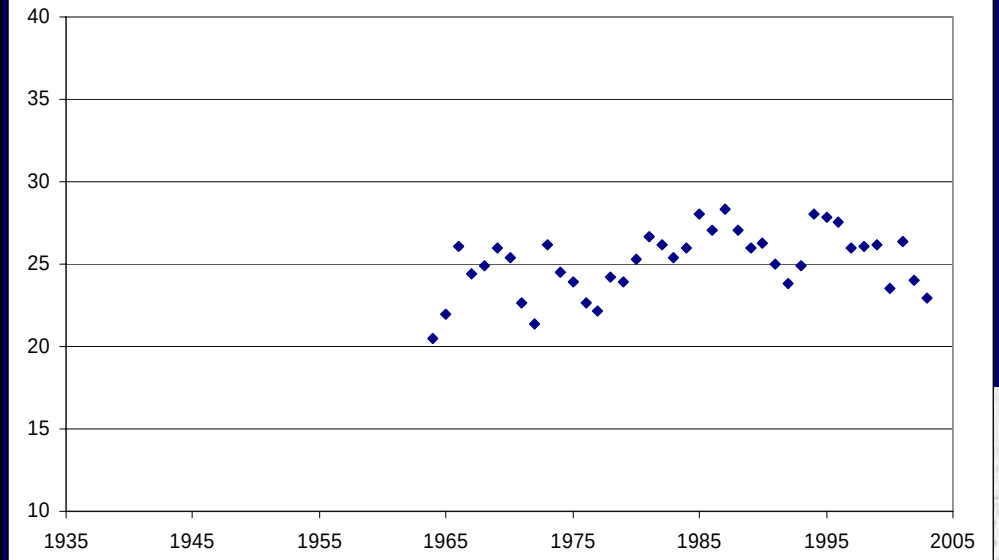

# Potential Evapotranspiration



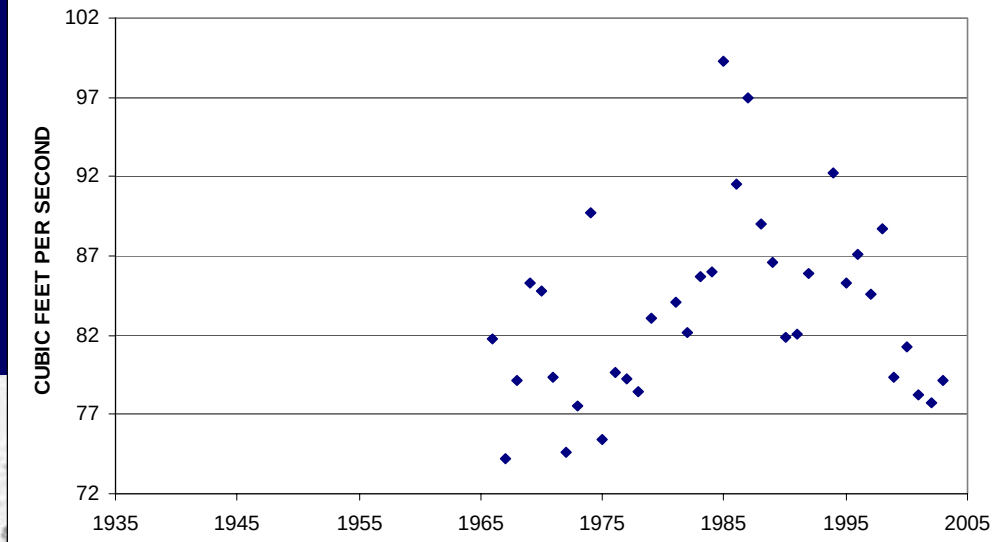
# Rainfall in the Watersheds



## Verde River Near Paulden



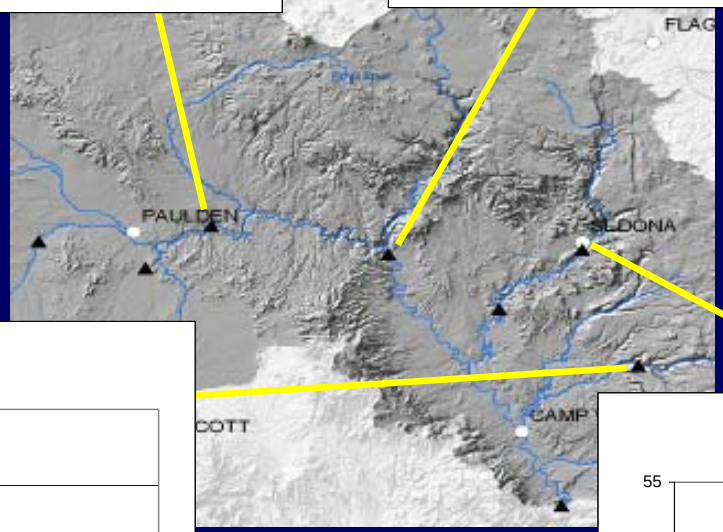

## Verde River Near Clarkdale



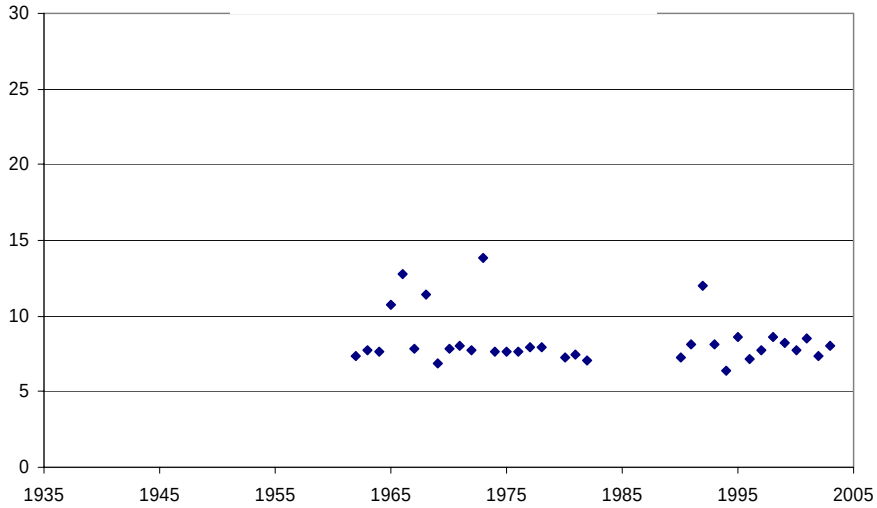

**Winter Base-Flow Trends**

**Y-Axis Base flow in cfs**

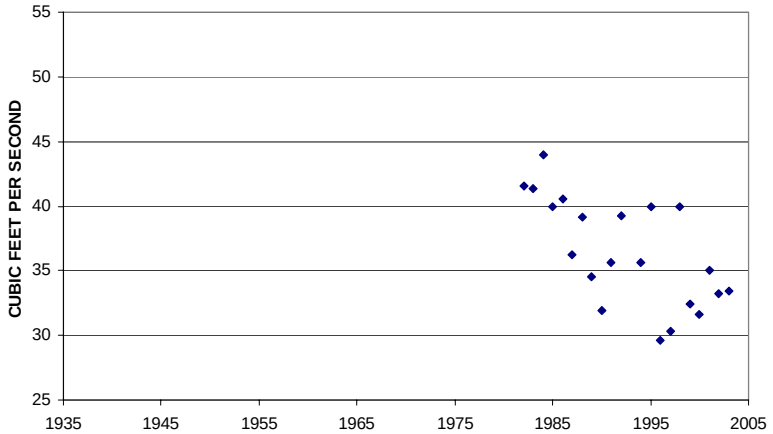
**X-Axis Time in years**

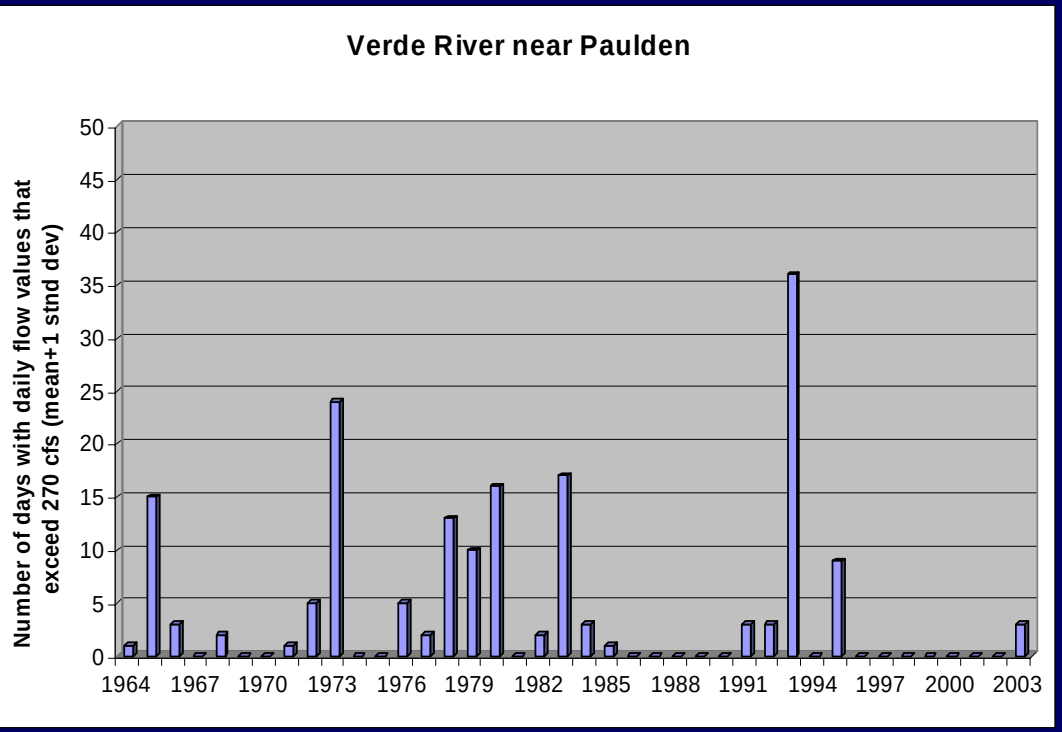



## Wet Beaver Creek

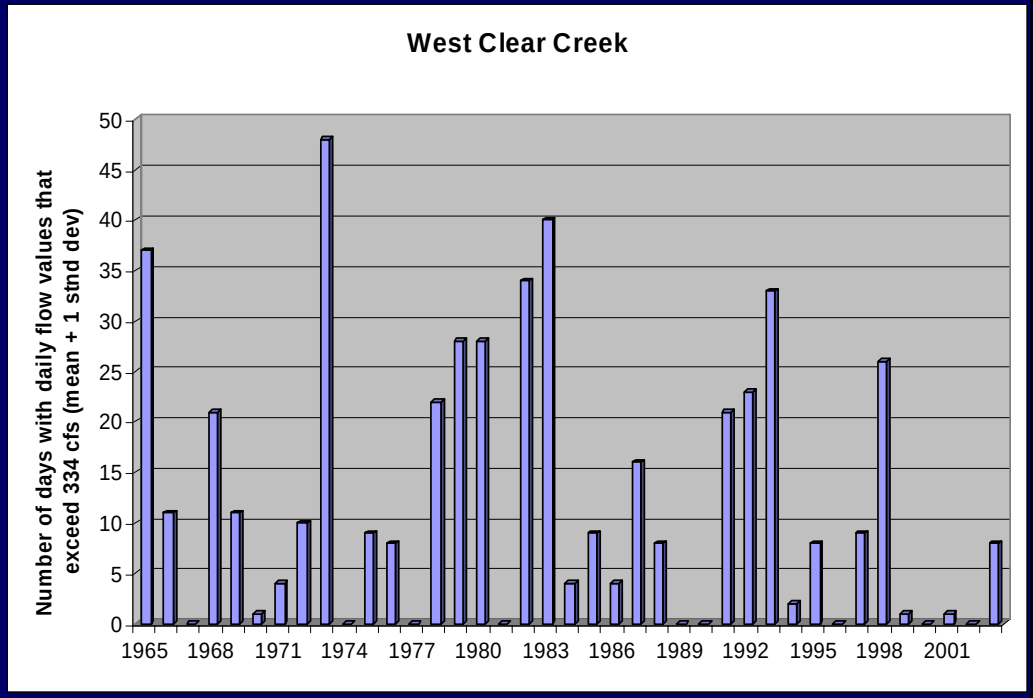


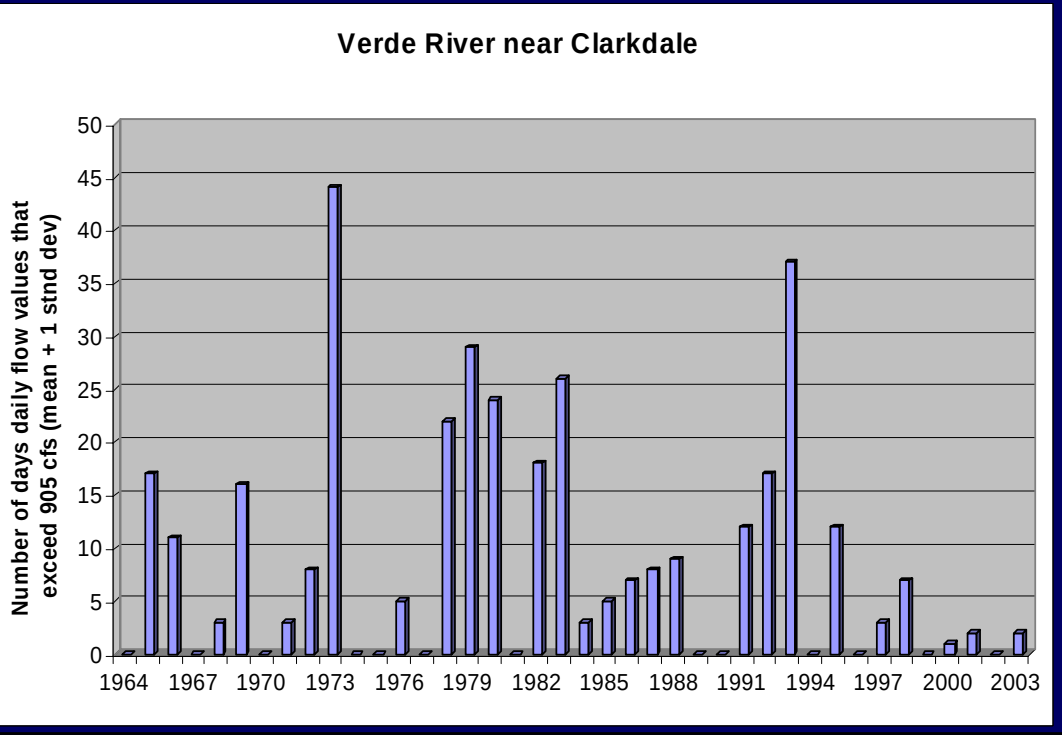

## Oak Creek at Sedona






# Extreme Events Important to Lifecycle of Certain Species

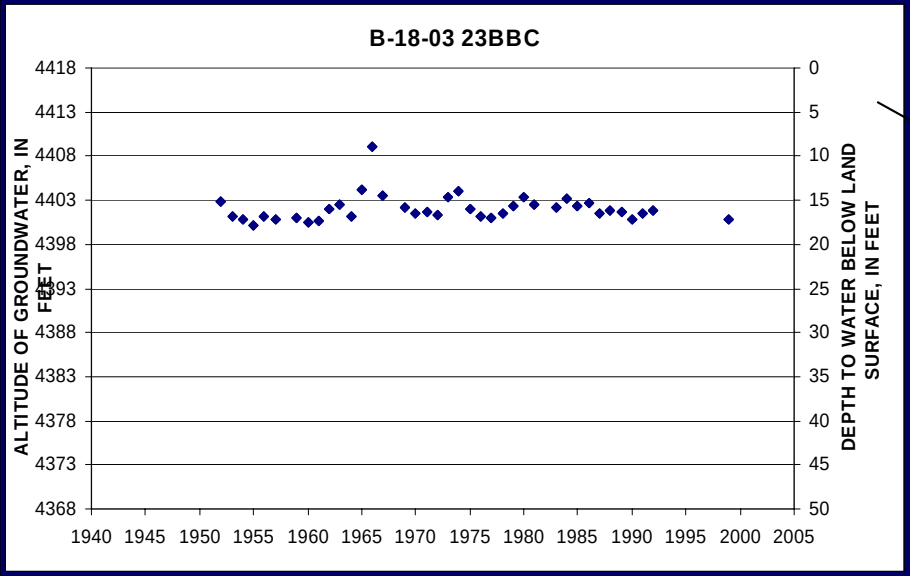


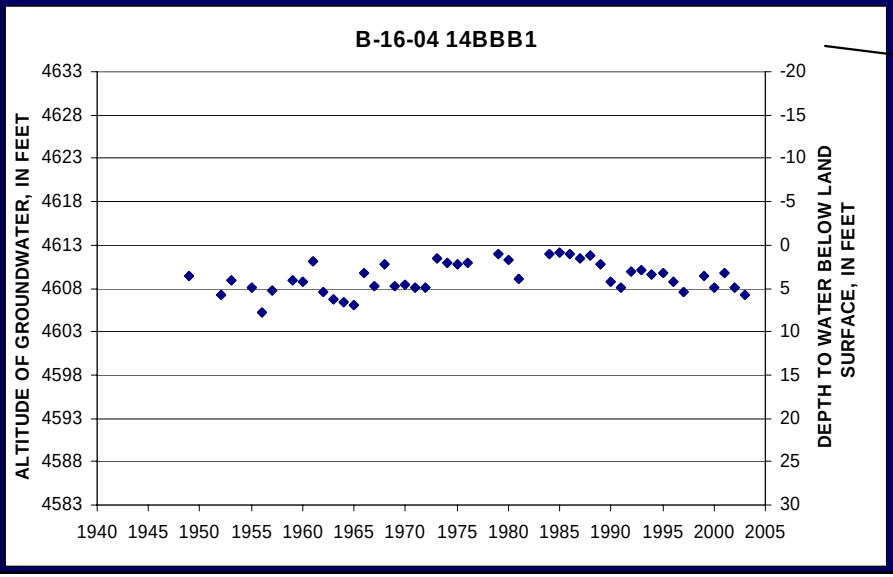

Number of days per year with daily discharge values above 1 standard deviation at selected gages

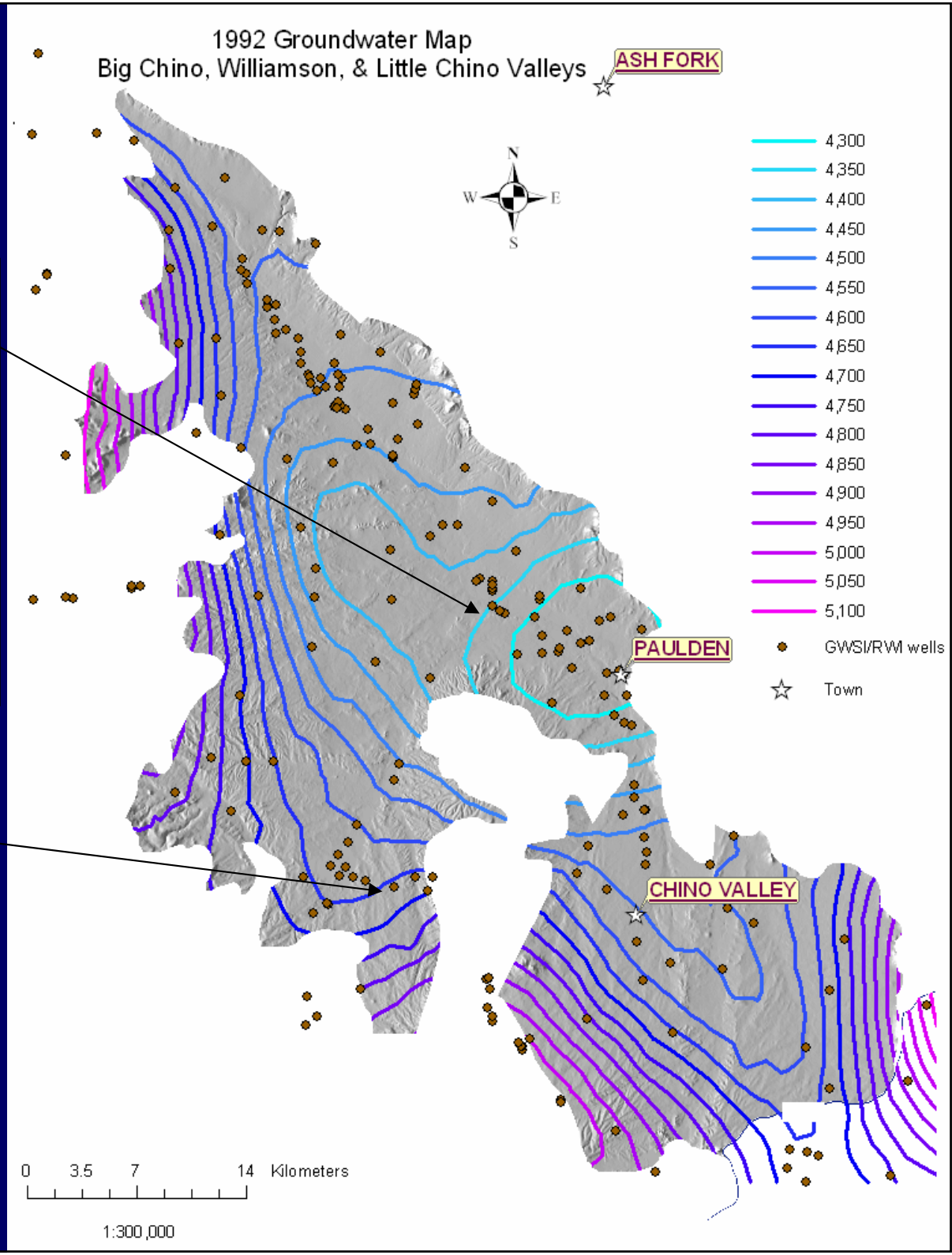
# Big Chino water level gradients: 1992

More recent water levels in Big Chino: Similar to 1992 with declines in a few areas.

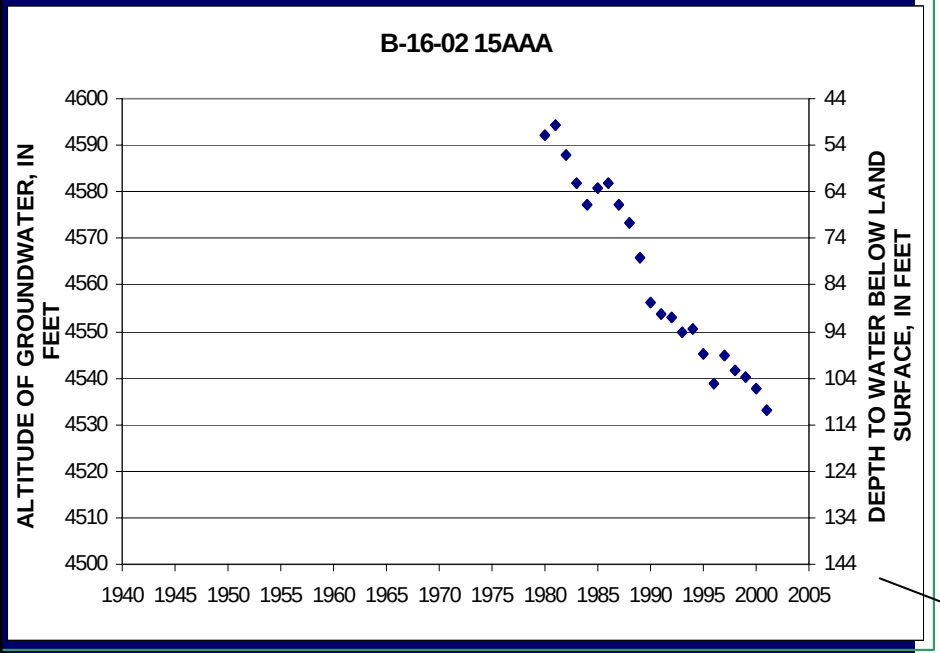



## Williamson Valley

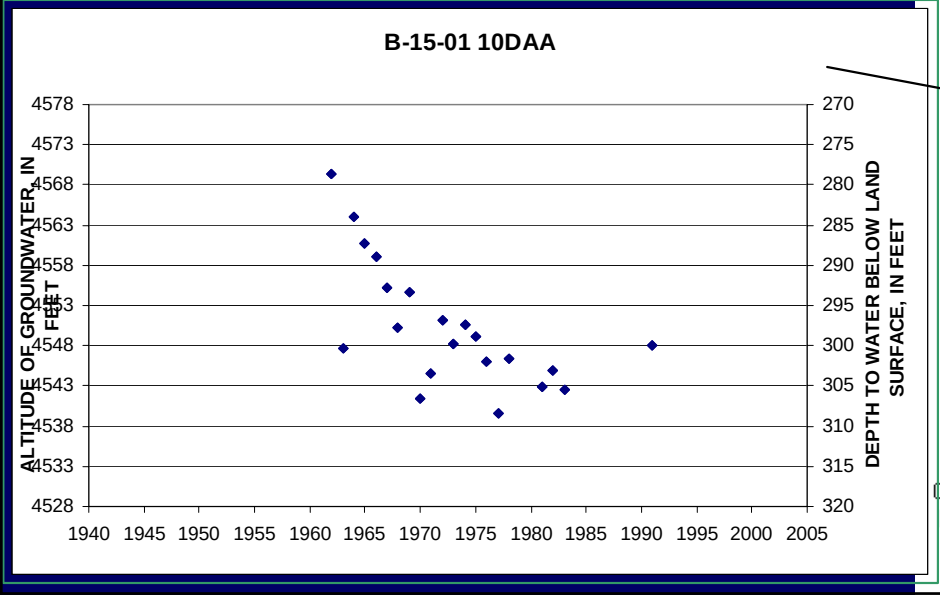


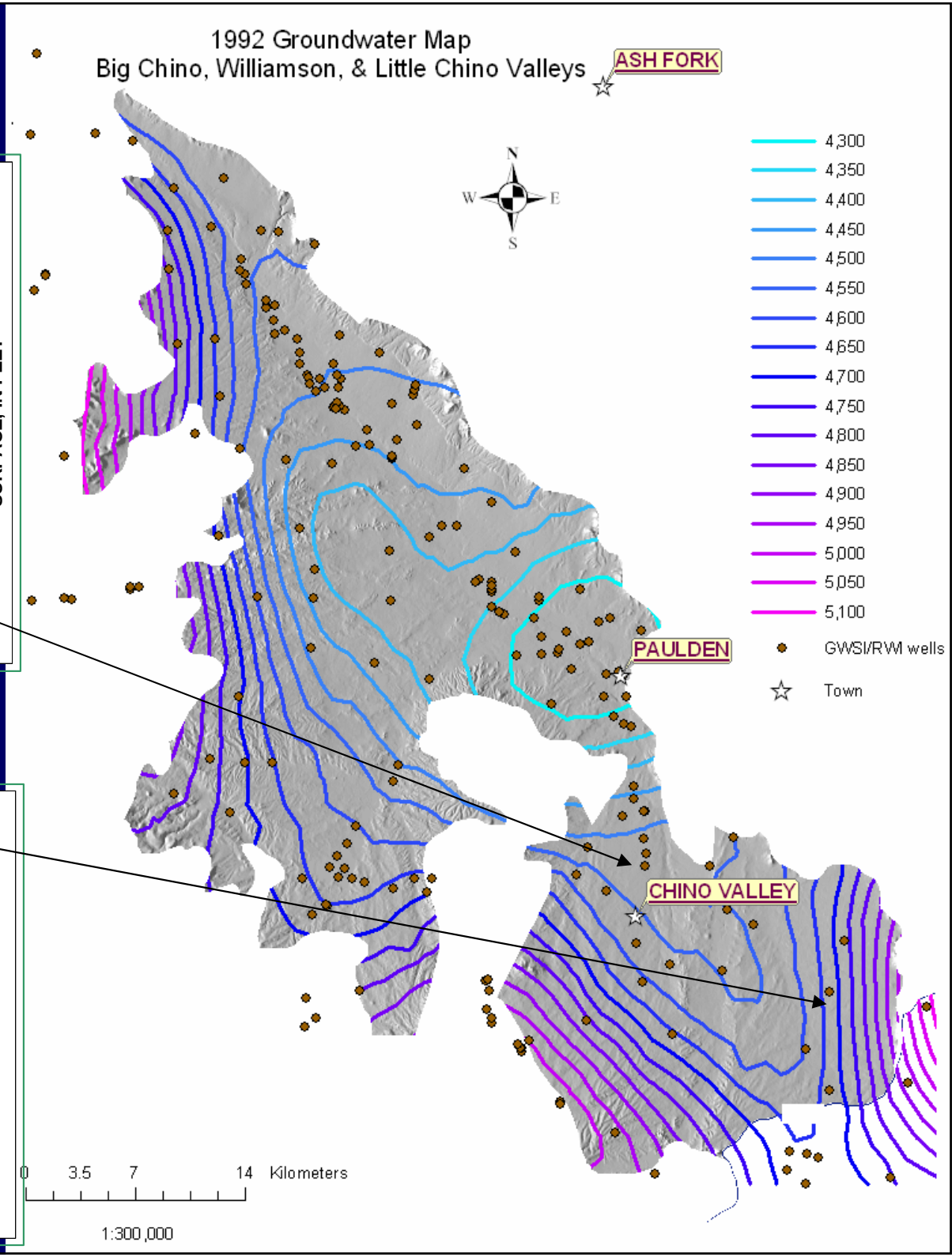



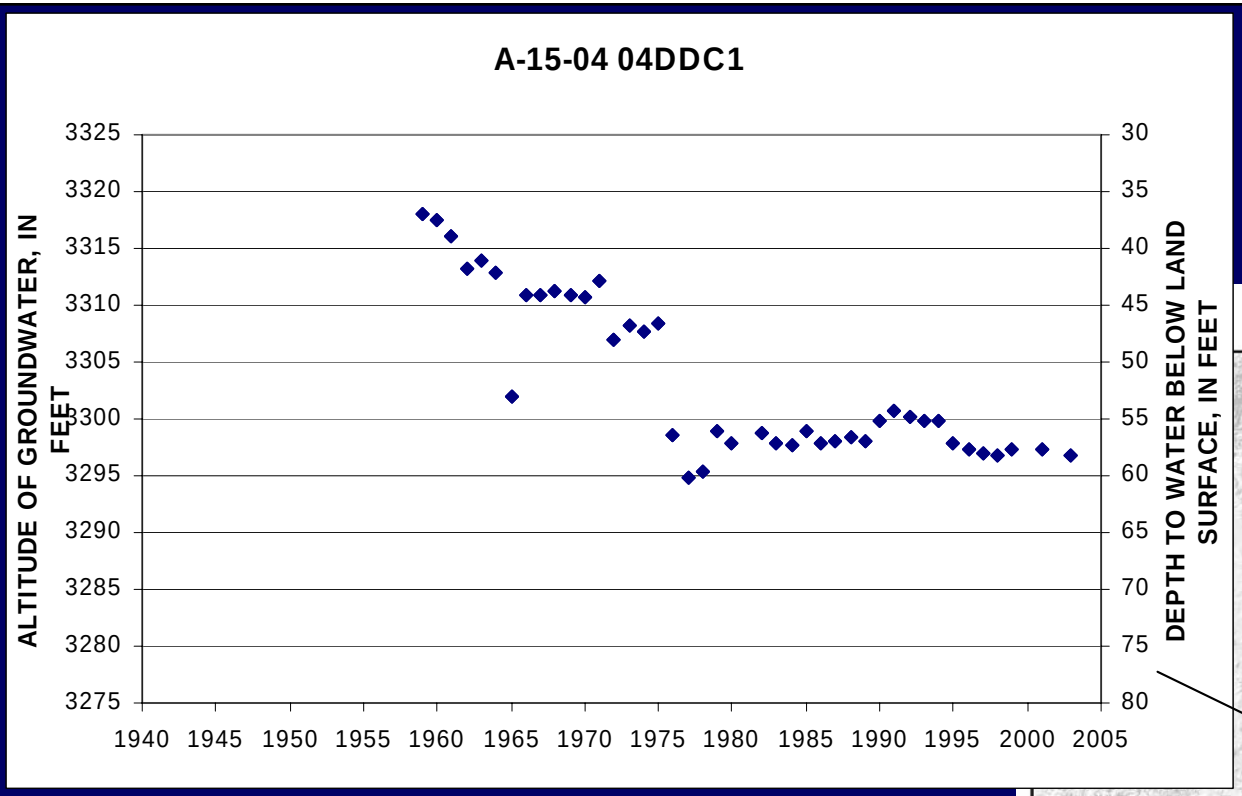
# Little Chino Valley (-0.5 to -2 ft/yr)

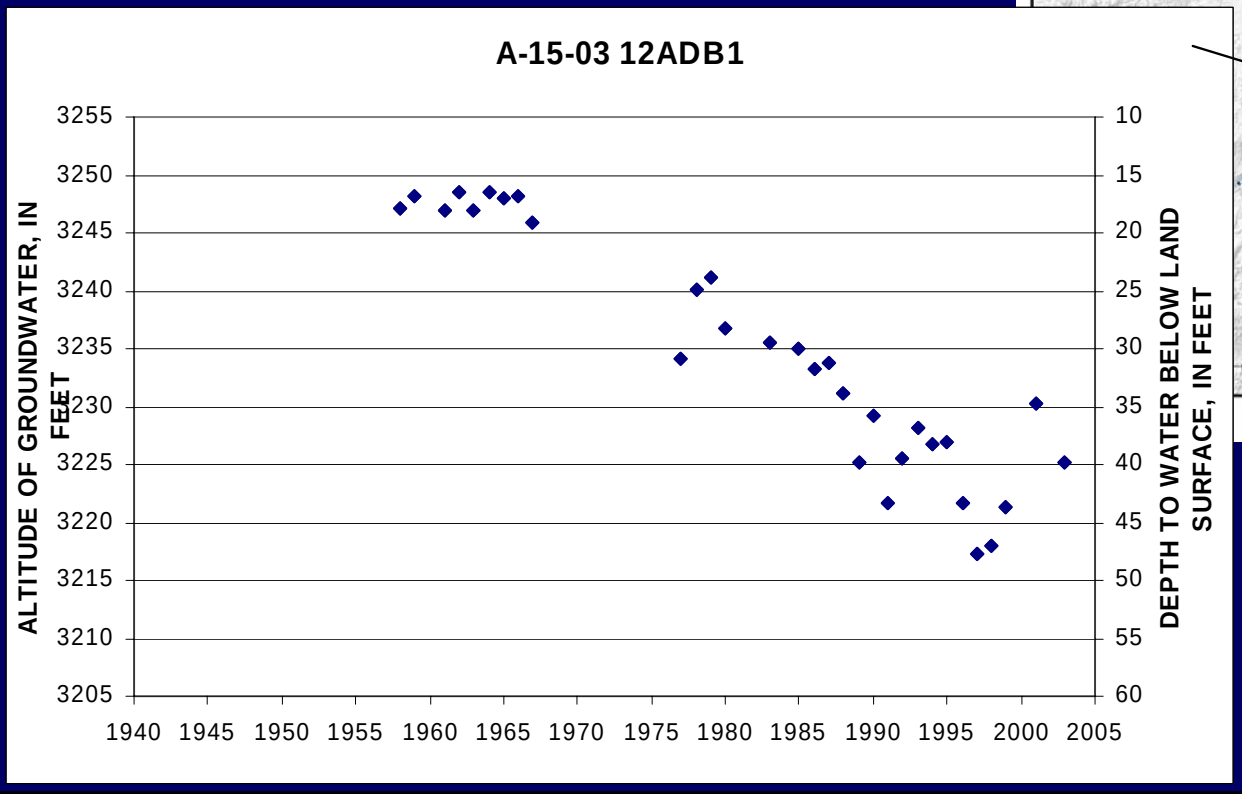



# Lonesome Valley (-1 to -2 ft/yr)

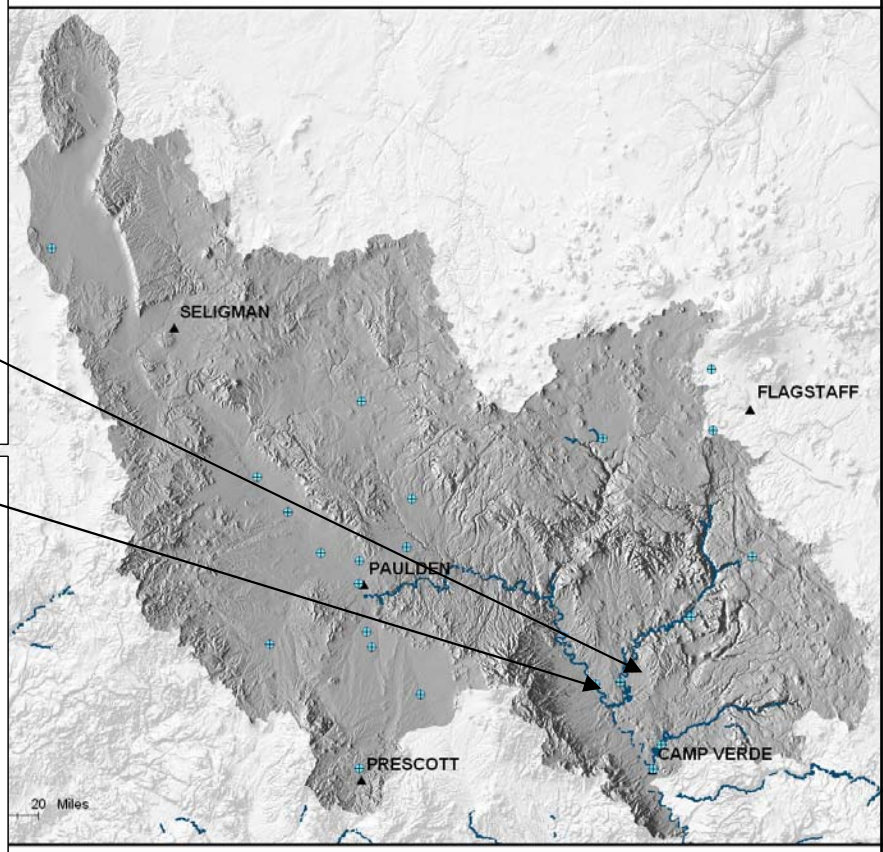


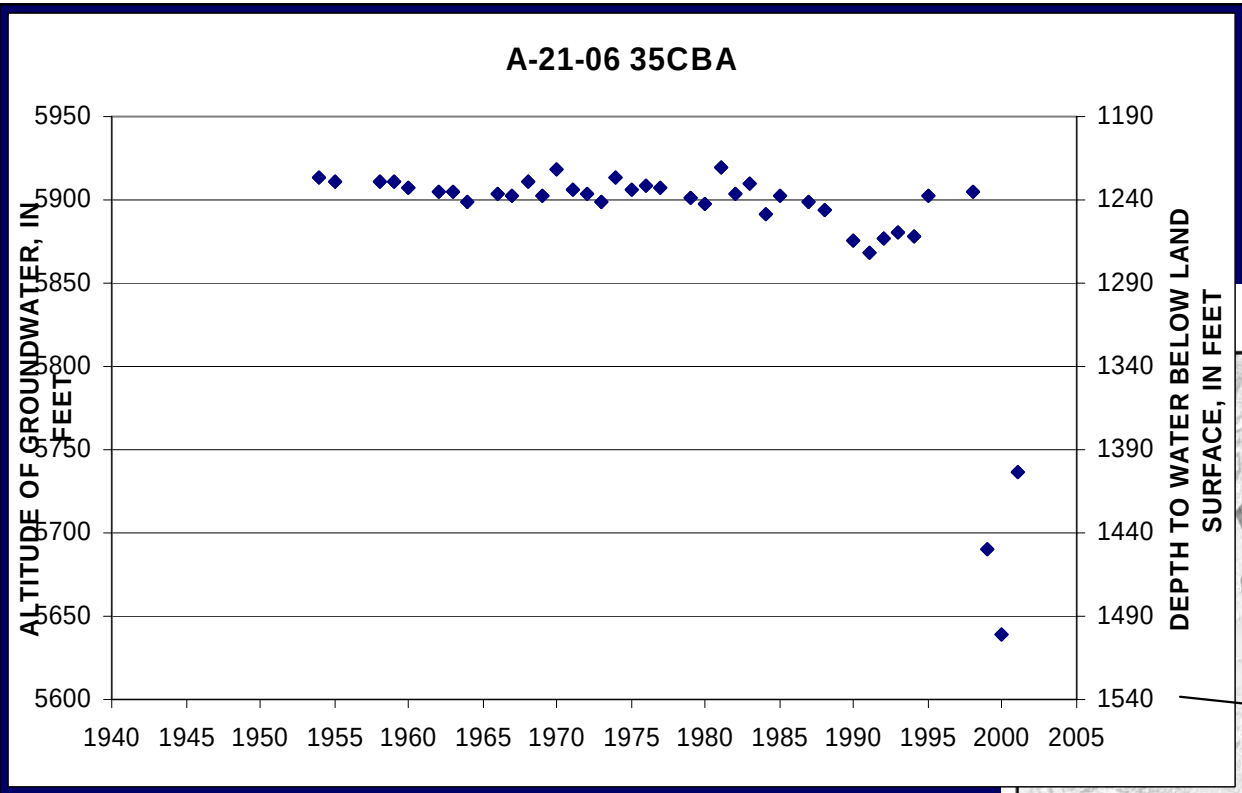



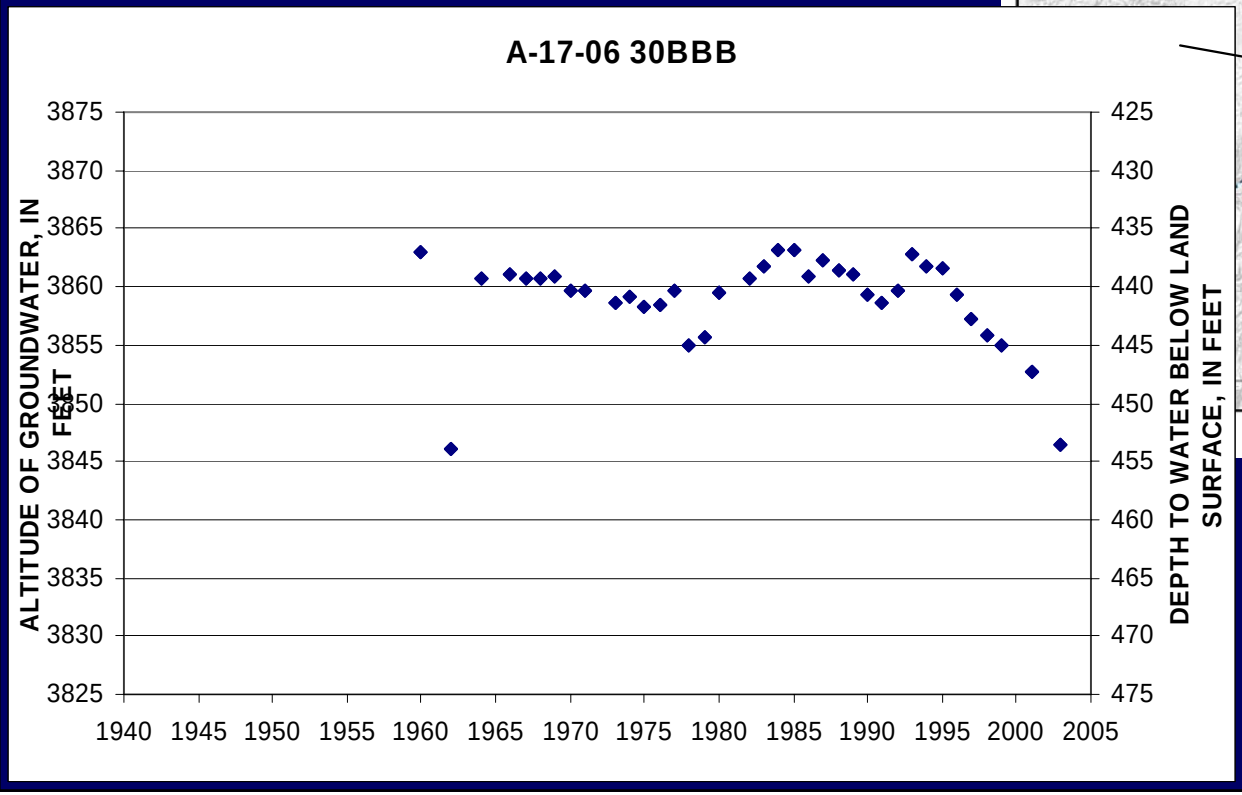


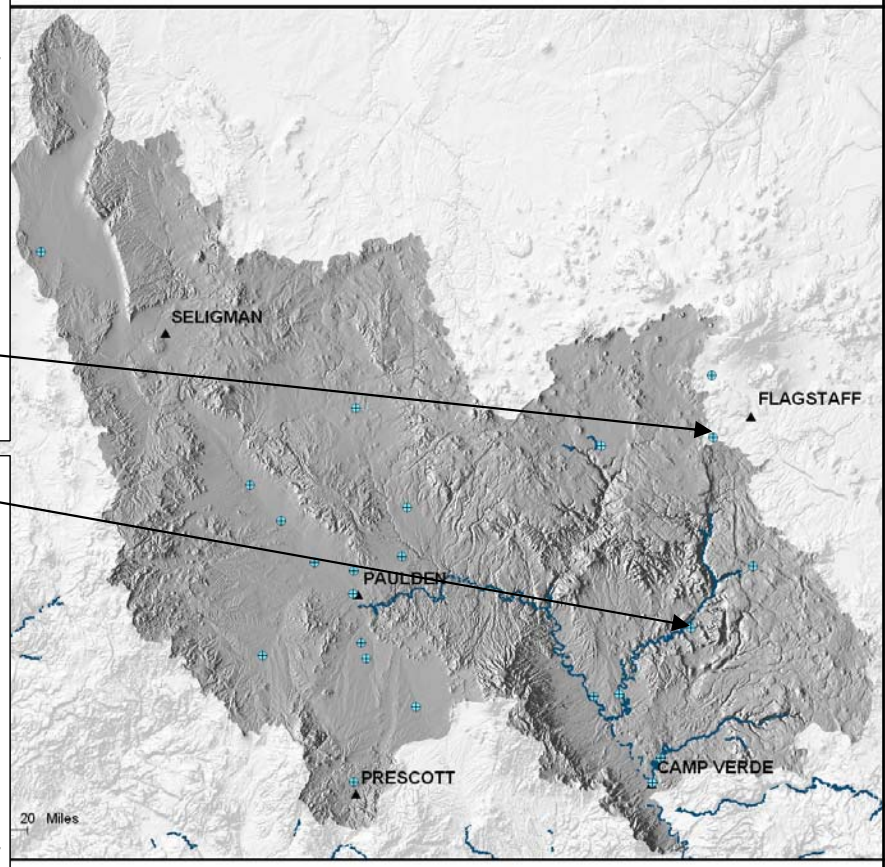

## Ground Water Verde Formation
## -5 to -10 ft of decline over 50 yrs





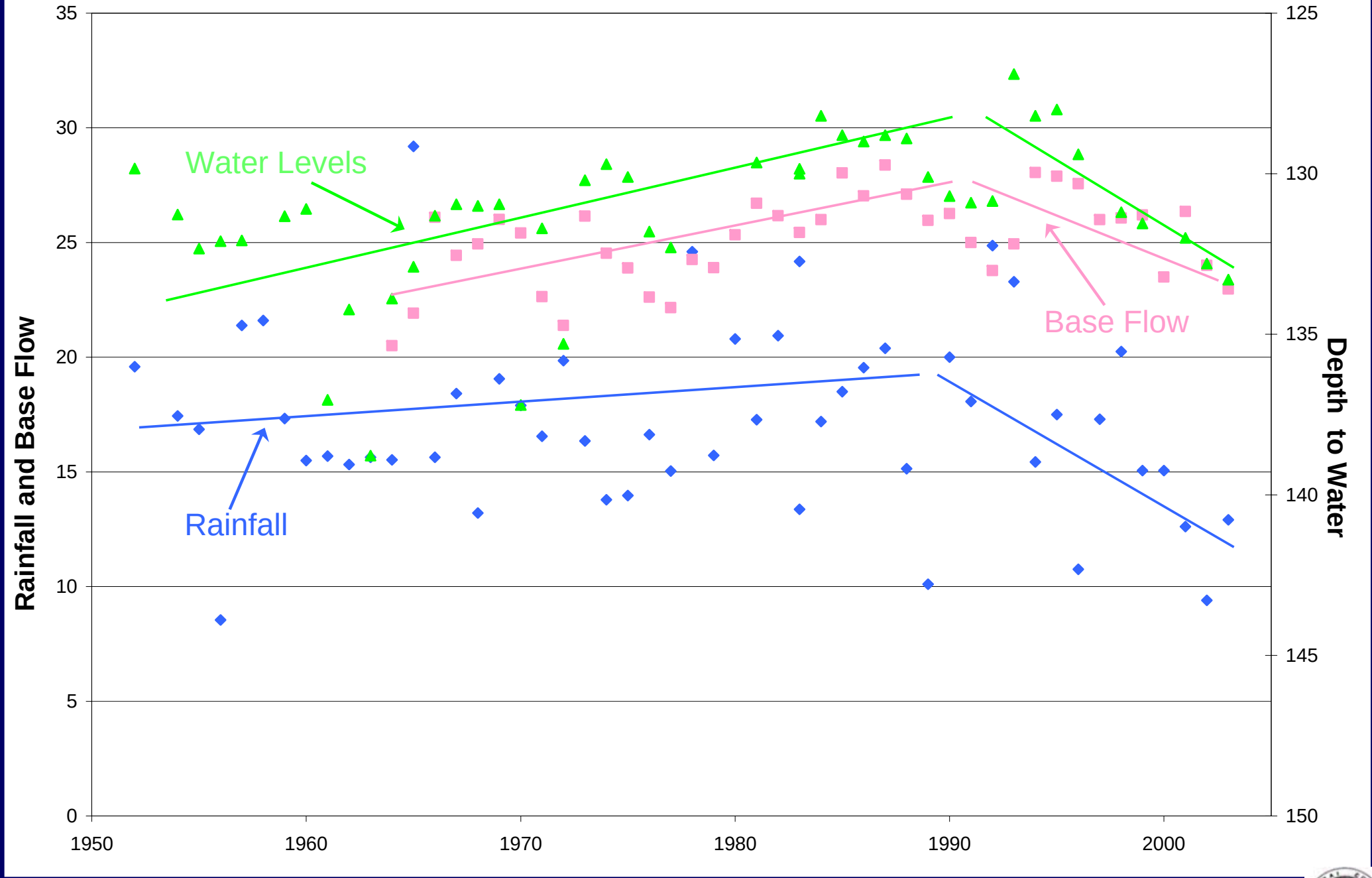




# Ground Water C-Aquifer




## Local Aquifers
## Greater Declines Measured

# Water Levels and Base Flow are Responsive to Changes in Rainfall

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# Sample Collection in the Upper and Middle Verde Watersheds


SELIGMAN

FLAGSTAFF

PAULDEN

PRESCOTT

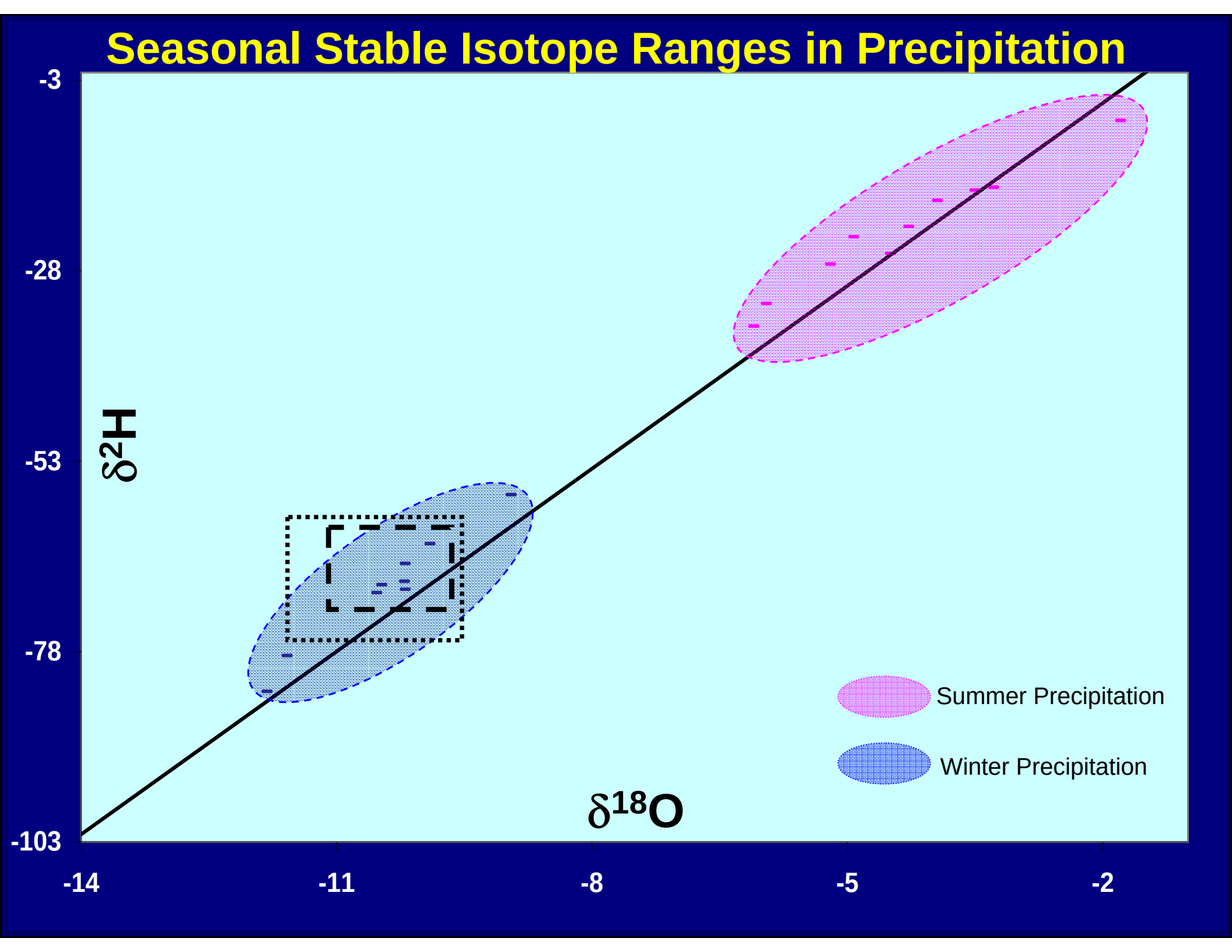
CAMP VERDE

Spring Samples

Precipitation Samples

Surface-water Samples

Ground-water Samples


Seasonal Stable Isotope Ranges in Precipitation
-3
-28
-53
-78
-103
δ2H
-14
-11
-8
-5
-2
δ18O
Summer Precipitation
Winter Precipitation

# Base Flow Contribution

Verde Valley

E. Coconino Plateau

Chino Valleys

Combined Chino Valley and W. Coconino Plateau

W. Coconino Plateau

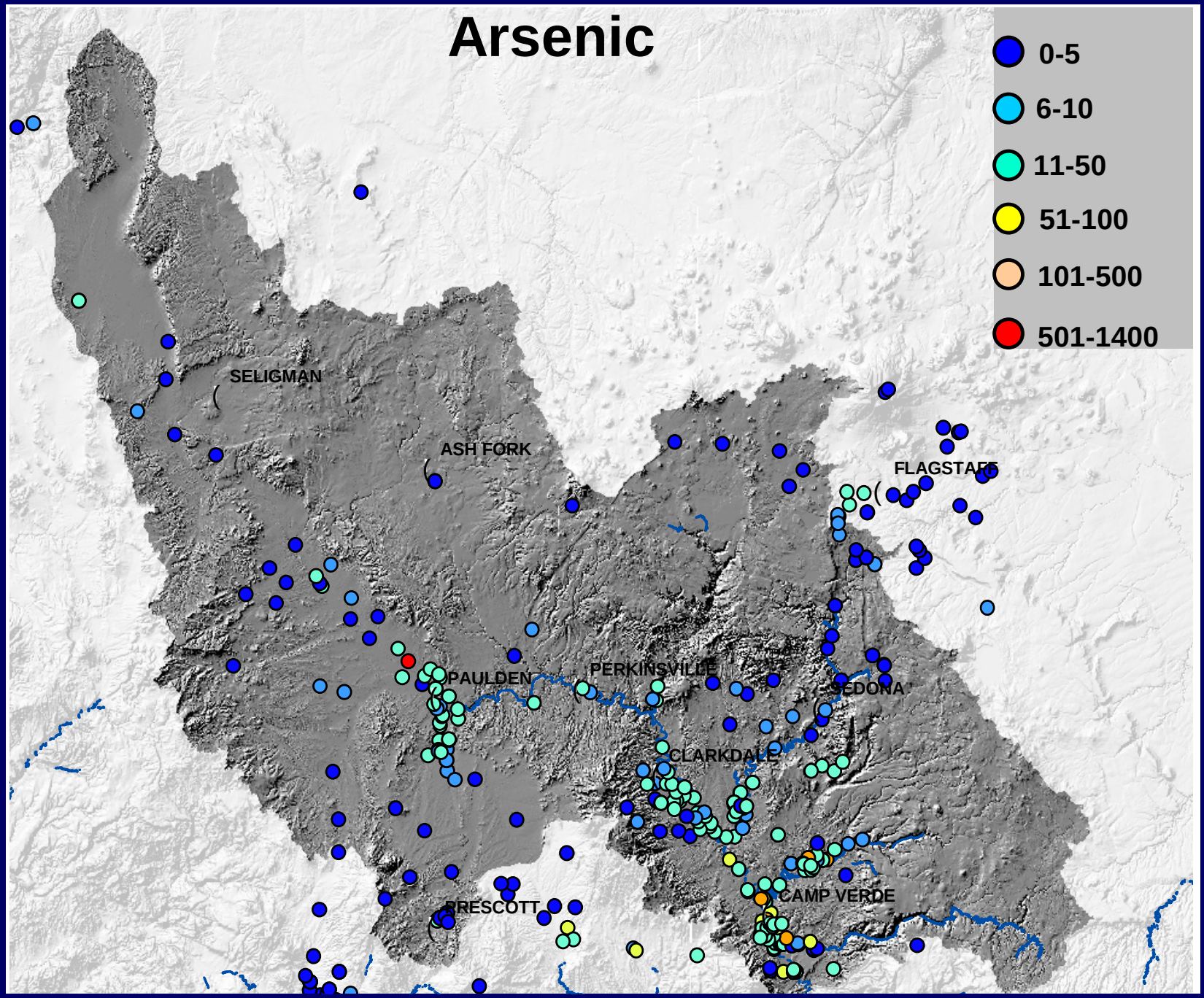
Base Flow (cubic feet per second)

220
200
180
160
140
120
100
80
60
40
20
0

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90

Distance from Grantite Creek (miles)

# Surface- and Ground-Water Quality is Pristine Except ARSENIC



# Conclusions

Concerns for Restoration

- Need for basic data to define system
- Current rainfall within bounds over last century
- Temperature increase observed
- Surface water in upper Verde responsive to storage changes
- Ground-water withdrawals impacting base flow of springs
- Winter recharge predominant
- Arsenic is the only water quality factor – natural source


Questions?