Interpreting Impacts to Spring Discharge During the Order 1169 Pumping Test

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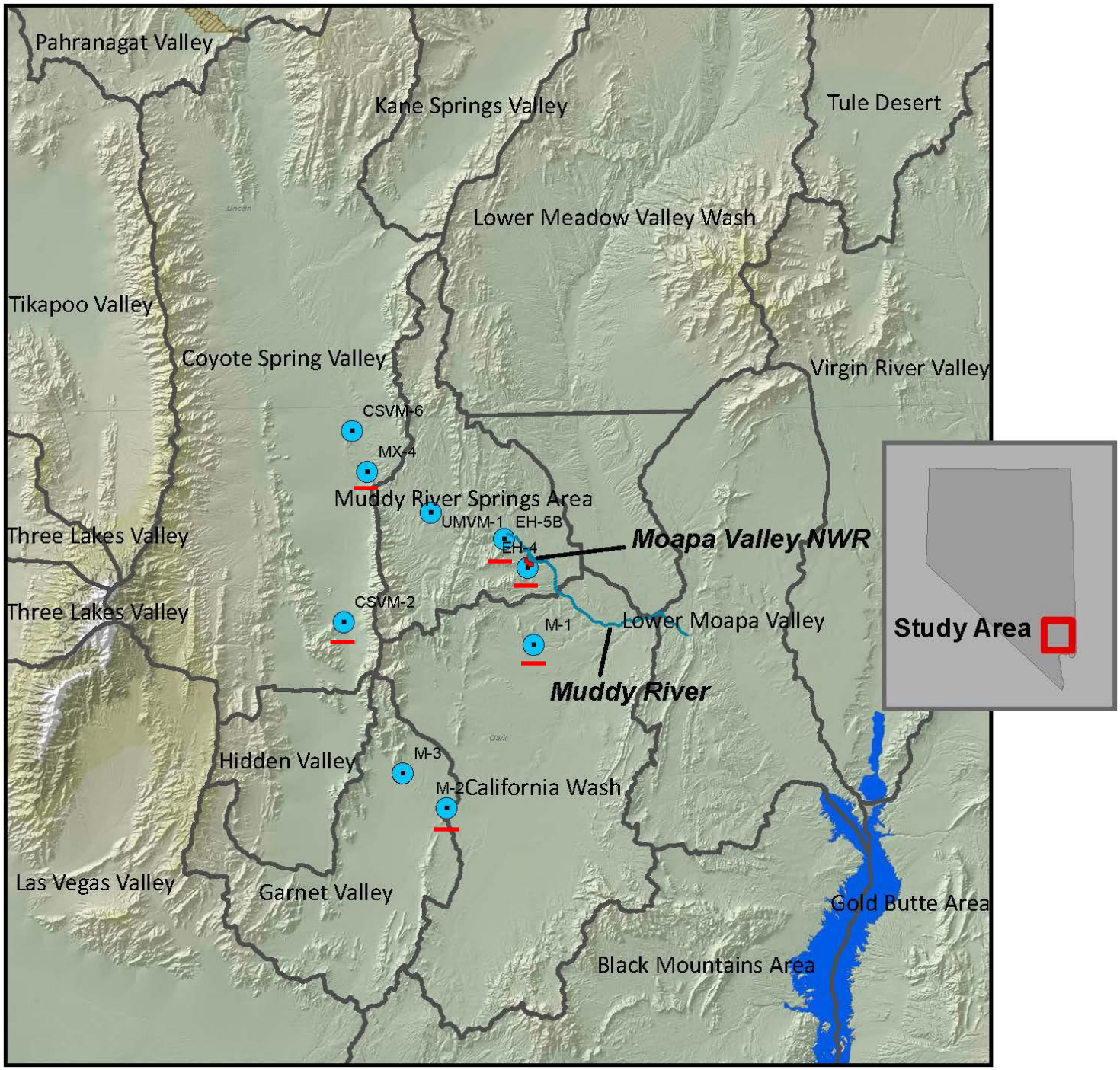
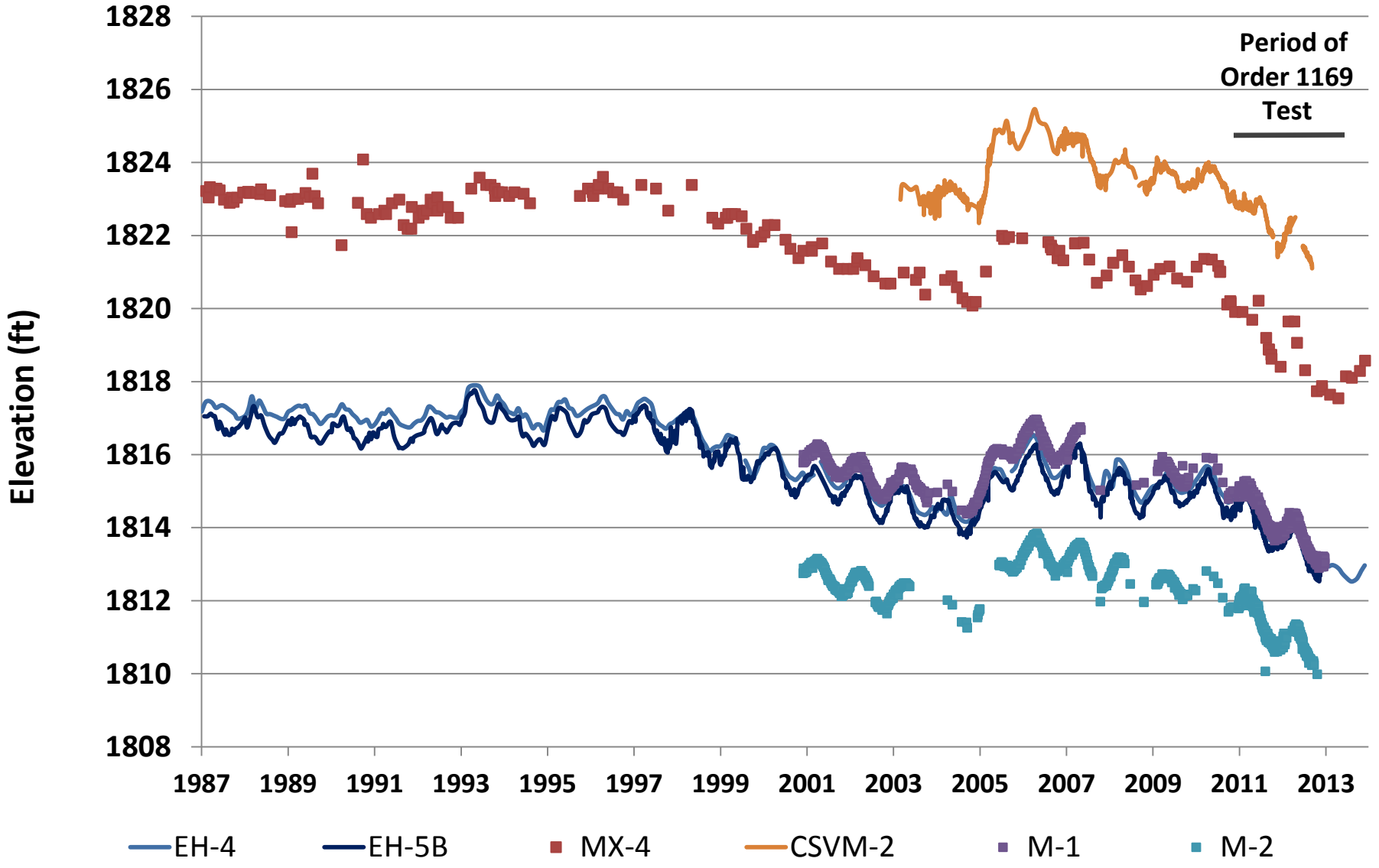
THE KISS PRINCIPLE
KEEP
IT
SIMPLE,
STUPID

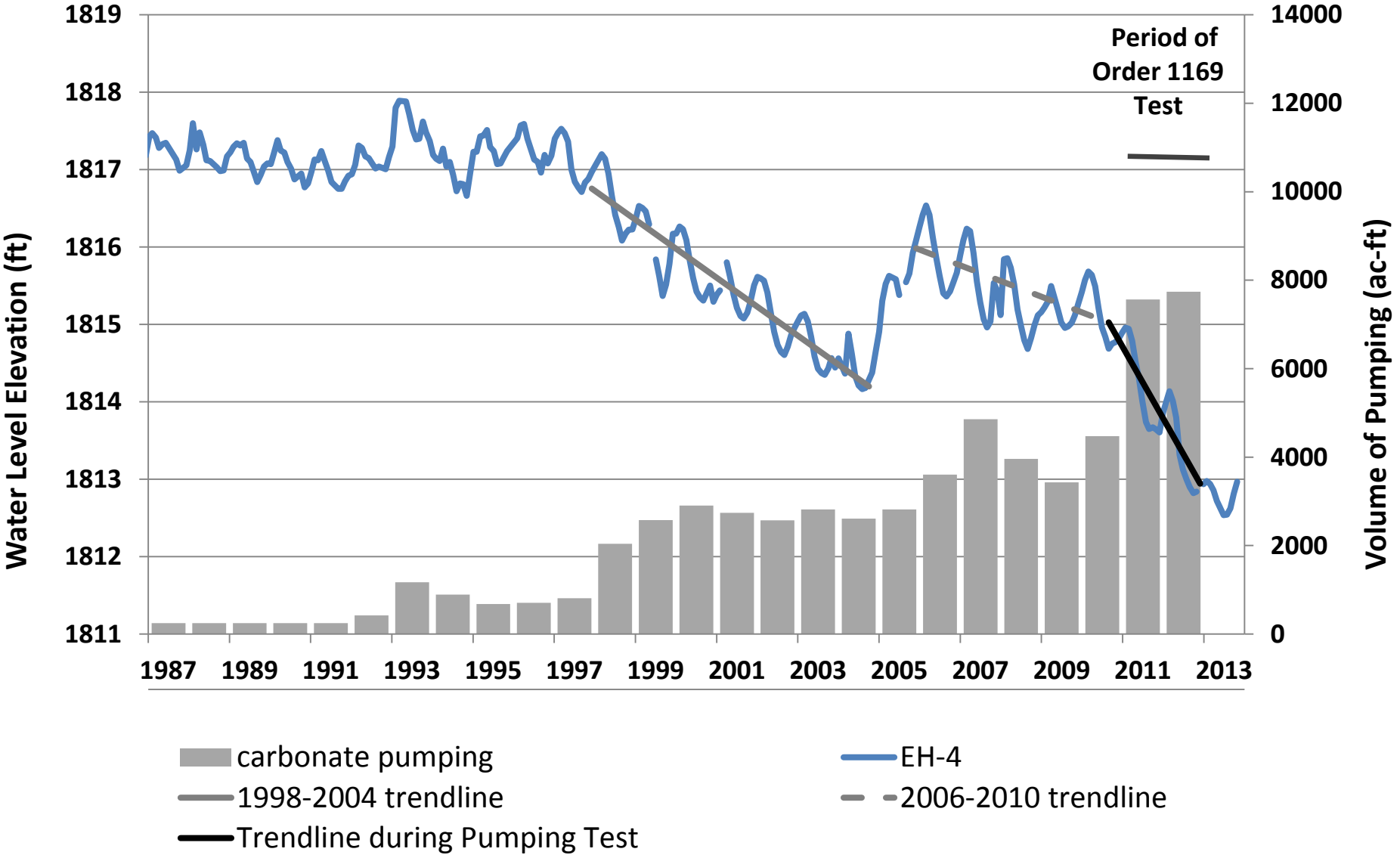

Pahranagat Valley
Kane Springs Valley
Tule Desert
Lower Meadow Valley Wash
Tikapoo Valley
Coyote Spring Valley
Virgin River Valley
CSVM-6
MX-4
Muddy River Springs Area
UMVM-1
EH-5B
EH-4
Moapa Valley NWR
Three Lakes Valley
Three Lakes Valley
CSVM-2
M-1
Lower Moapa Valley
Muddy River
Study Area
Hidden Valley
M-3
M-2
California Wash
Las Vegas Valley
Garnet Valley
Gold Butte Area
Black Mountains Area

Carbonate Water Level Elevations in the Order 1169 Study Area

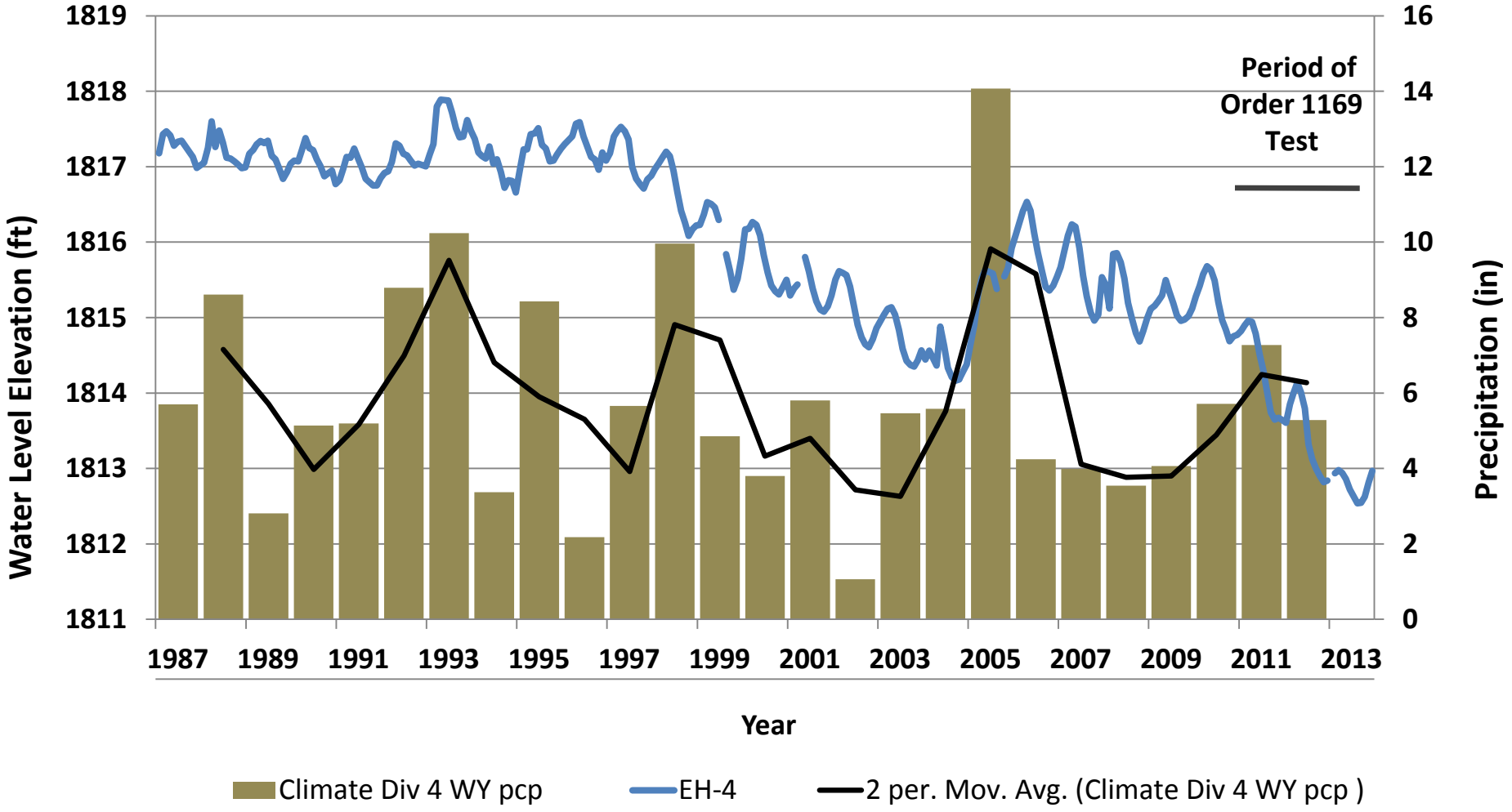


- Question: **What affects groundwater levels?**
  - **Pumping**
  - **Climate**

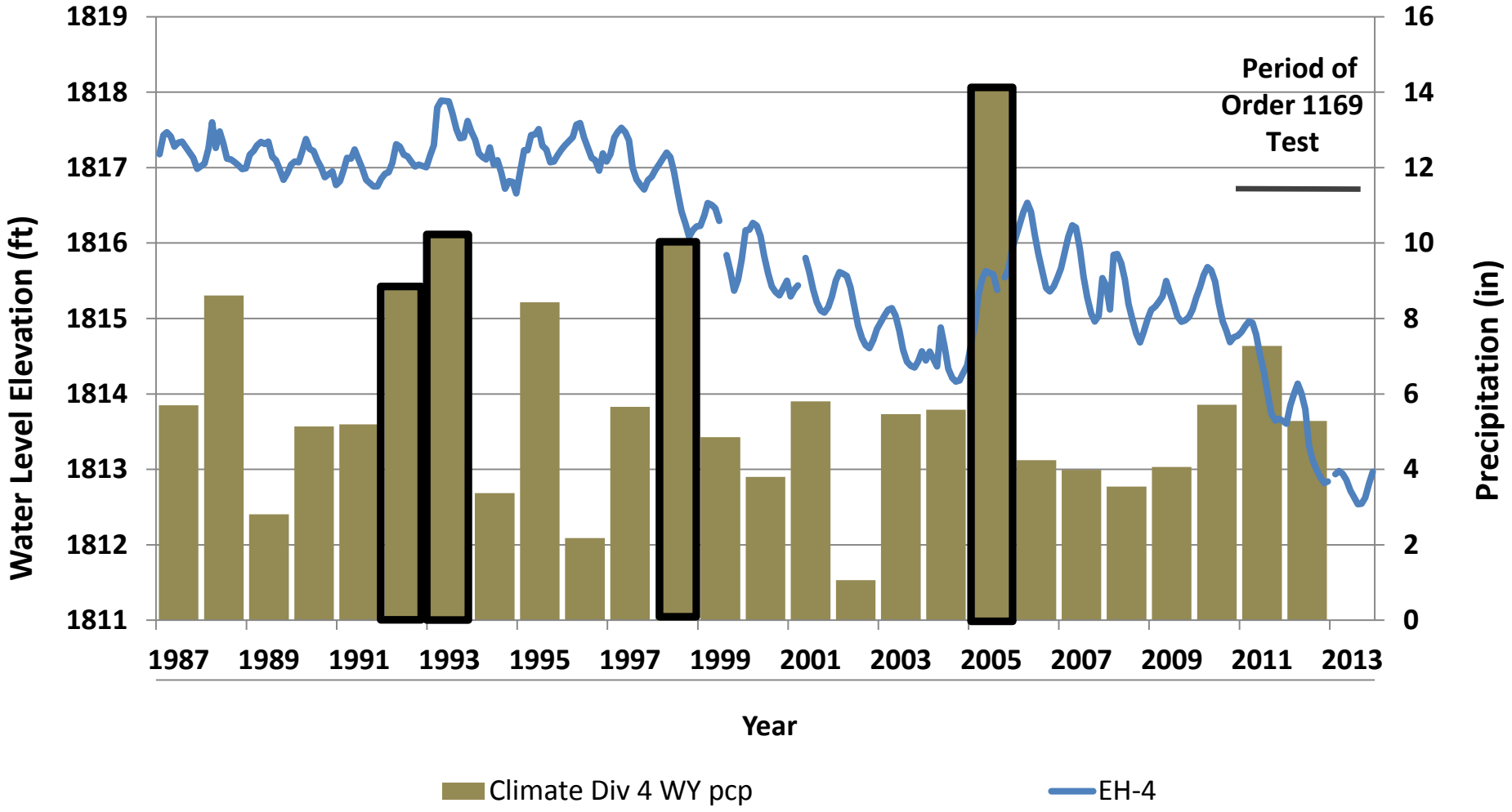
EH-4 Water Level Elevations and Carbonate Pumping Volumes



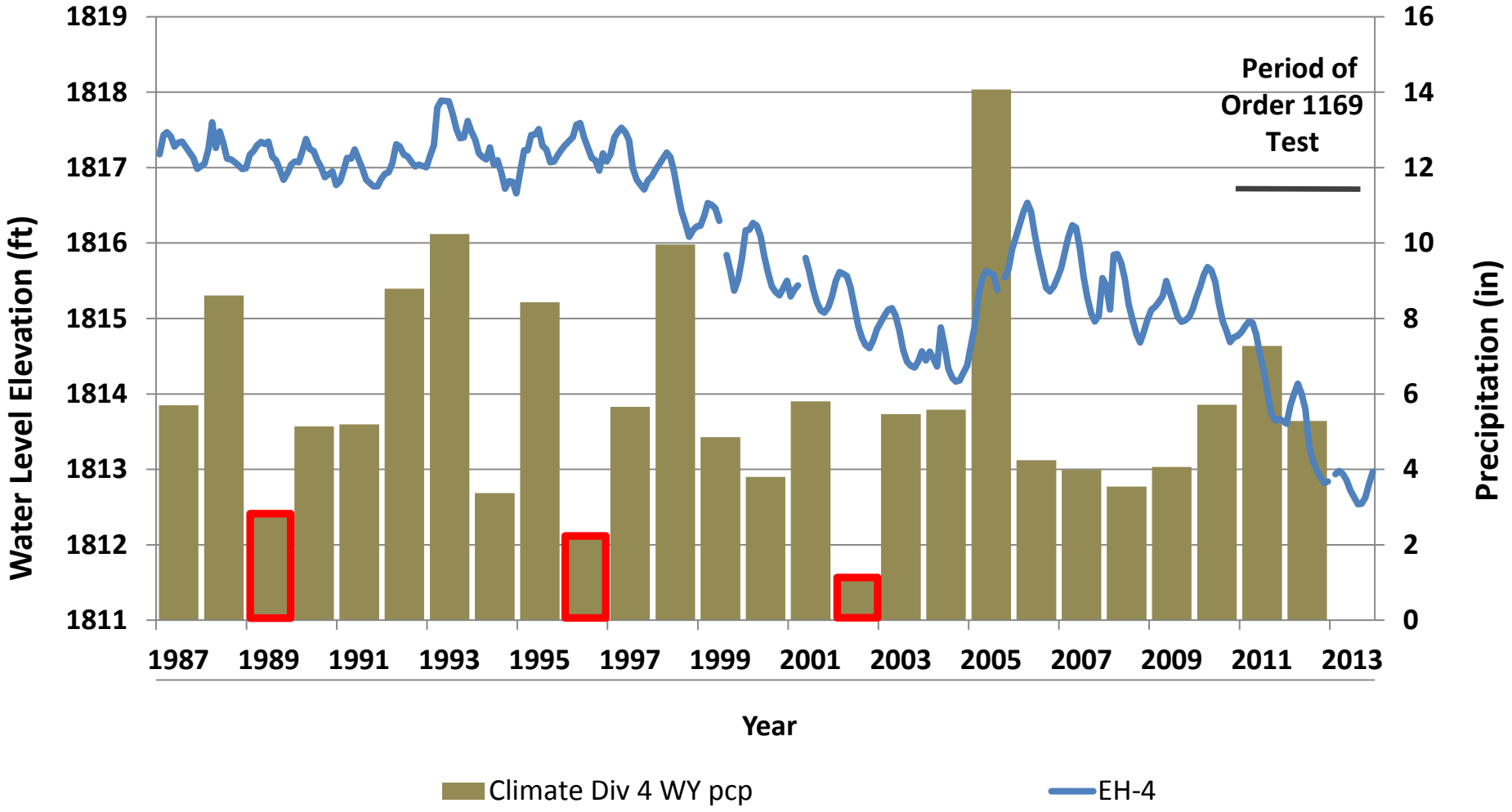
EH-4 Water Level Elevations and Annual Precipitation



EH-4 Water Level Elevations and Annual Precipitation



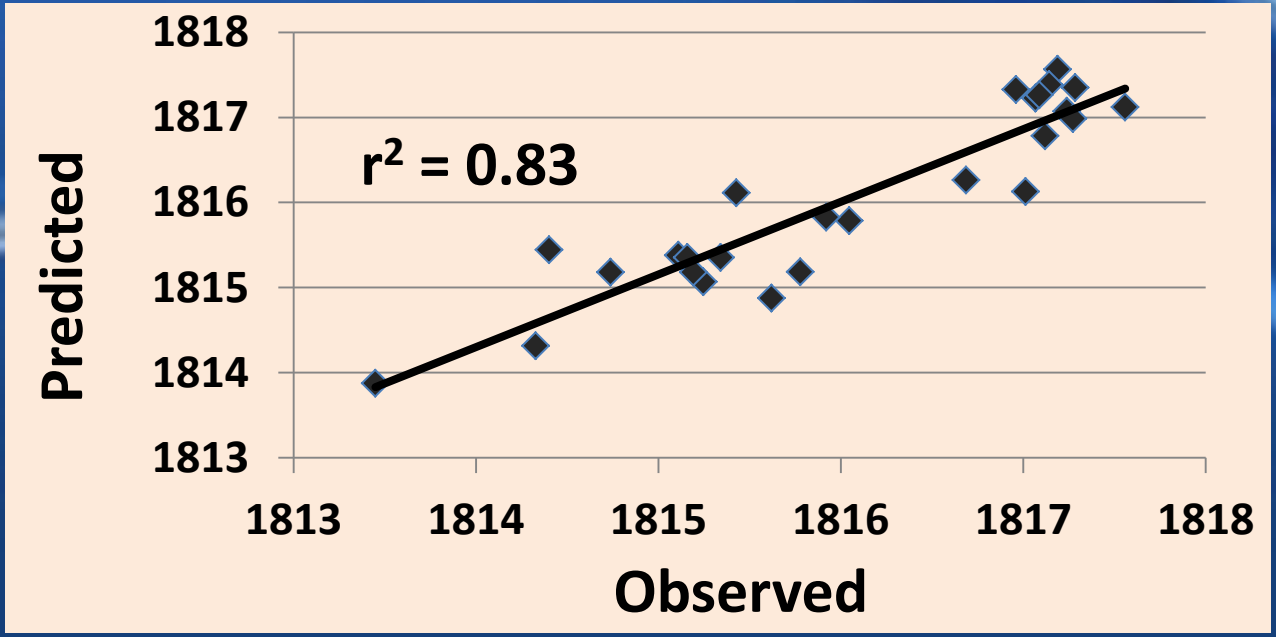
EH-4 Water Level Elevations and Annual Precipitation



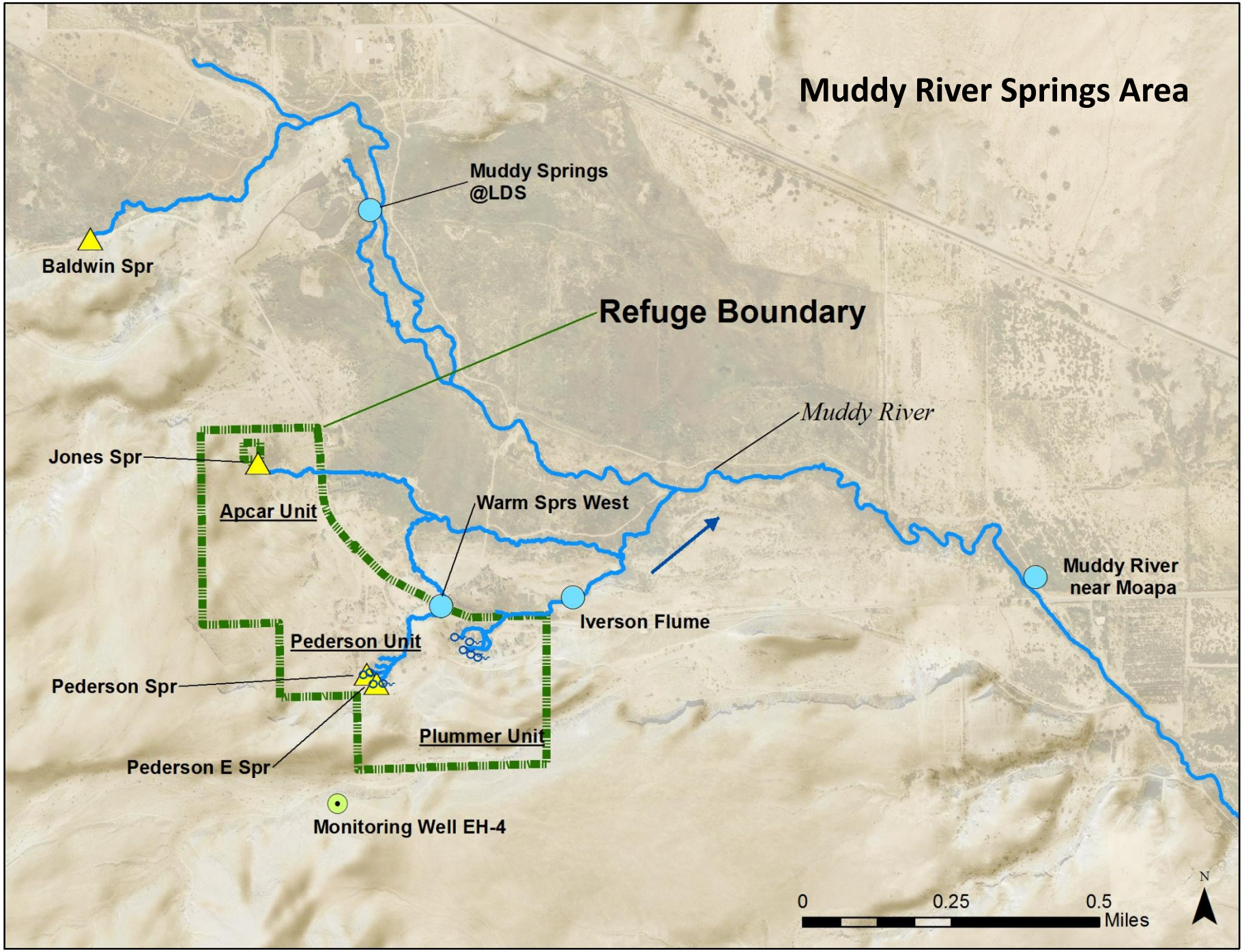
MULTIPLE REGRESSION

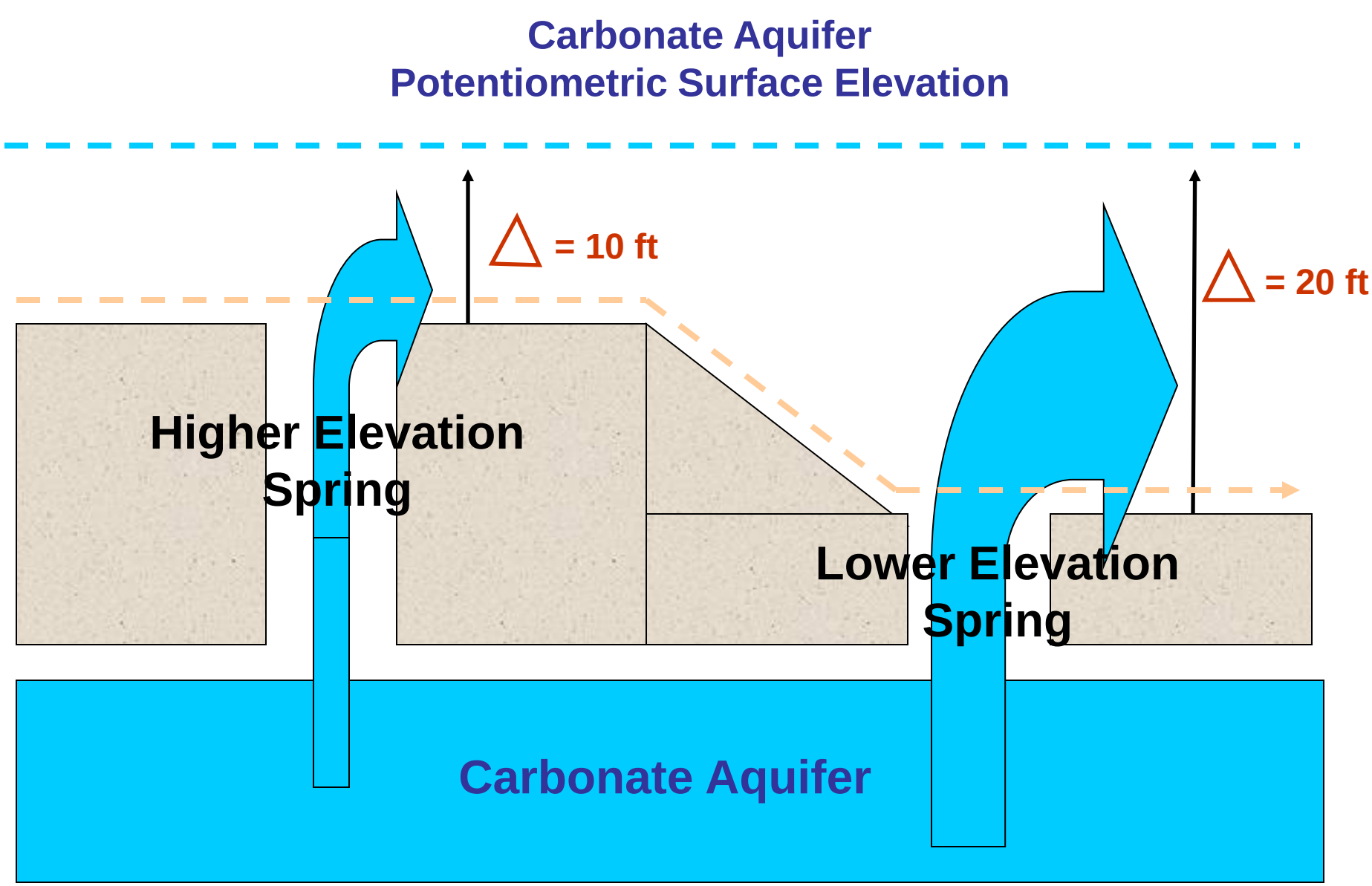
1987-2013 annual water levels in EH-4 predicted from:

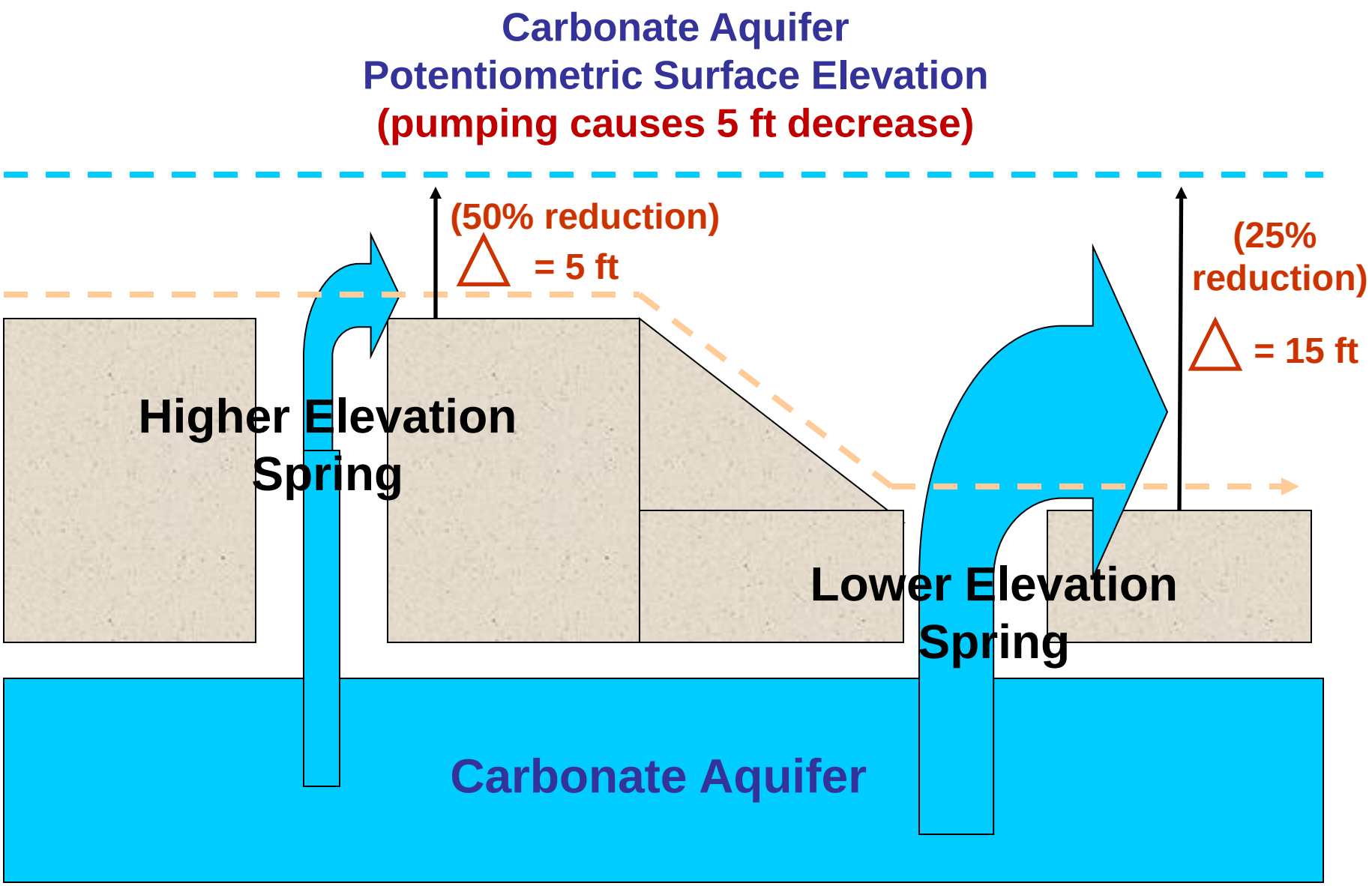
Annual carbonate pumping
Annual precipitation



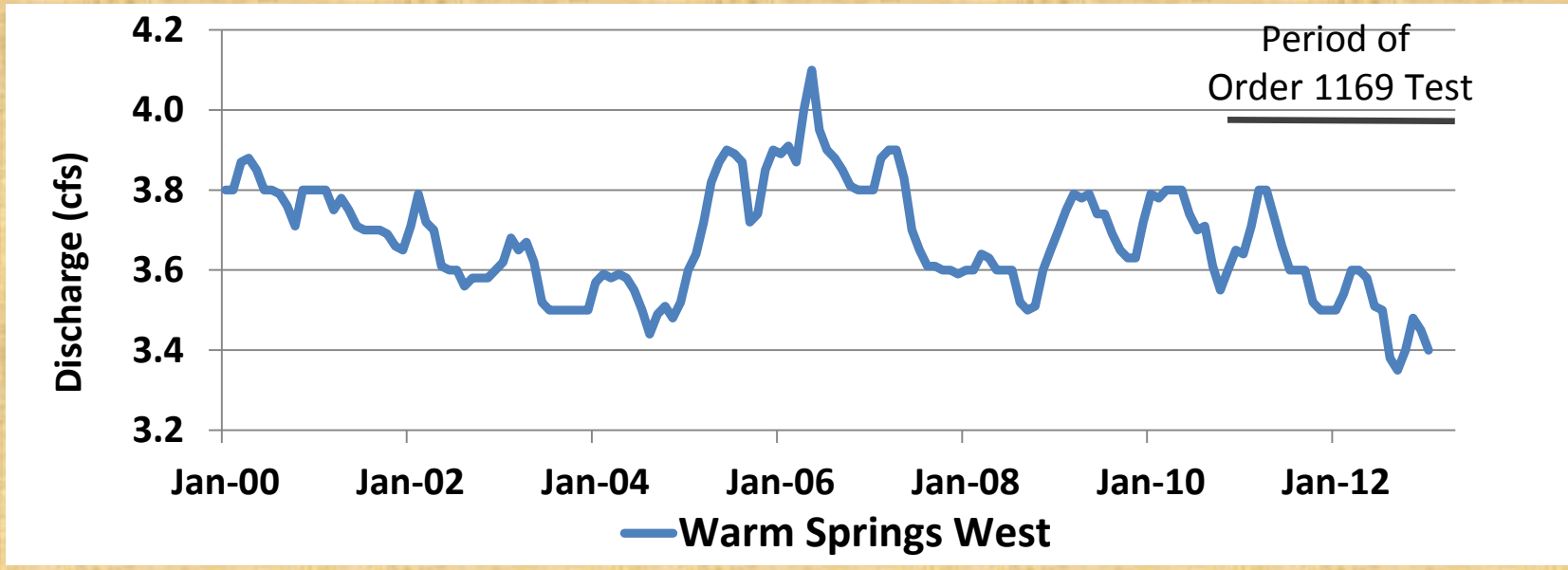
- Question: **How do springs respond to changes and trends in groundwater levels?**

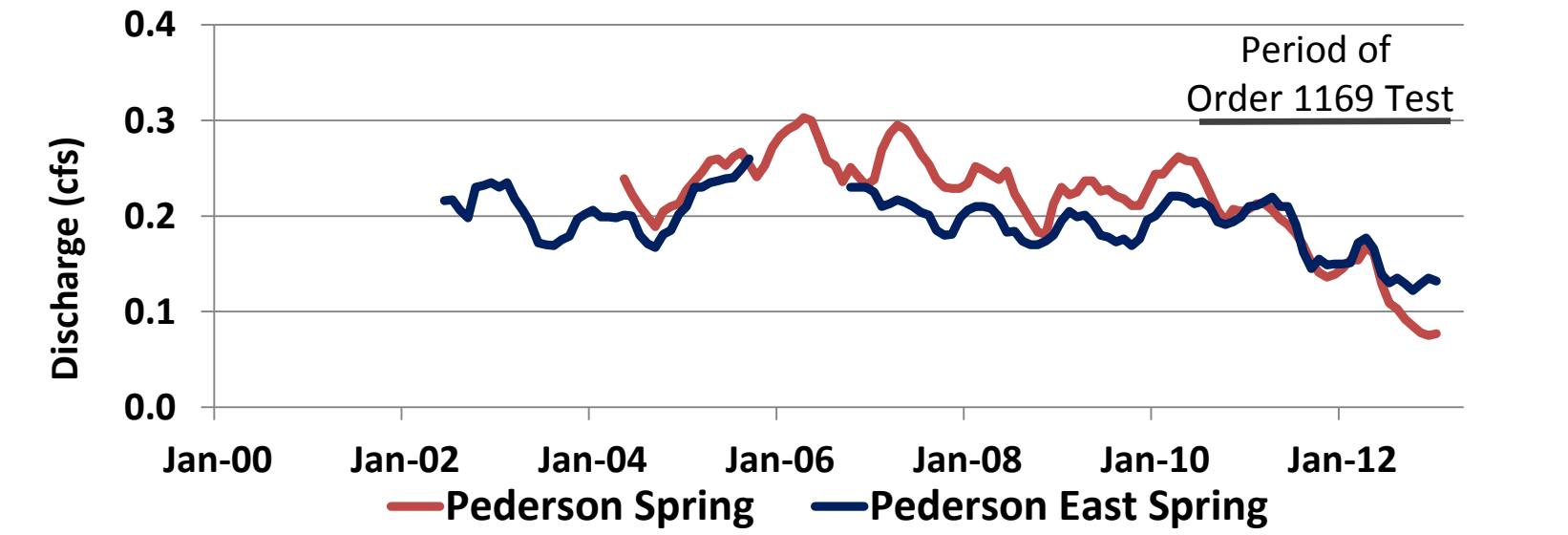

Muddy River Springs Area
Muddy Springs @LDS
Baldwin Spr
Refuge Boundary
Muddy River
Jones Spr
Apcar Unit
Warm Sprs West
Muddy River near Moapa
Iverson Flume
Pederson Unit
Pederson Spr
Plummer Unit
Pederson E Spr
Monitoring Well EH-4
0
0.25
0.5
Miles
N


Carbonate Aquifer
Potentiometric Surface Elevation
= 10 ft
= 20 ft
Higher Elevation
Spring
Lower Elevation
Spring
Carbonate Aquifer

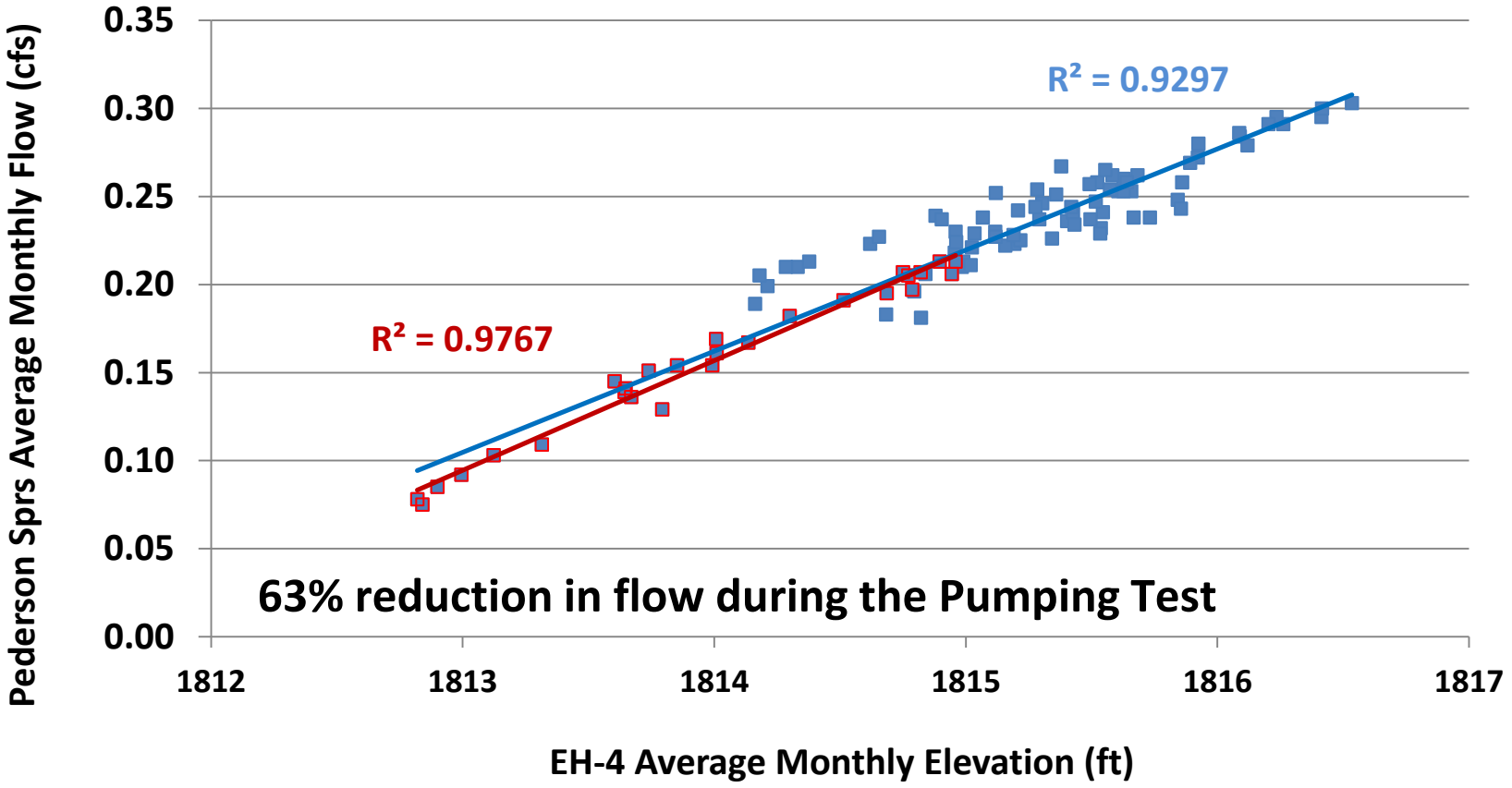

Carbonate Aquifer
Potentiometric Surface Elevation
(pumping causes 5 ft decrease)
(50% reduction)
= 5 ft
(25% reduction)
= 15 ft
Higher Elevation Spring
Lower Elevation Spring
Carbonate Aquifer

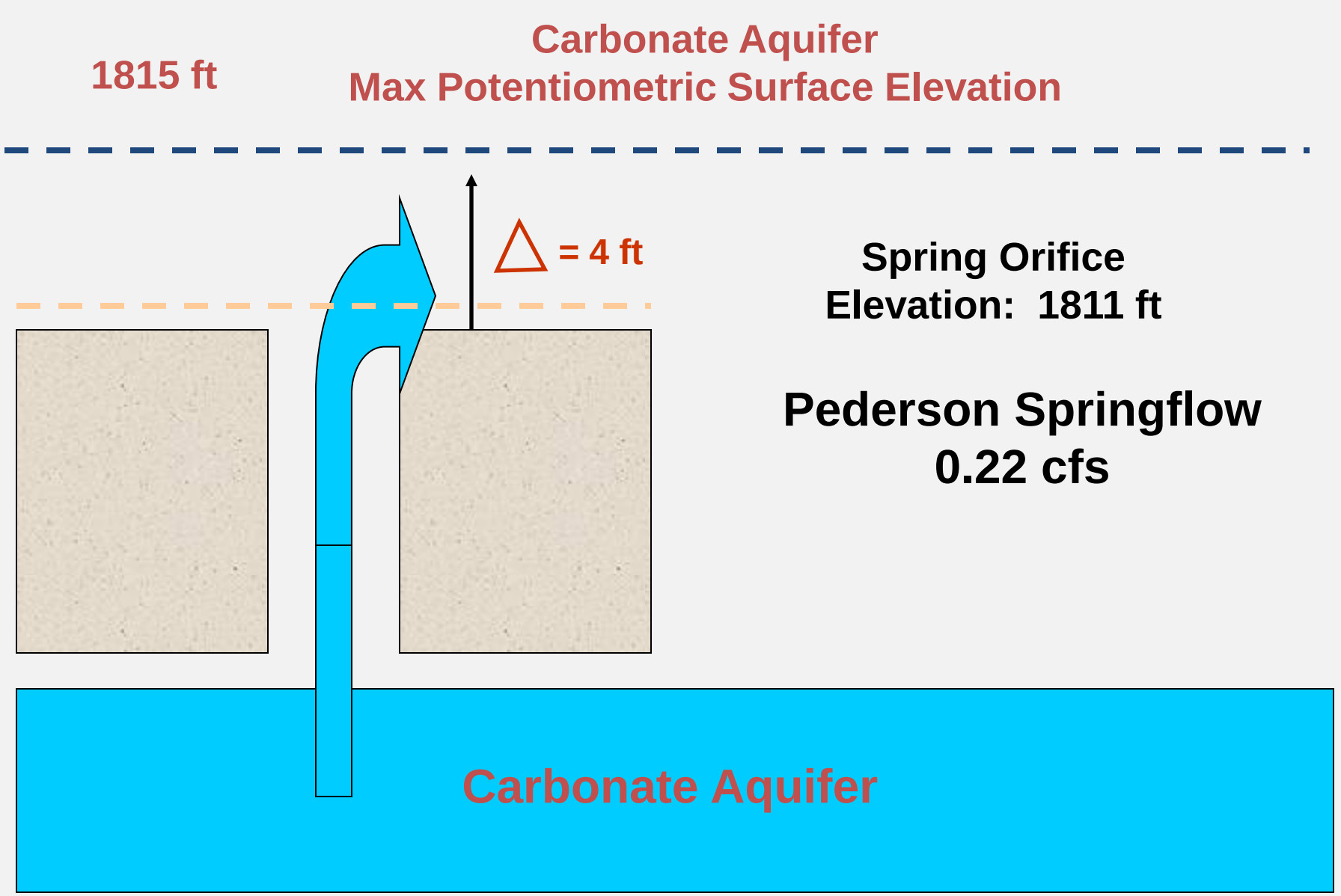
Warm Springs West, Pederson Spring, Pederson East Spring Discharge 2000 - 2012





Regression of Monthly Discharge and Monthly GW Levels
Pederson Spring 2004 - 2012

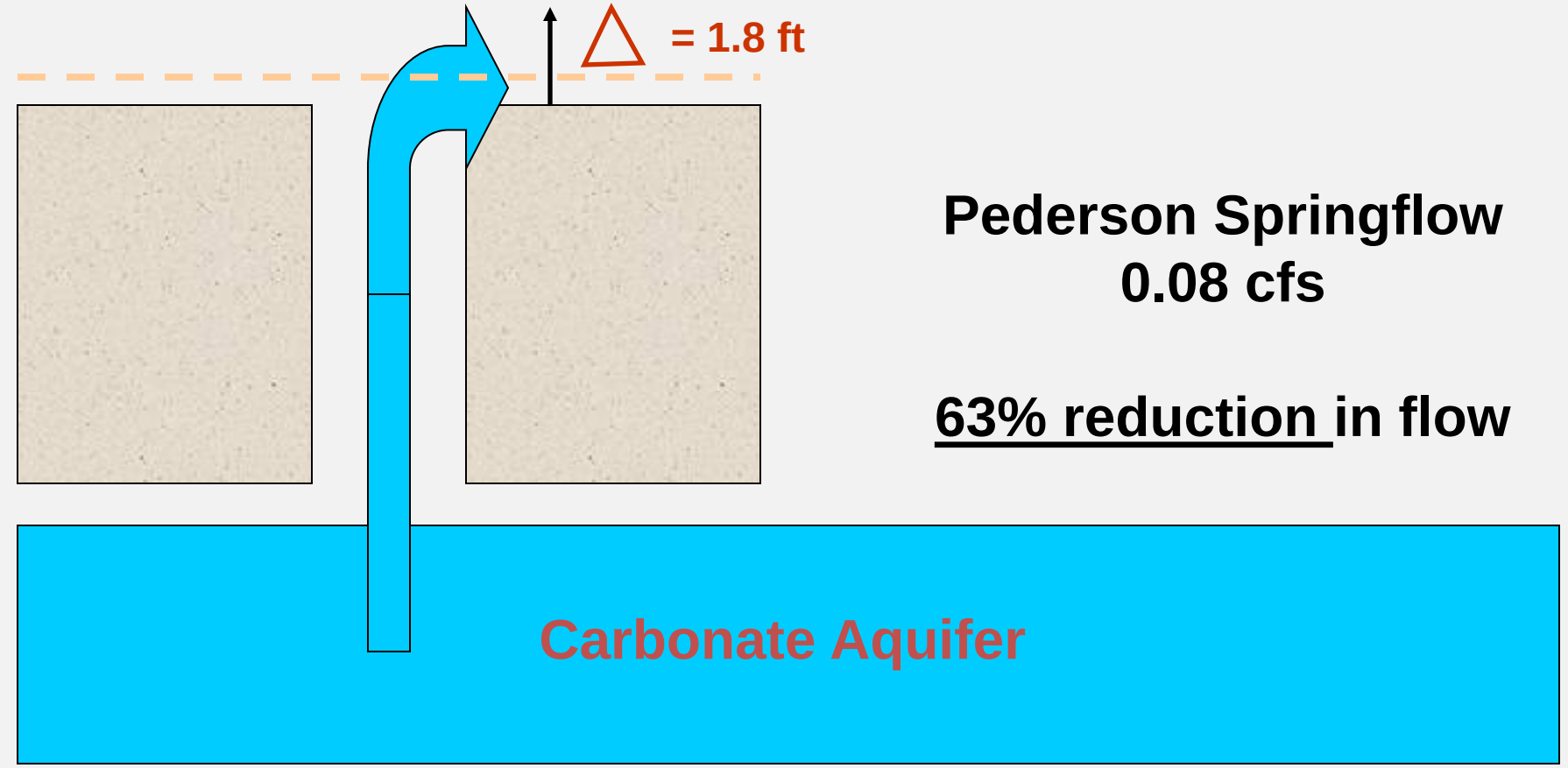



1815 ft
Carbonate Aquifer
Max Potentiometric Surface Elevation
= 4 ft
Spring Orifice
Elevation: 1811 ft
Pederson Springflow
0.22 cfs
Carbonate Aquifer

Carbonate Aquifer
Min Potentiometric Surface Elevation

1812.8 ft

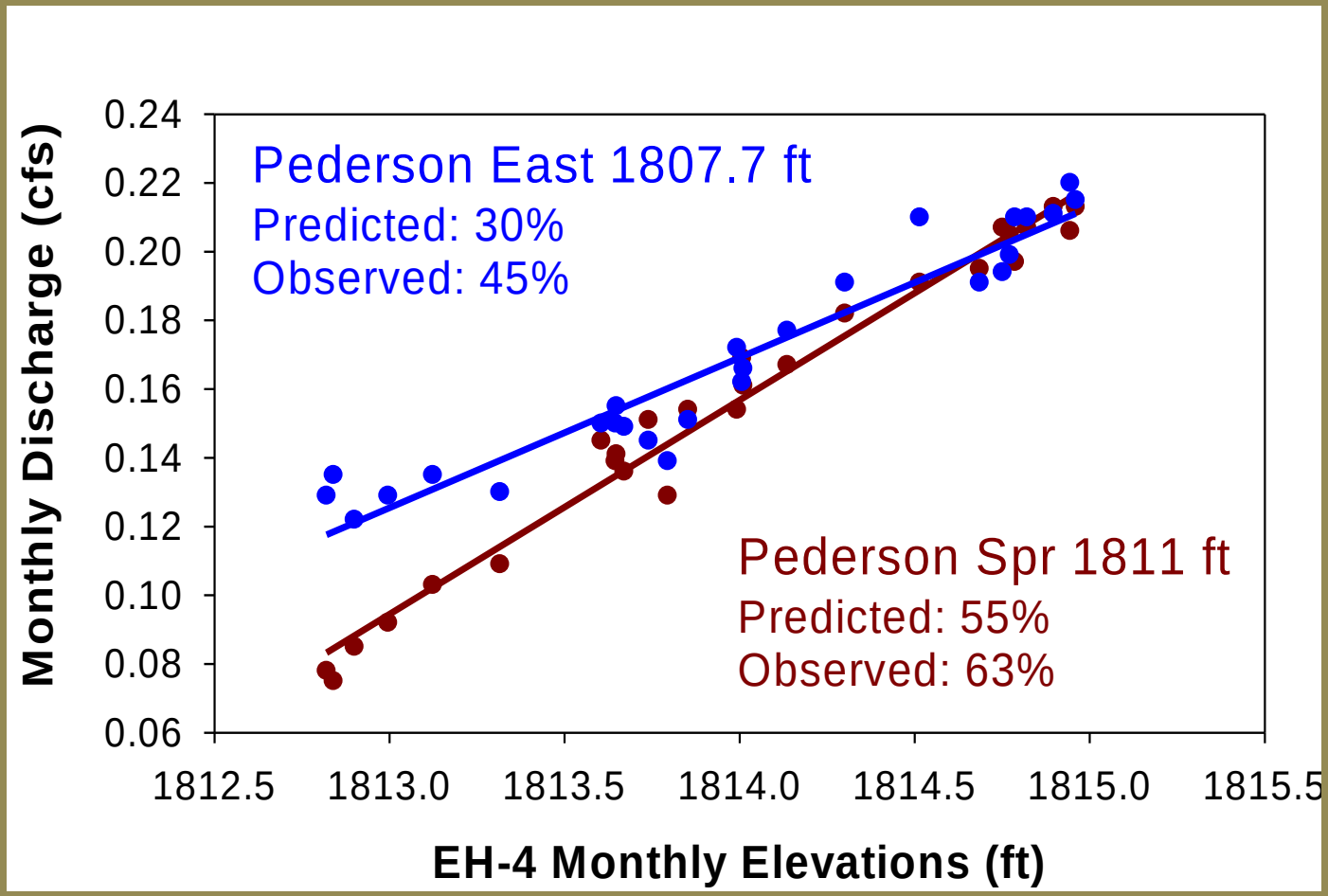
55% reduction in head



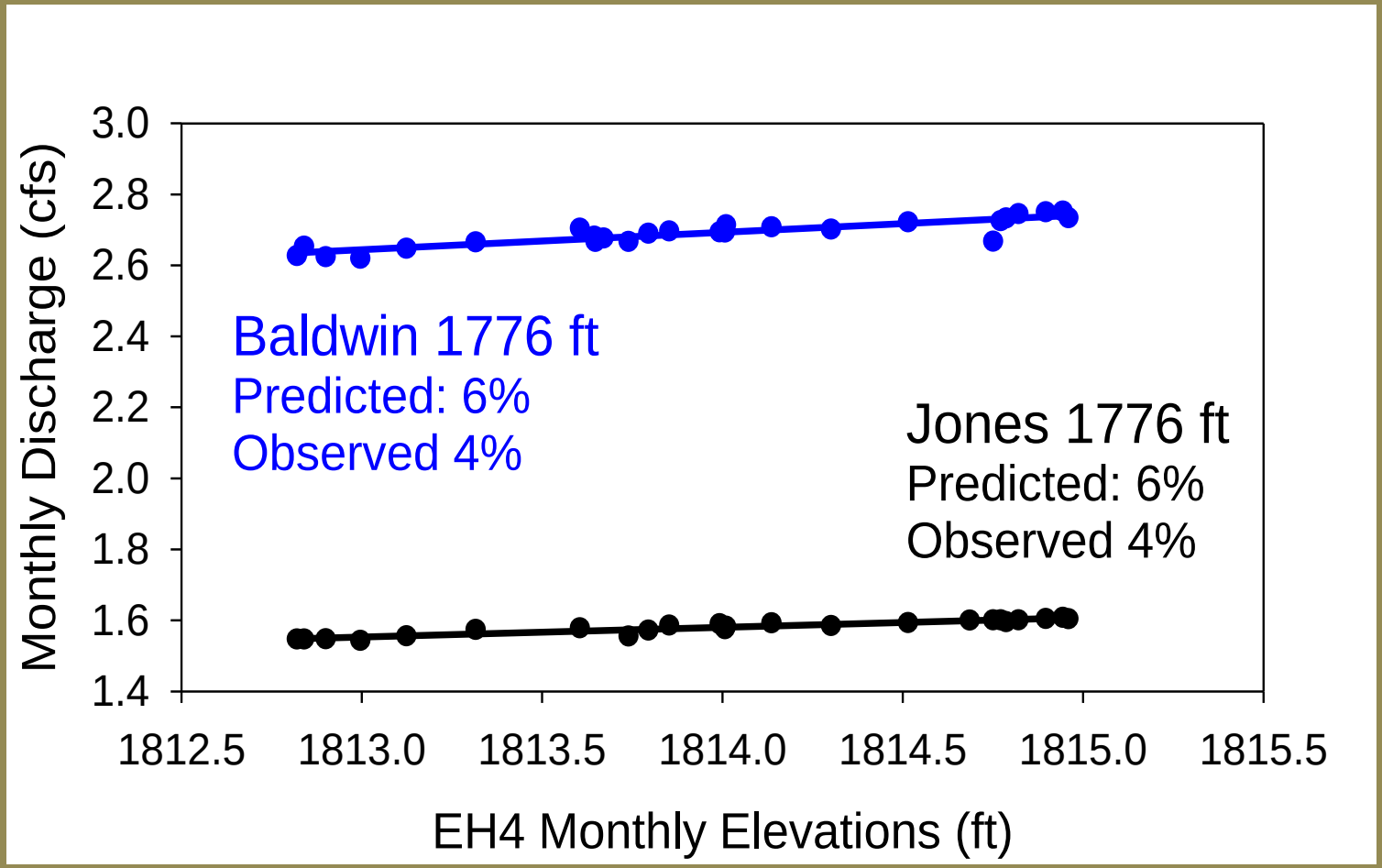
Pederson Springflow
0.08 cfs

63% reduction in flow

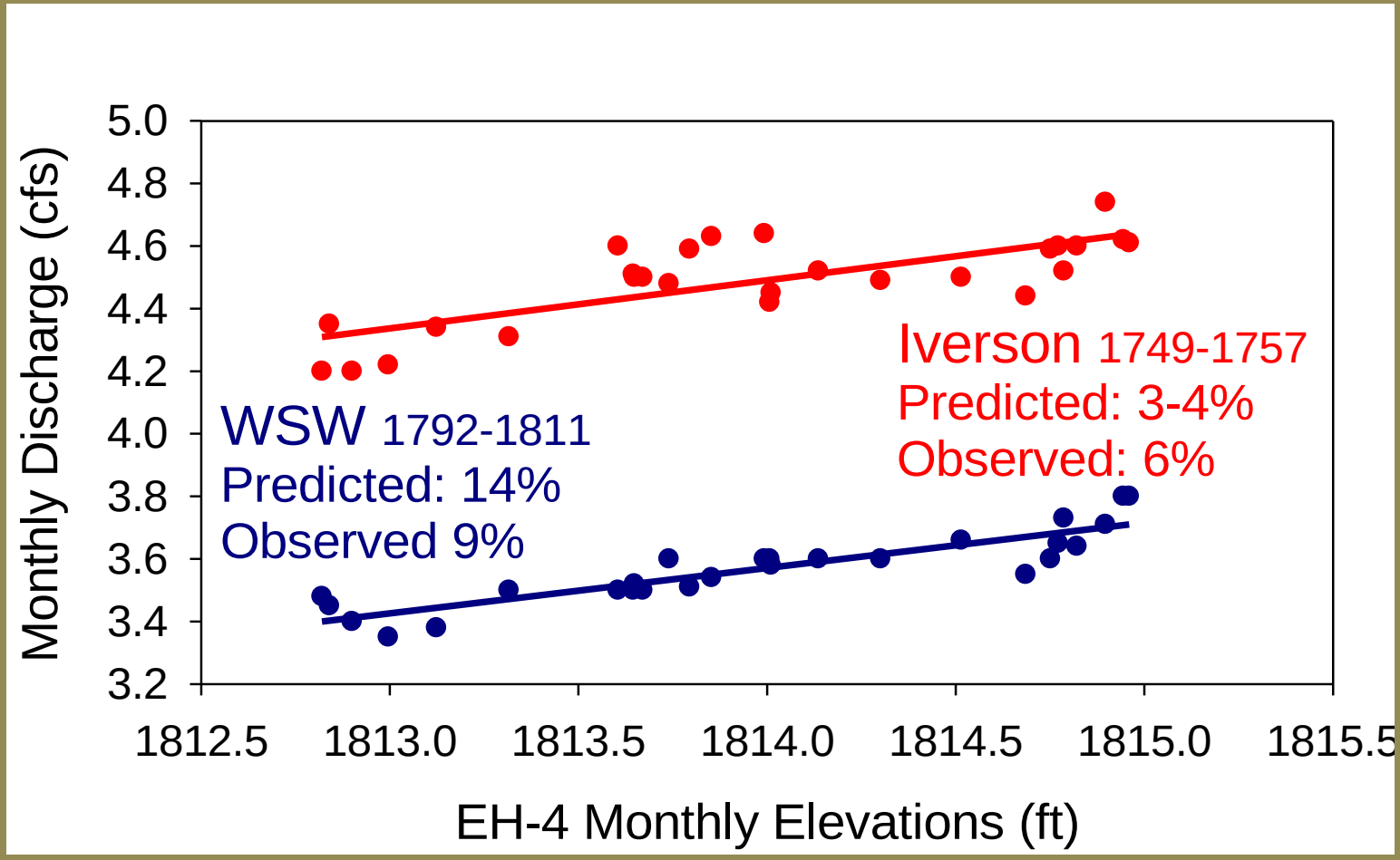
Higher Elevation Springs
Pederson and Pederson East Springs
Oct 2010 to Dec 2012



Lower Elevation Springs
Baldwin Spring and Jones Spring
Oct 2010 to Dec 2012



Flow Monitoring Sites
Warm Springs West and Iverson Flume
Oct 2010 to Dec 2012



Conclusions

- Higher elevation springs are more sensitive.
- Total flow reductions, observed and predicted:

  0.77 cfs versus 0.83 cfs
- Most pumping came from storage.
- Only 1/3 of the total appropriated volume in Coyote Spring Valley was pumped.