Analysis of Trends in Climate , Stream Flow, and Stream Temperature in North Coastal California Park Units

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NPS Vital Signs Monitoring Networks

Monitoring:

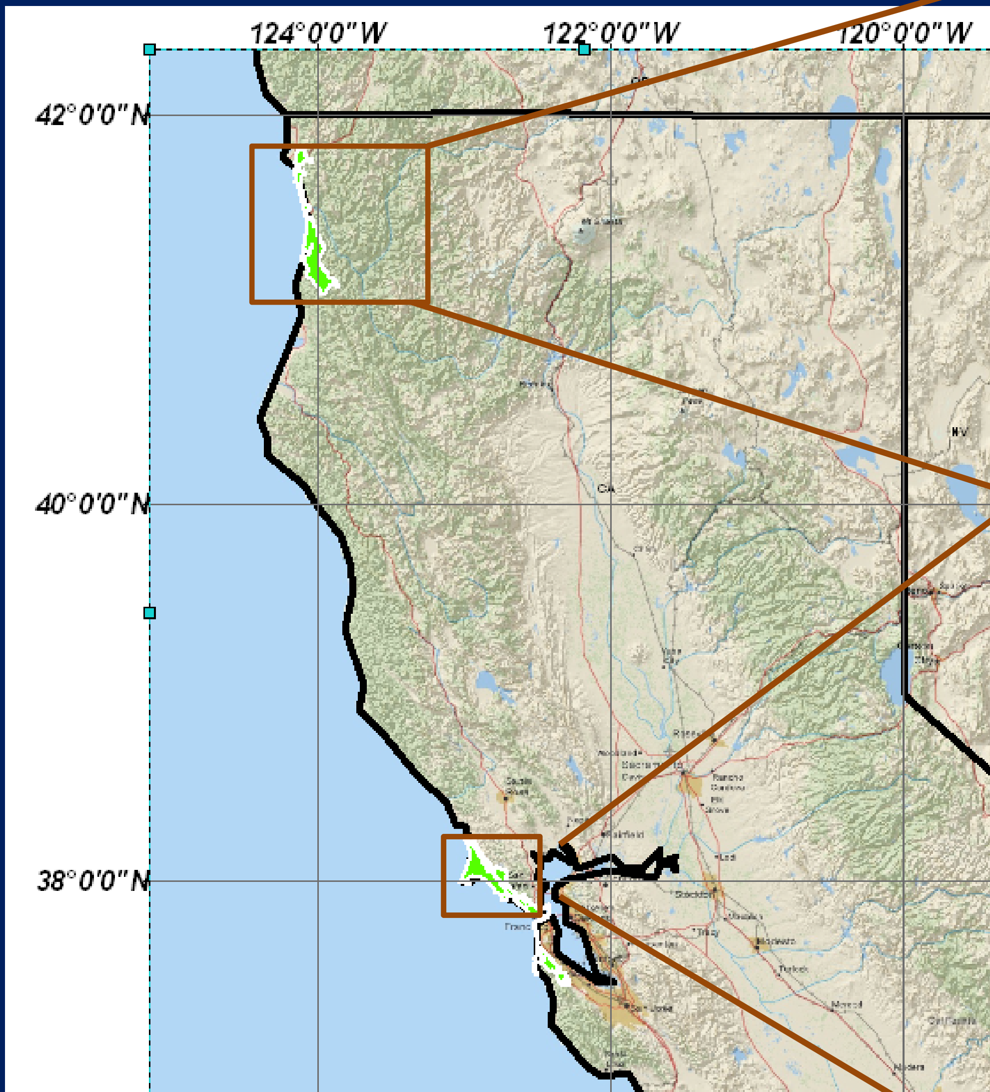
Temperature
Precipitation
Stream Flow
Vegetation
Fish

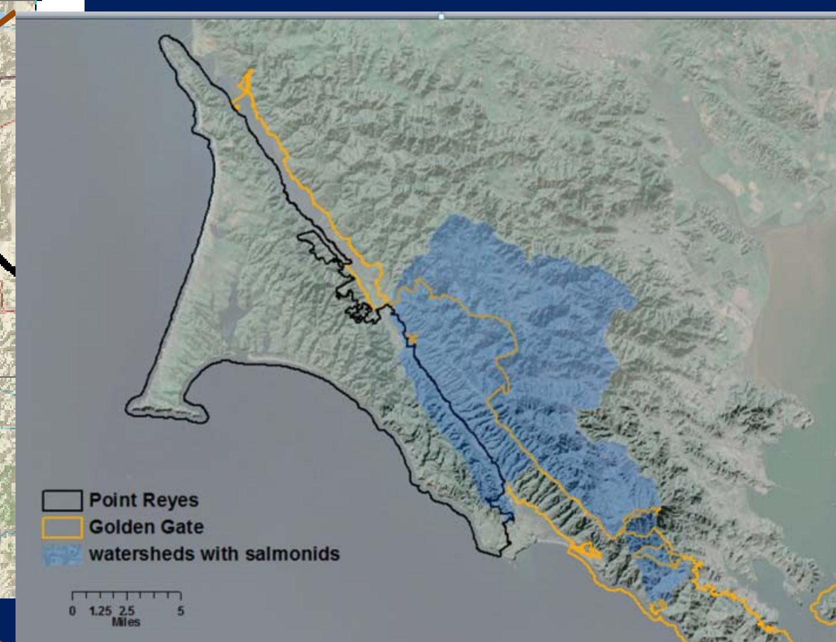
USGS

Possible Climate Impacts

- Change in seasonal and annual air temperature
- Change in seasonal and annual precipitation
- Change in timing and amount of runoff
  - (fish migration, estuary dynamics)
- Reduction of coastal fog
- Increase in stream temperature
- Increased frequency of extreme events
- Change in vegetation (and evapotranspiration)

Challenges – Park lands are "islands"





Focusing on Freshwater Phase

Fall First Flows

Adults return to spawn

Need to exceed minimum flows for migration

Winter Peak Flows

Eggs incubating in redds

- High flow scours redds
- Eggs/juveniles washed out
- Channel morphology changed
- Fine sediments flushed out

Summer Dry-down

Parr → 1 yr → 2 yr Smolt

-Enough winter & spring PPT to replenish groundwater?

-Adequate pools for rearing

Spring Run-off

Fry → Parr → Smolt

- If high flow & no side channels fry & parr wash out
- Fog/PPT trigger smolt to ocean?
- SUNNY → Algal blooms

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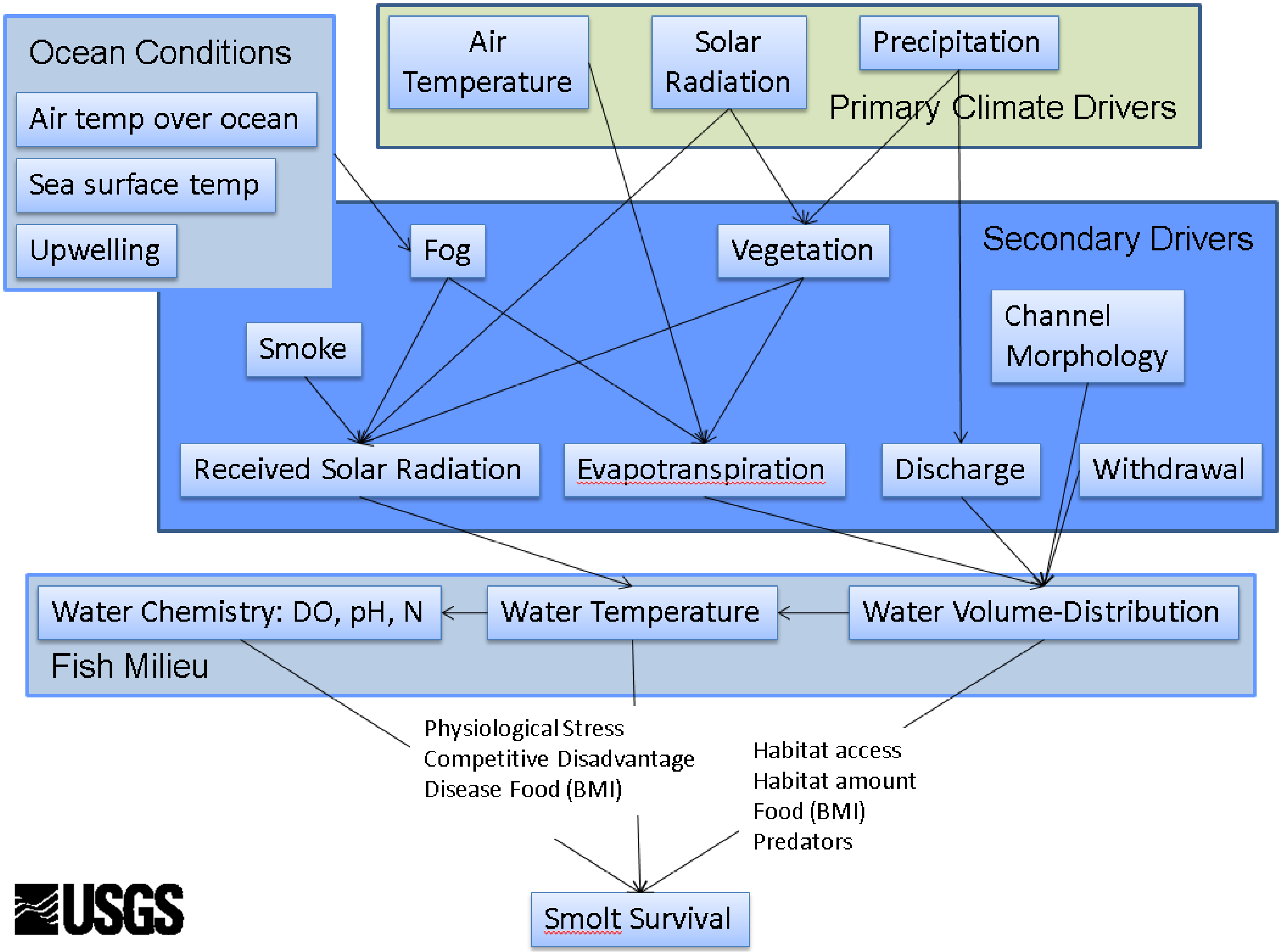
Summer Model



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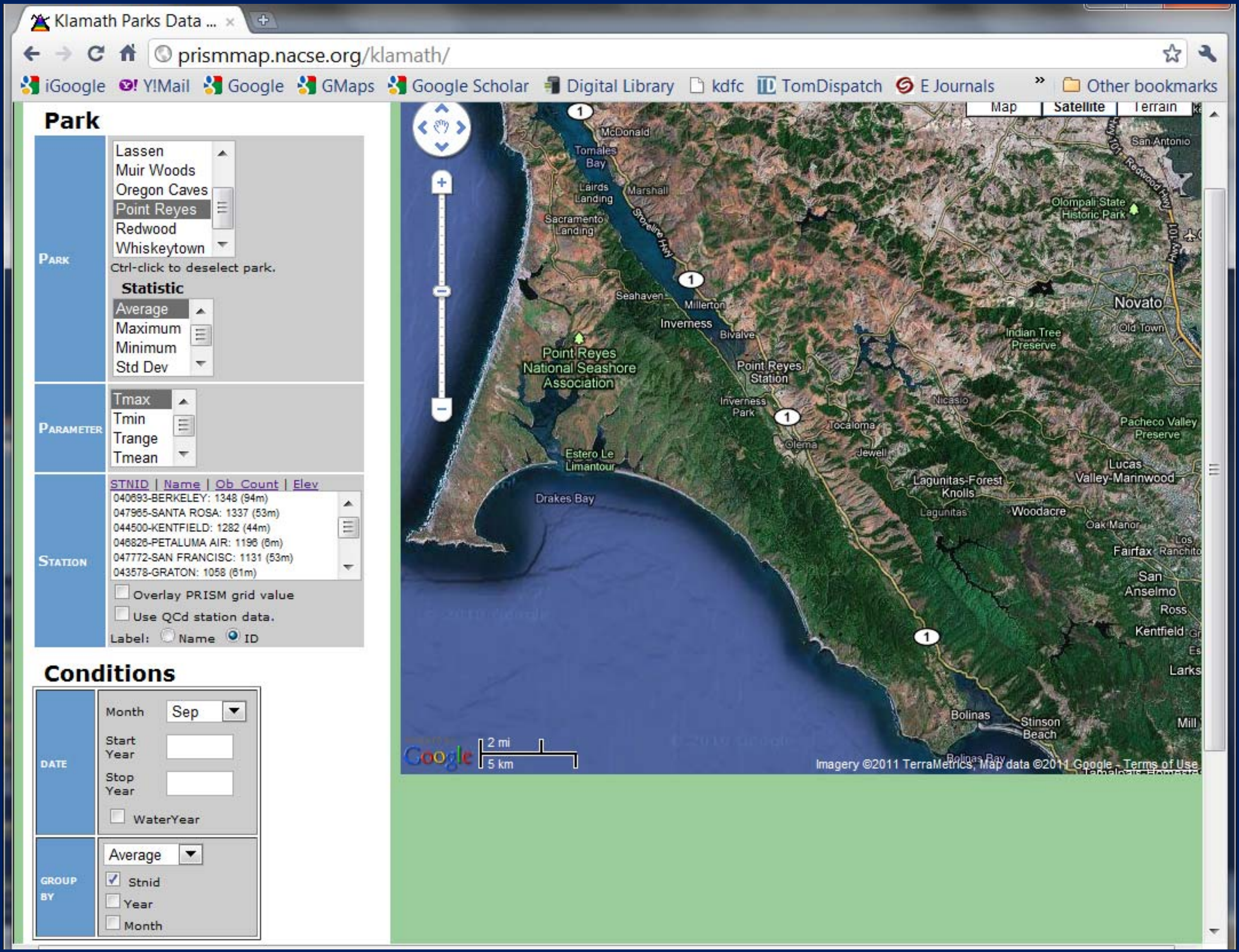
Step 1: Assess Trends in Climate

http://prismmap.nacse.org/klamath



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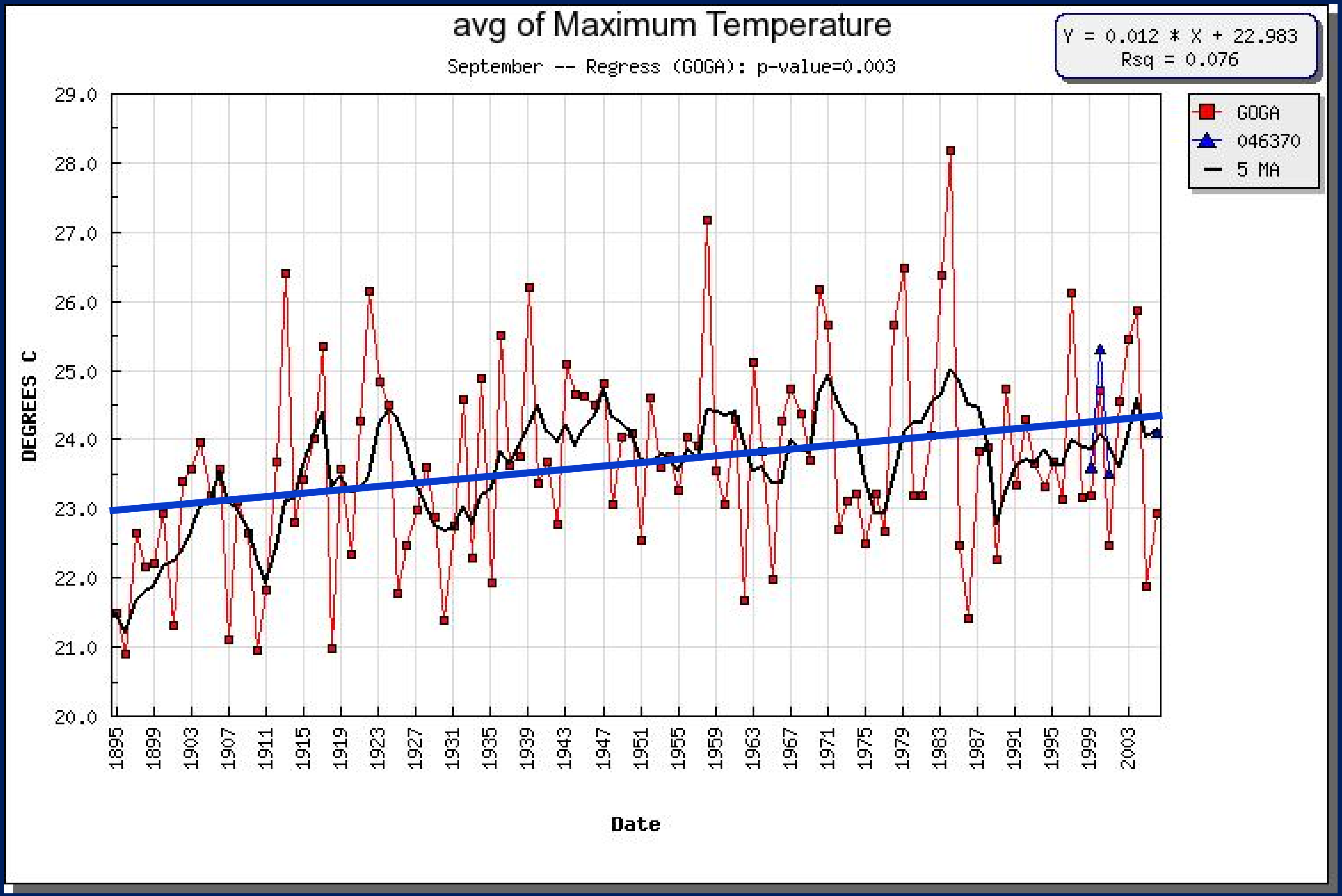
Average Maximum Air Temperature- September Golden Gate NRA, 1895 – 2004



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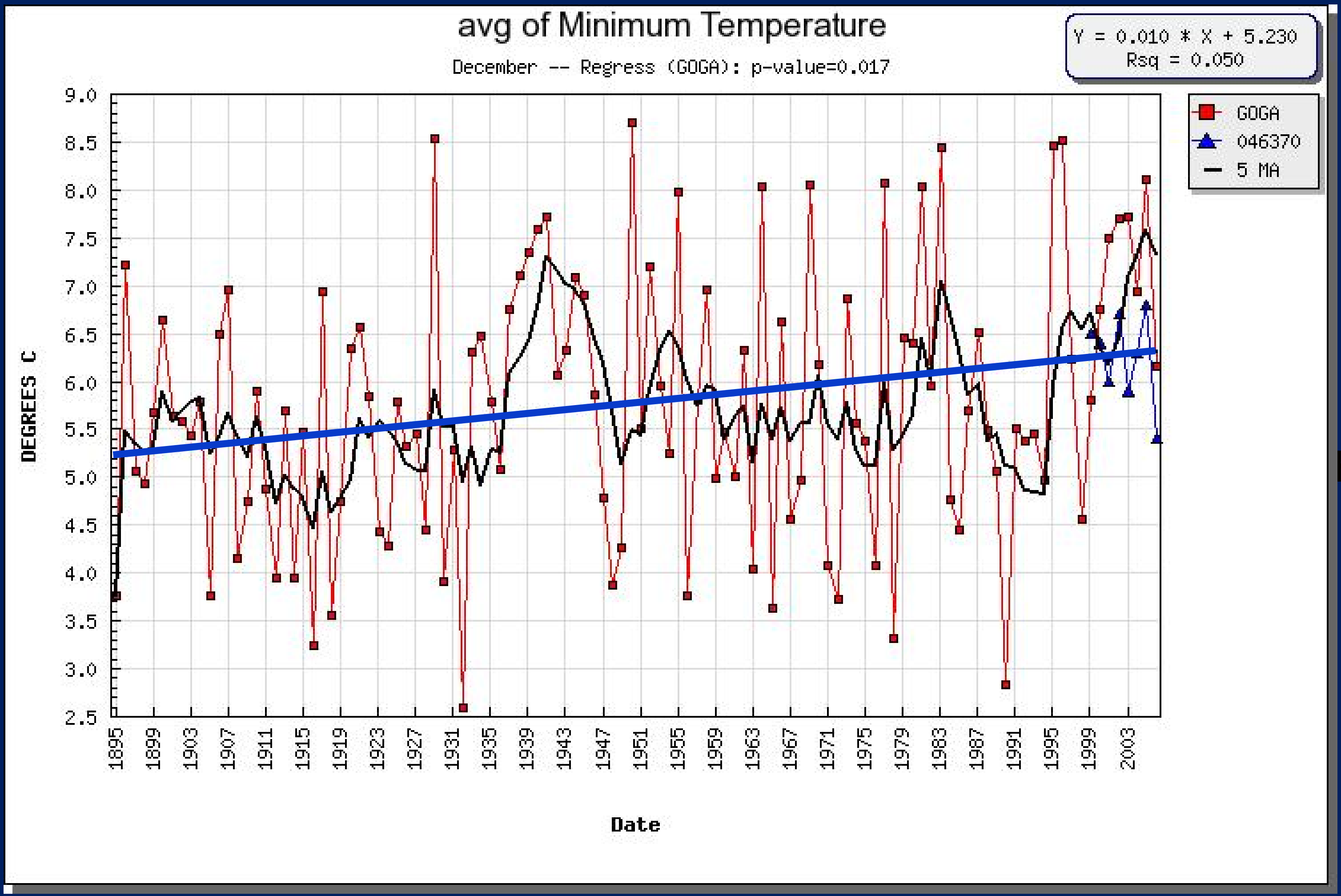
Average Minimum Air Temperature- December Golden Gate NRA, 1895 – 2004



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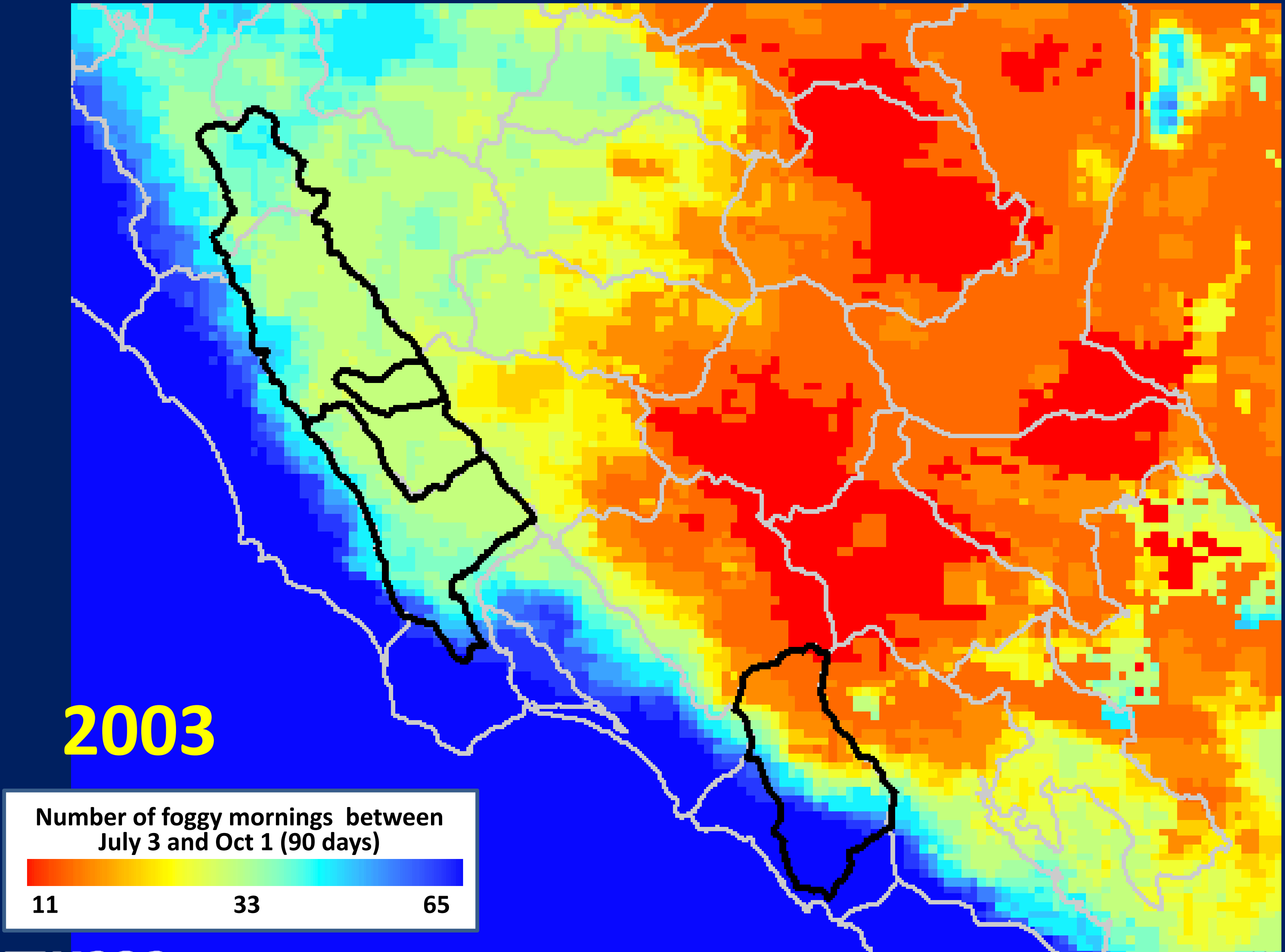
Summer fog is critical to redwood ecology

From National Geographic



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Data from Park Williams, UCSB

Average Daily Max Air Temperature By Month: 1895 – 2004

P values	REDW	GOGA	PORE	MUWO
Average Maximum Temperature	1895-2007	1895-2007	1895-2007	1895-2007
January	↑ 0.051-0.10	↑ <0.01	↑ <0.01	↑ <0.01
Feburary	not significant	↑ <0.01	↑ 0.011-0.05	↑ <0.01
March	not significant	↑ <0.01	↑ 0.011-0.05	↑ <0.01
April	↓ 0.011-0.05	not significant	not significant	↑ 0.051-0.10
May	not significant	↑ <0.01	↑ <0.01	↑ <0.01
June	not significant	not significant	not significant	not significant
July	not significant	not significant	not significant	not significant
August	not significant	↑ <0.01	↑ <0.01	↑ 0.051-0.10
September	not significant	↑ <0.01	↑ <0.01	↑ 0.011-0.05
October	not significant	↑ <0.01	↑ <0.01	↑ <0.01
November	↓ 0.011-0.05	not significant	not significant	not significant
December	not significant	↑ 0.011-0.05	not significant	not significant

	decreasing trend	increasing trend
<0.01	↓	↑
0.011-0.05	↓	↑
0.051-0.10	↓	↑
not significant	▭	▭

USGS

Average Daily Min Air Temperature By Month: 1895 – 2004

P values	REDW	GOGA	PORE	MUWO
Average Min Temperature	1895-2007	1895-2007	1895-2007	1895-2007
January	not significant	not significant	not significant	↑ (0.051-0.10)
Feburary	not significant	not significant	↑ (0.051-0.10)	↑ (0.011-0.05)
March	not significant	↑ (0.011-0.05)	↑ (<0.01)	↑ (<0.01)
April	not significant	↑ (0.051-0.10)	↑ (<0.01)	↑ (<0.01)
May	not significant	↑ (<0.01)	↑ (<0.01)	↑ (<0.01)
June	not significant	↑ (<0.01)	↑ (<0.01)	↑ (<0.01)
July	not significant	↑ (<0.01)	↑ (<0.01)	↑ (<0.01)
August	↑ (0.051-0.10)	↑ (<0.01)	↑ (<0.01)	↑ (<0.01)
September	not significant	↑ (<0.01)	↑ (<0.01)	↑ (<0.01)
October	not significant	↑ (<0.01)	↑ (<0.01)	↑ (<0.01)
November	not significant	↑ (0.011-0.05)	↑ (0.011-0.05)	↑ (0.011-0.05)
December	not significant	↑ (0.011-0.05)	↑ (0.011-0.05)	↑ (<0.01)

	decreasing trend	increasing trend
<0.01	↓	↑
0.011-0.05	↓	↑
0.051-0.10	↓	↑
not significant	▭	▭

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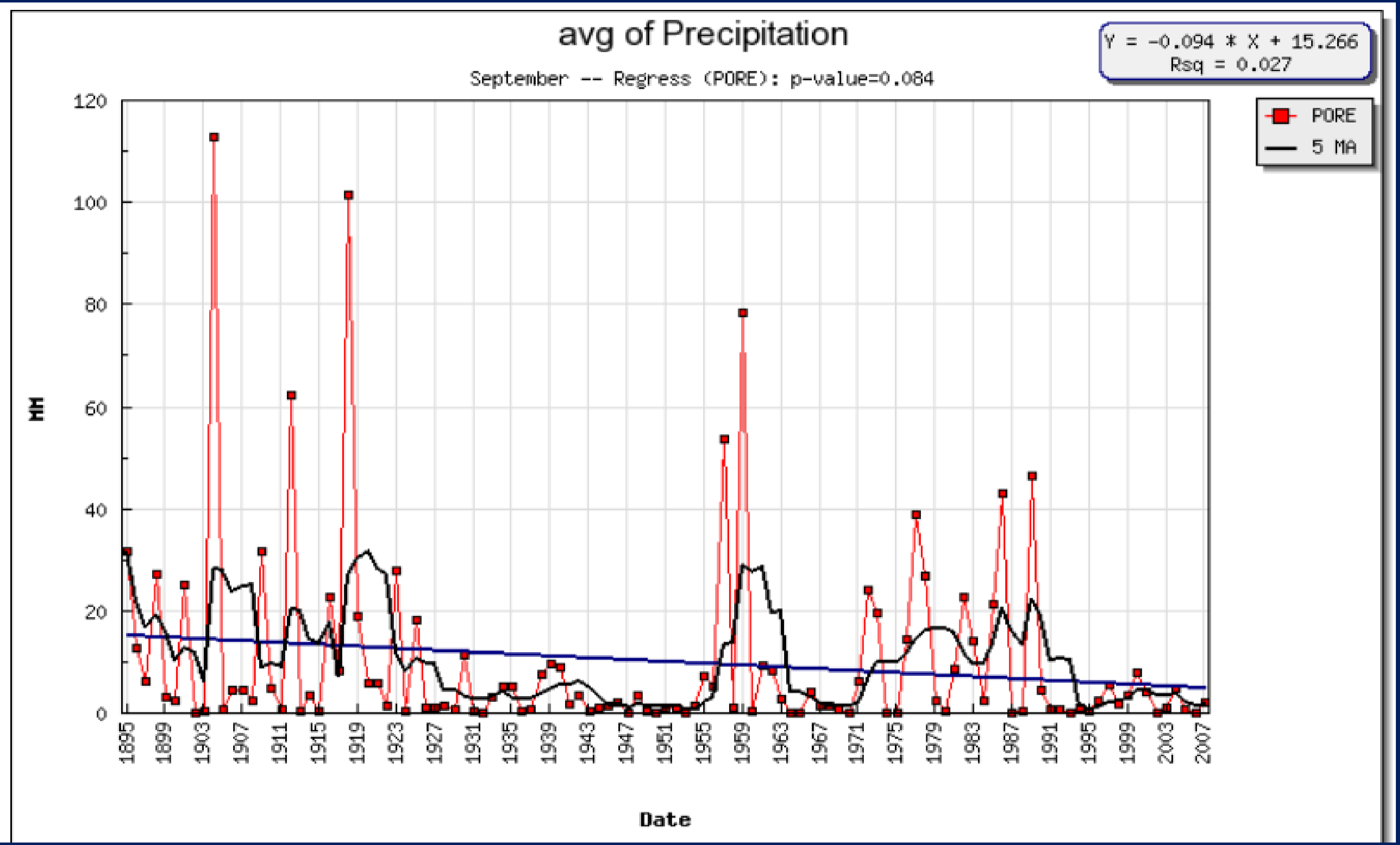
September Precipitation, PORE

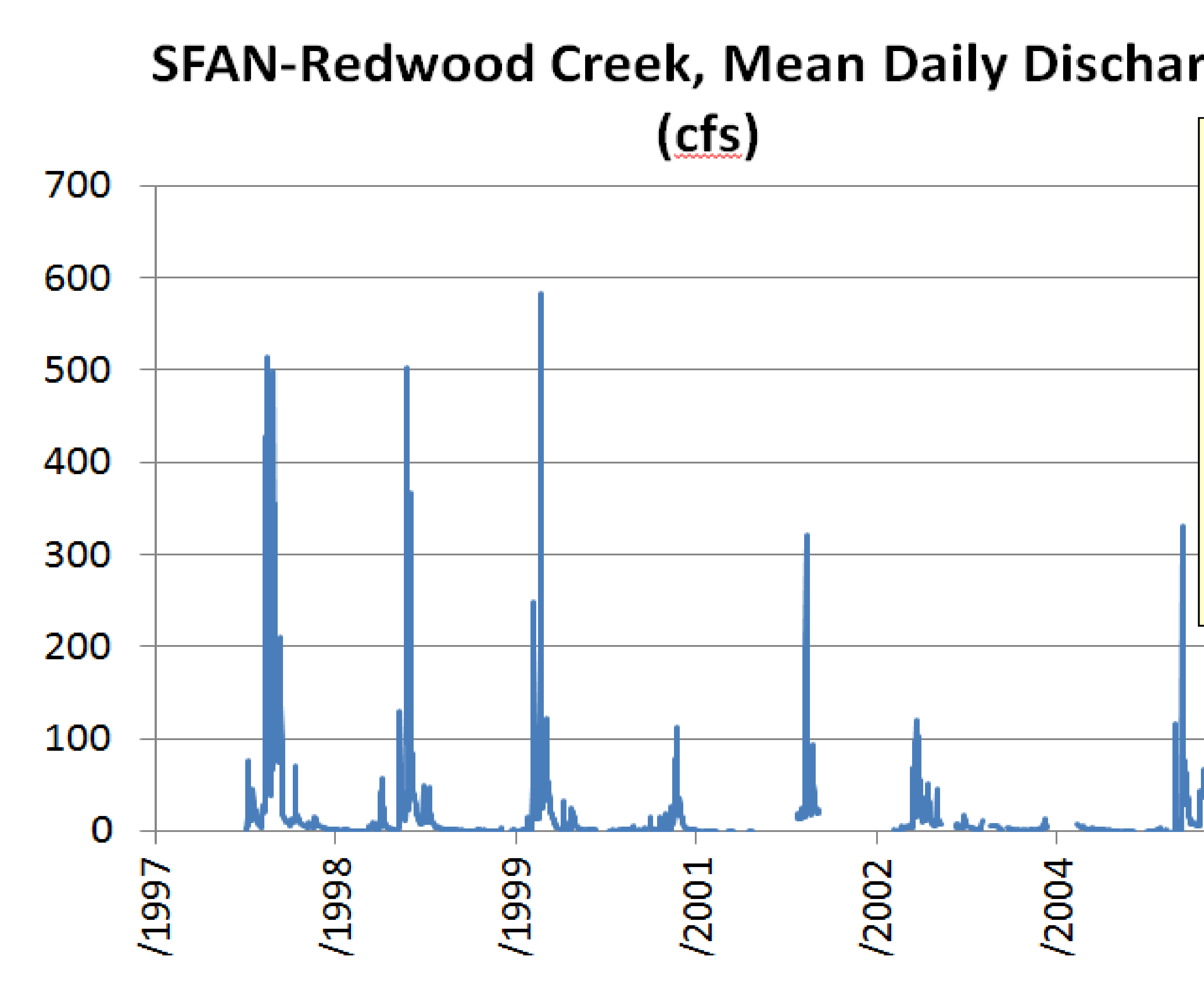


Average Monthly Precipitation 1895 – 2004

P values	REDW	GOGA	PORE	MUWO
Average Precipitation	1895-2007	1895-2007	1895-2007	1895-2007
January				↓
Feburary				
March				
April				
May				
June				
July				
August				↑
September	↓	↓	↓	↓
October				
November				
December				↑

	decreasing trend	increasing trend
<0.01	↓	↑
0.011-0.05	↓	↑
0.051-0.10	↓	↑
not significant		

Step 2: Assess Trends in Runoff



Analysis:

Peak flows

Timing of flows

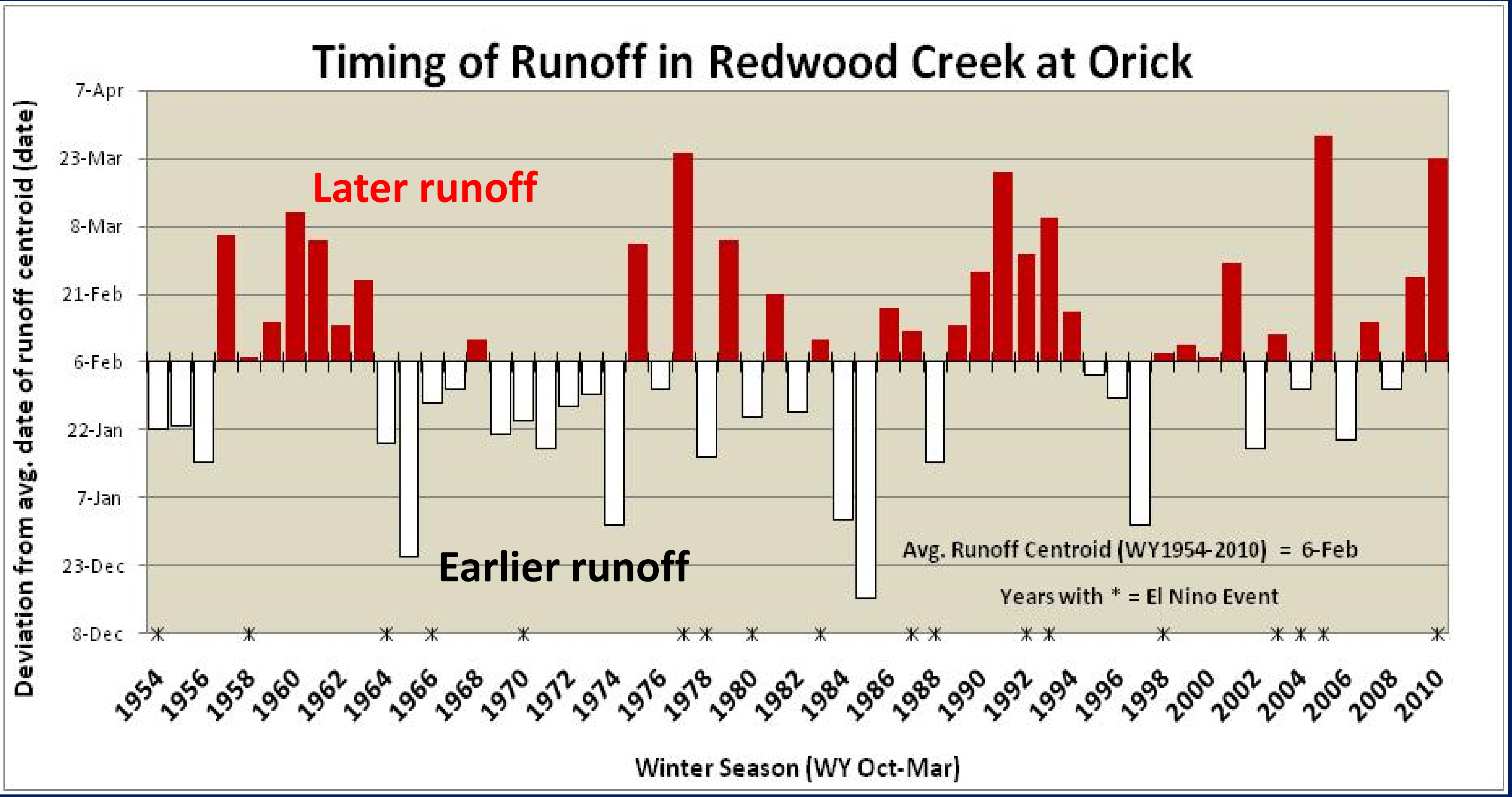
Low flows

Total runoff

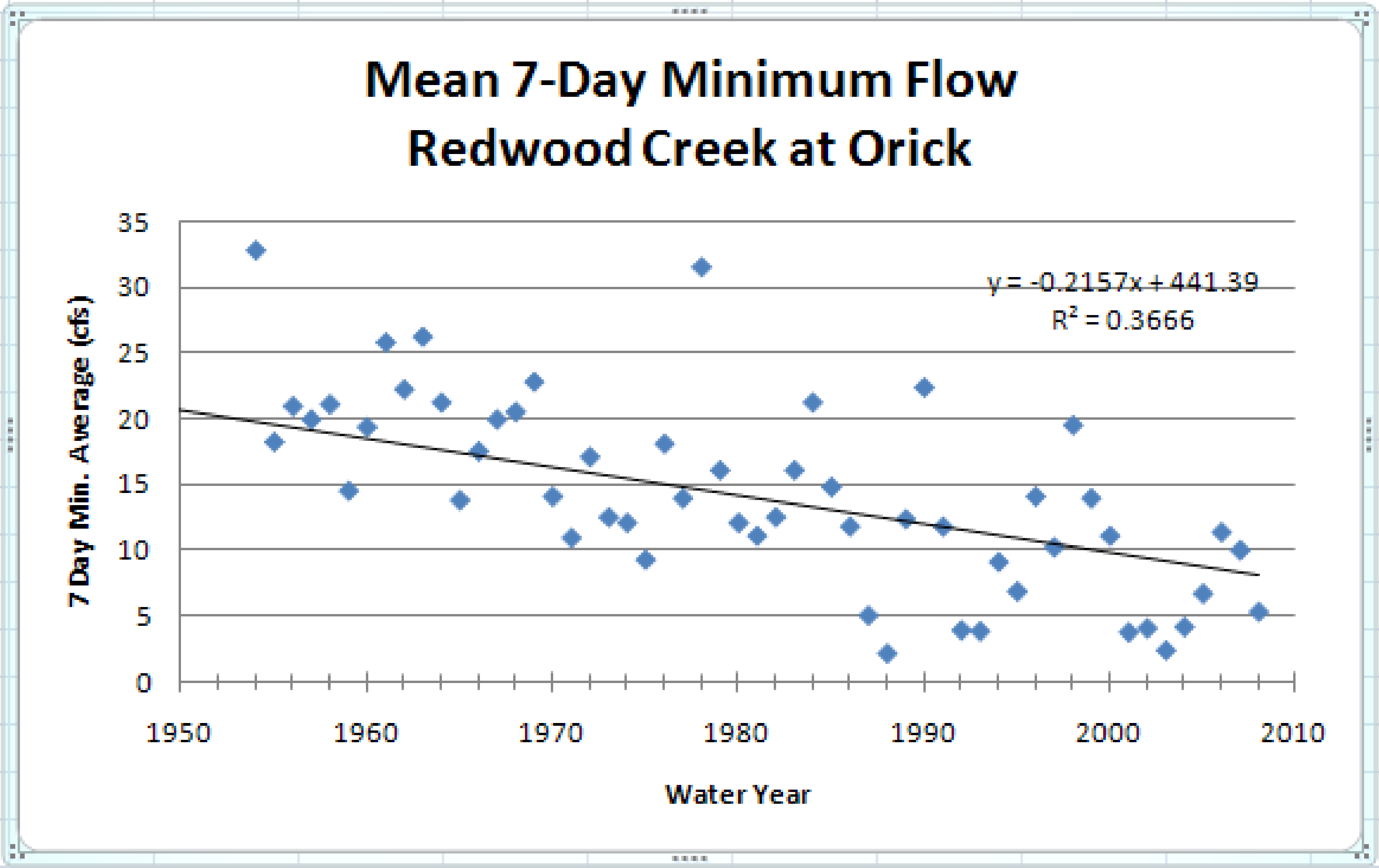
Variability

USGS

DATE



Timing of Runoff in Redwood Creek at Orick
Later runoff
Earlier runoff
Avg. Runoff Centroid (WY1954-2010) = 6-Feb
Years with * = El Nino Event
Deviation from avg. date of runoff centroid (date)
7-Apr
23-Mar
8-Mar
21-Feb
6-Feb
22-Jan
7-Jan
23-Dec
8-Dec
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Winter Season (WY Oct-Mar)


Mean 7-Day Minimum Flow
Redwood Creek at Orick
y = -0.2157x + 441.39
R² = 0.3666
7 Day Min. Average (cfs)
Water Year
0
5
10
15
20
25
30
35
1950
1960
1970
1980
1990
2000
2010

Redwood Creek goes dry, 2002

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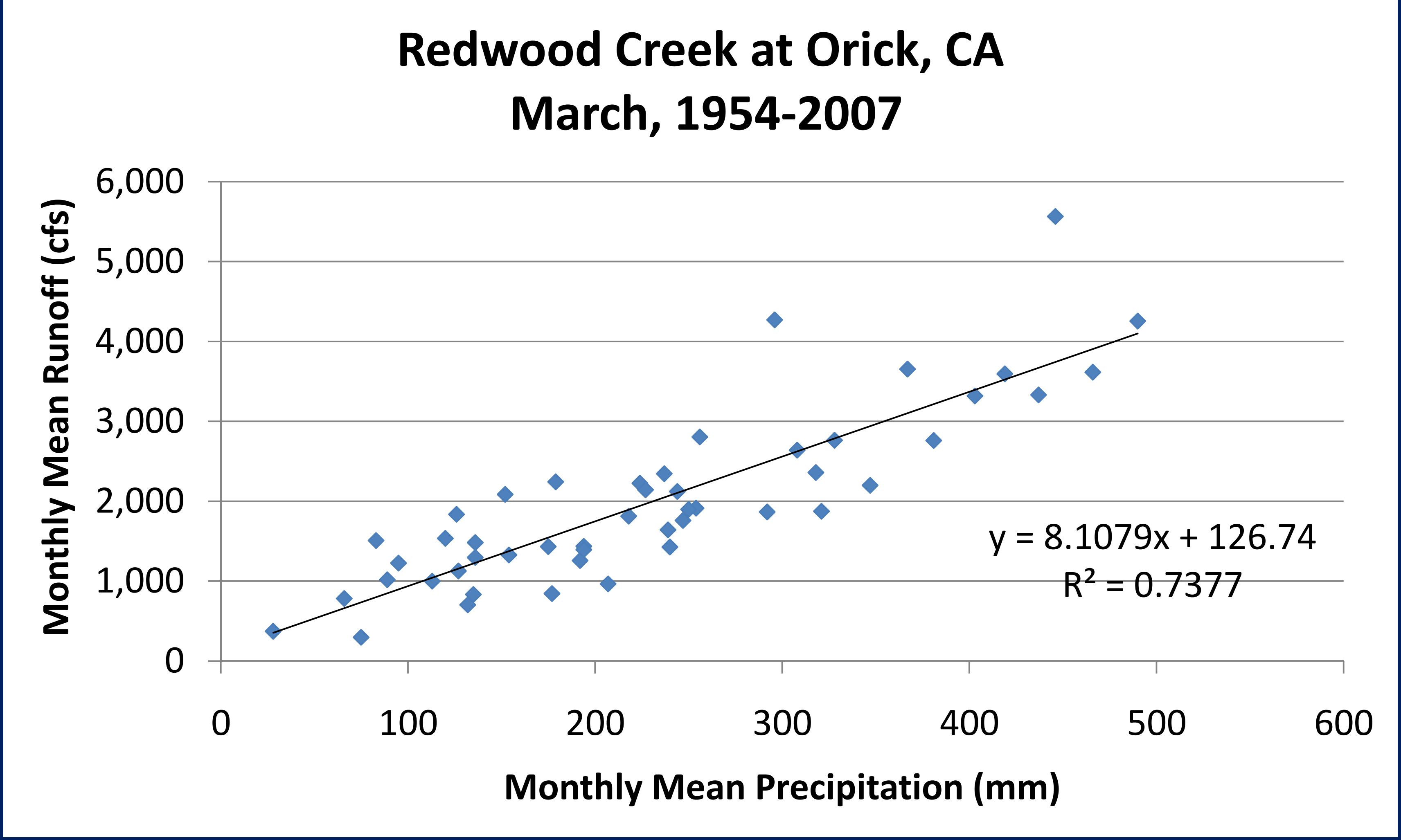
Step 3: Assess Relationships among Variables



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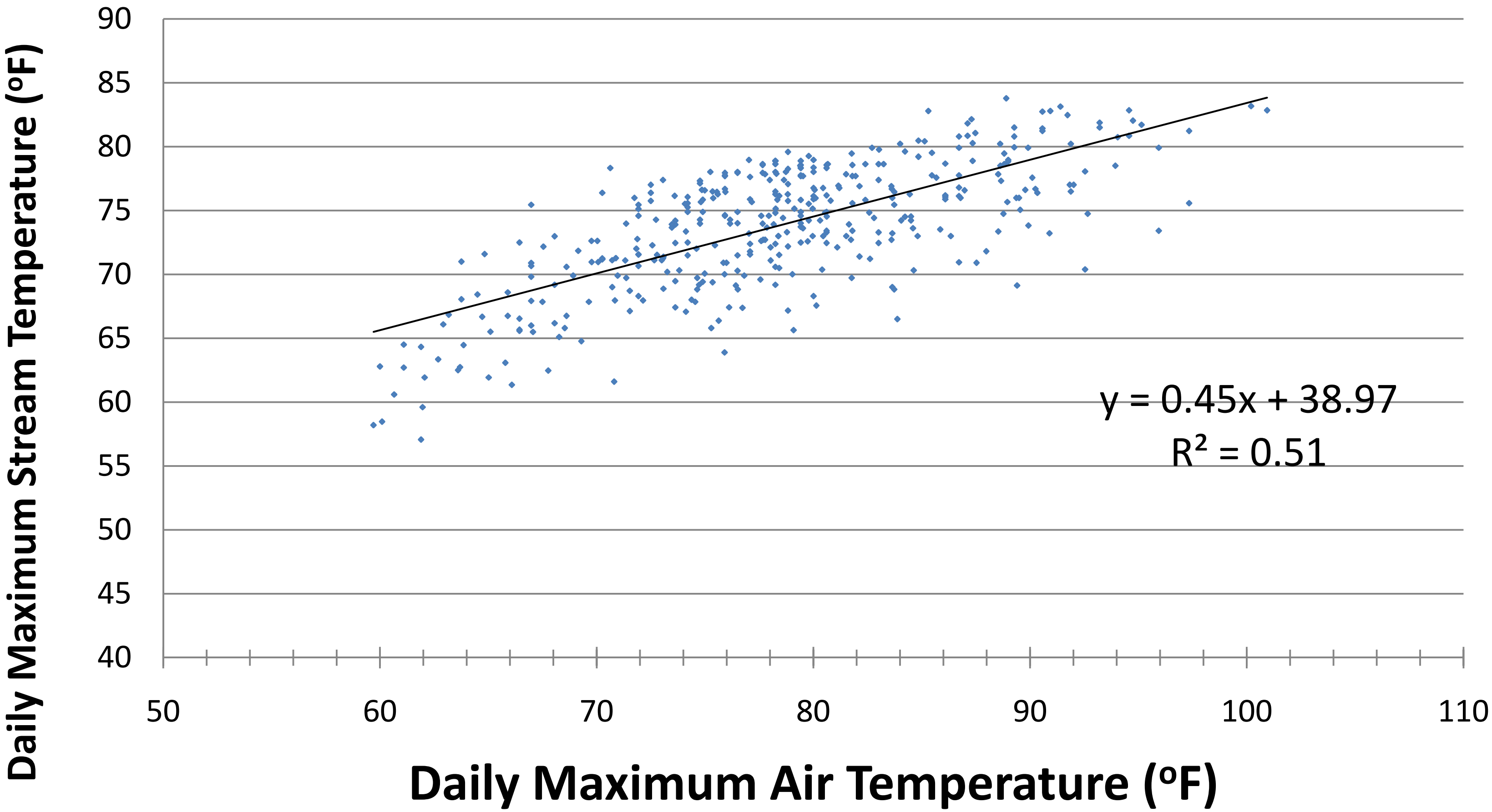
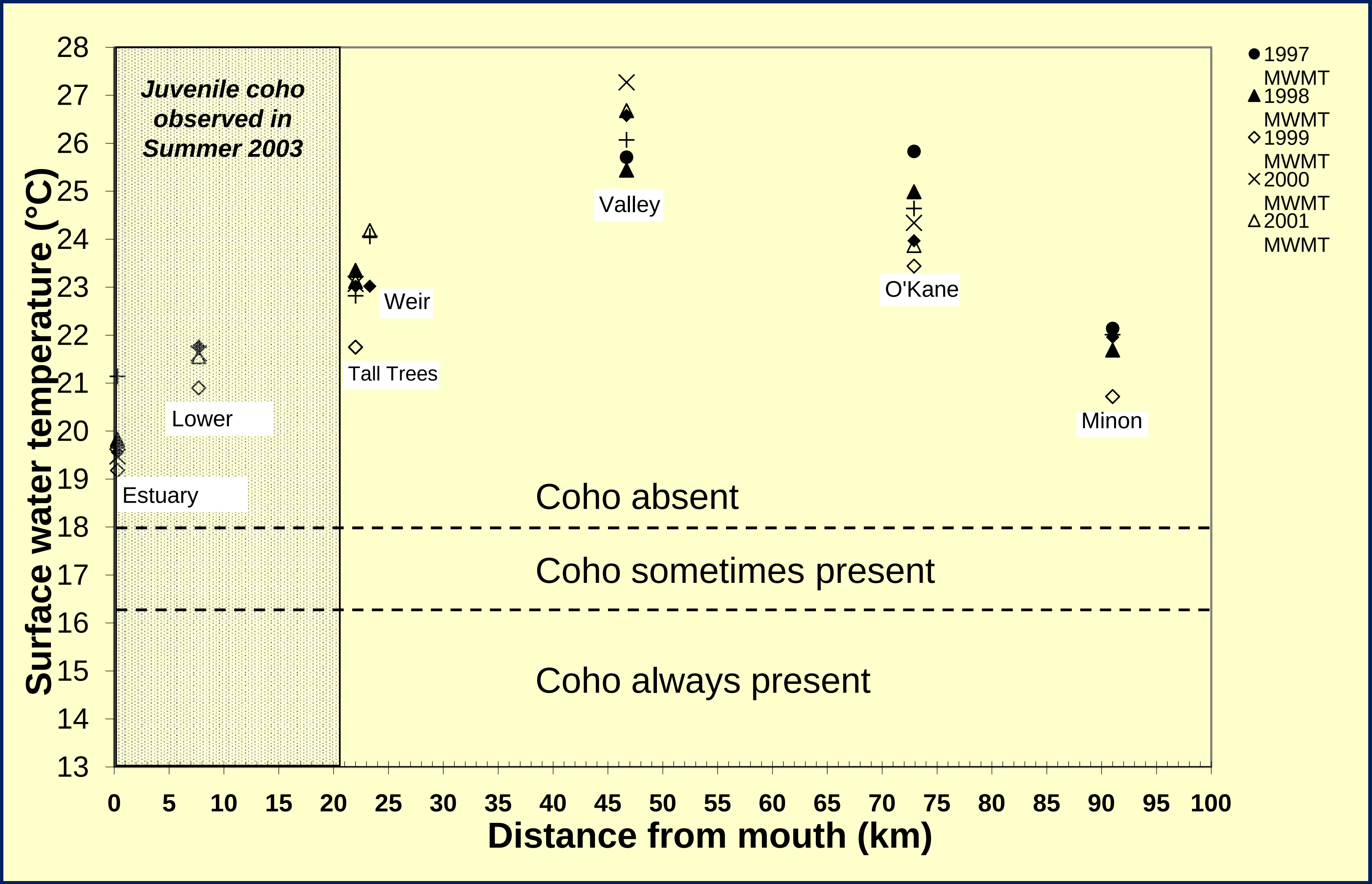
Upper Redwood Creek, Orick, Maximum Temperatures, Summers, 2001 - 2009



Stream temperatures in Redwood Creek no longer favorable for salmon



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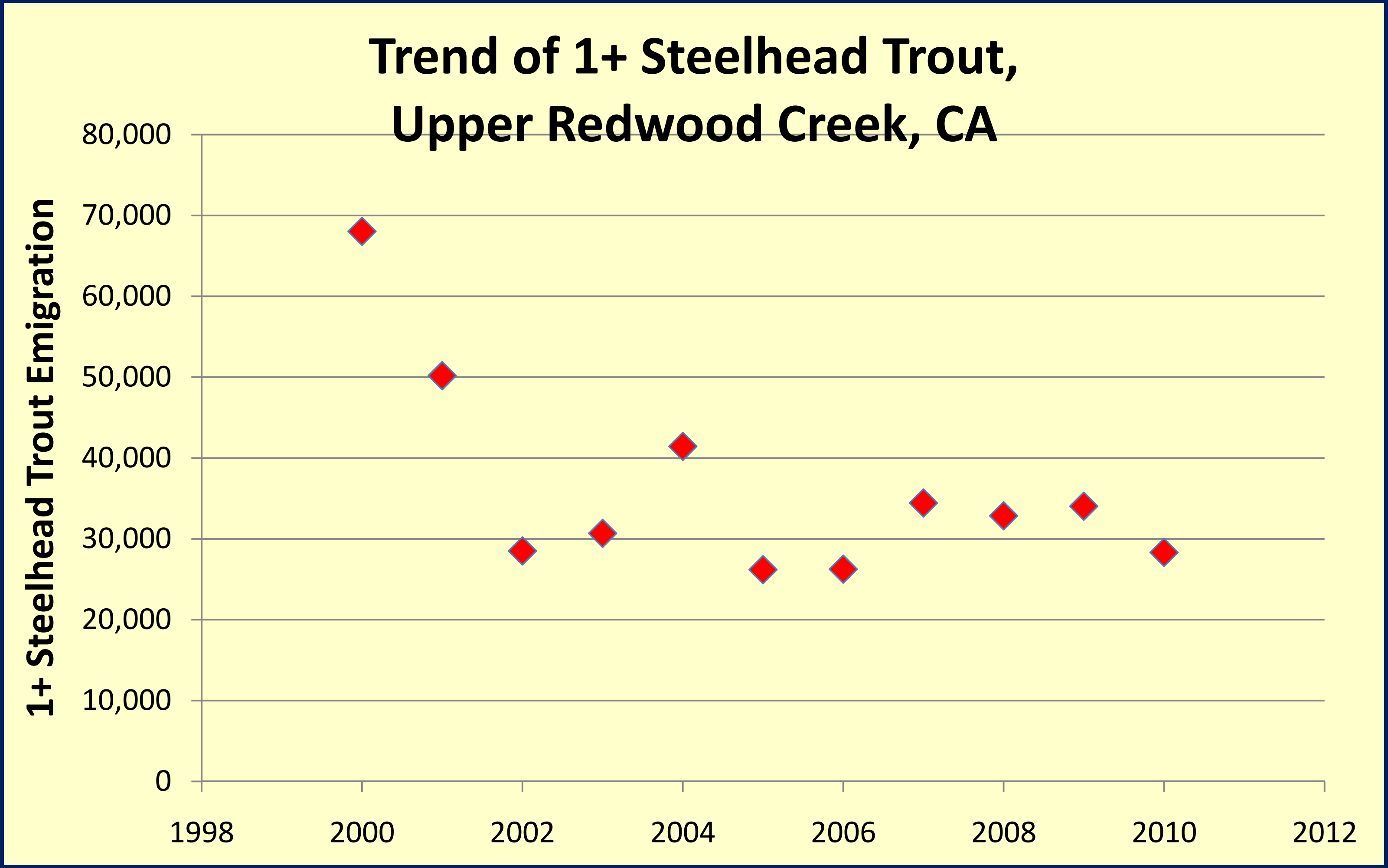
How do trends in climate, stream flow and stream temperature affect salmon populations?



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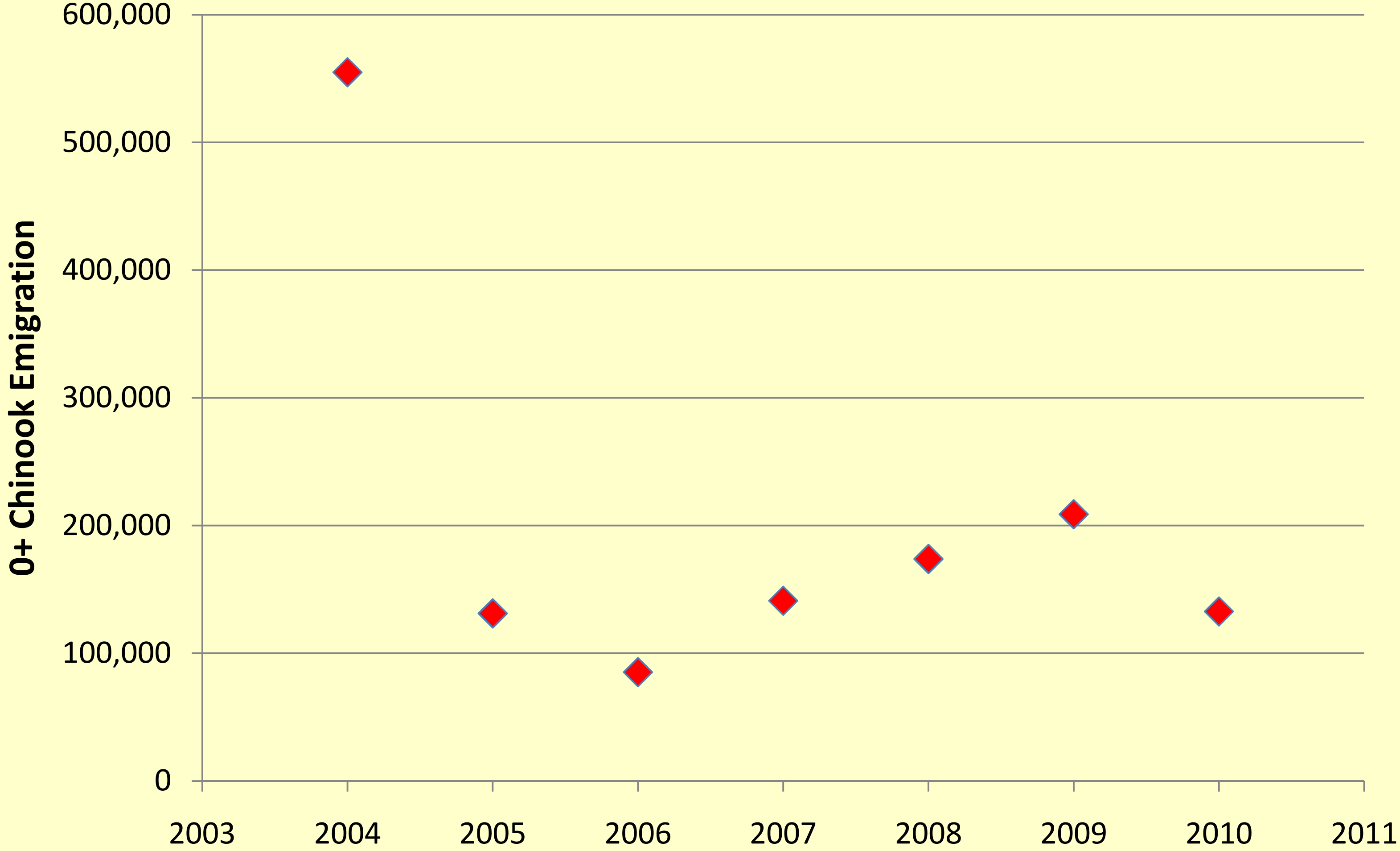
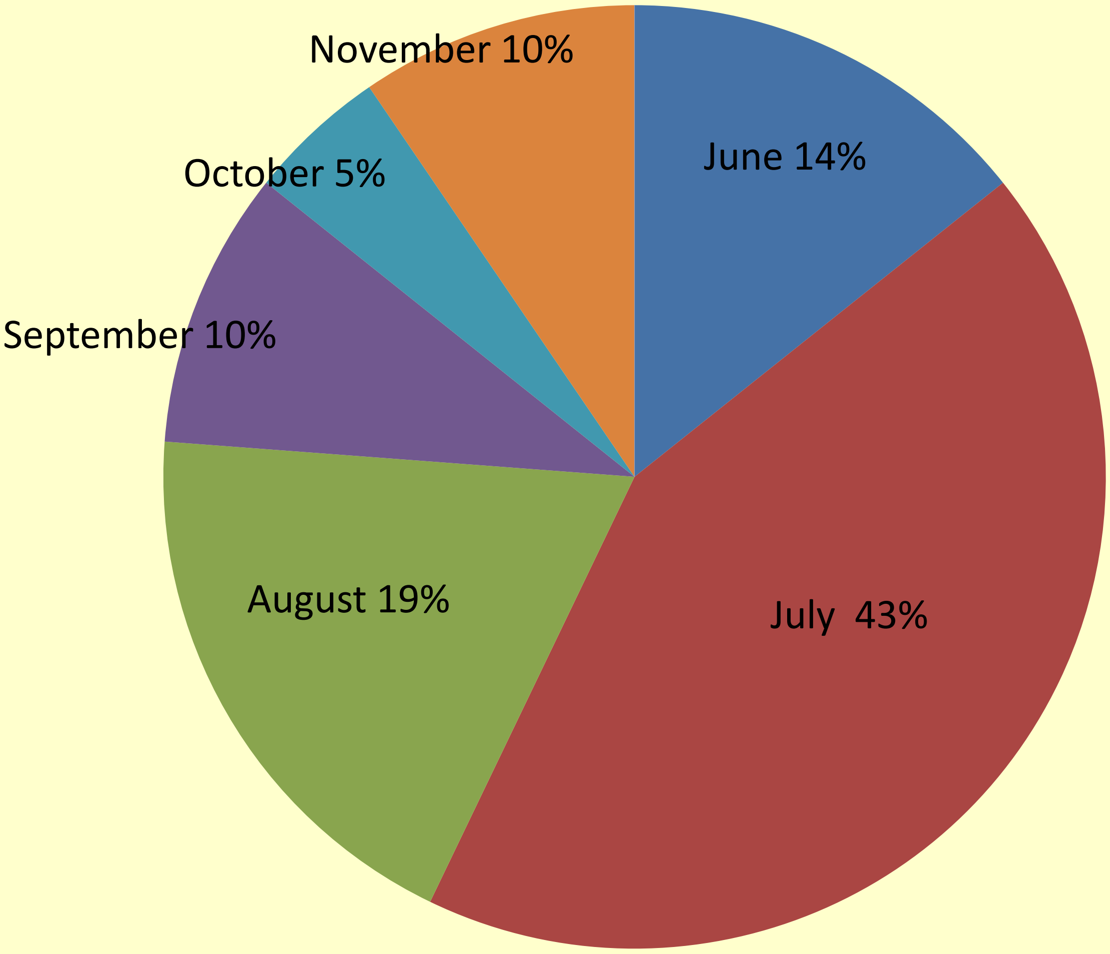
Data from CA Dept. of Fish and Game

Trend of 0+ Chinook Salmon, Lower Redwood Creek, CA



Data from CA Dept. of Fish and Game

Redwood Creek Mouth Closure by Month 1997 - 2010



Ultimate Goal

Synthesize monitoring data to understand the strength of relationships to better target management activities

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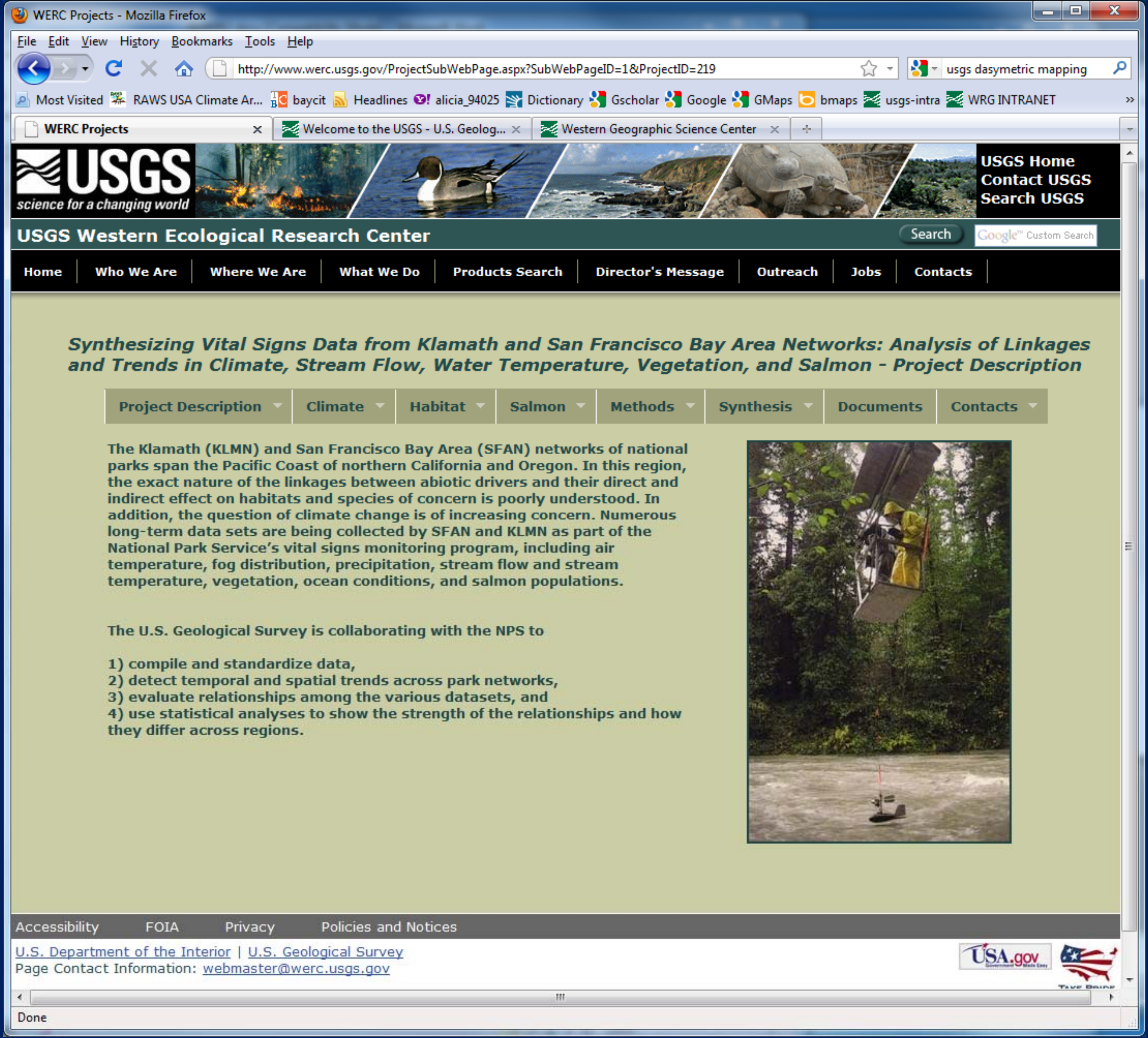

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Synthesizing Vital Signs Data from Klamath and San Francisco Bay Area Networks: Analysis of Linkages and Trends in Climate, Stream Flow, Water Temperature, Vegetation, and Salmon - Project Description

Project Description | Climate | Habitat | Salmon | Methods | Synthesis | Documents | Contacts

The Klamath (KLMN) and San Francisco Bay Area (SFAN) networks of national parks span the Pacific Coast of northern California and Oregon. In this region, the exact nature of the linkages between abiotic drivers and their direct and indirect effect on habitats and species of concern is poorly understood. In addition, the question of climate change is of increasing concern. Numerous long-term data sets are being collected by SFAN and KLMN as part of the National Park Service's vital signs monitoring program, including air temperature, fog distribution, precipitation, stream flow and stream temperature, vegetation, ocean conditions, and salmon populations.

The U.S. Geological Survey is collaborating with the NPS to

1) compile and standardize data,
2) detect temporal and spatial trends across park networks,
3) evaluate relationships among the various datasets, and
4) use statistical analyses to show the strength of the relationships and how they differ across regions.

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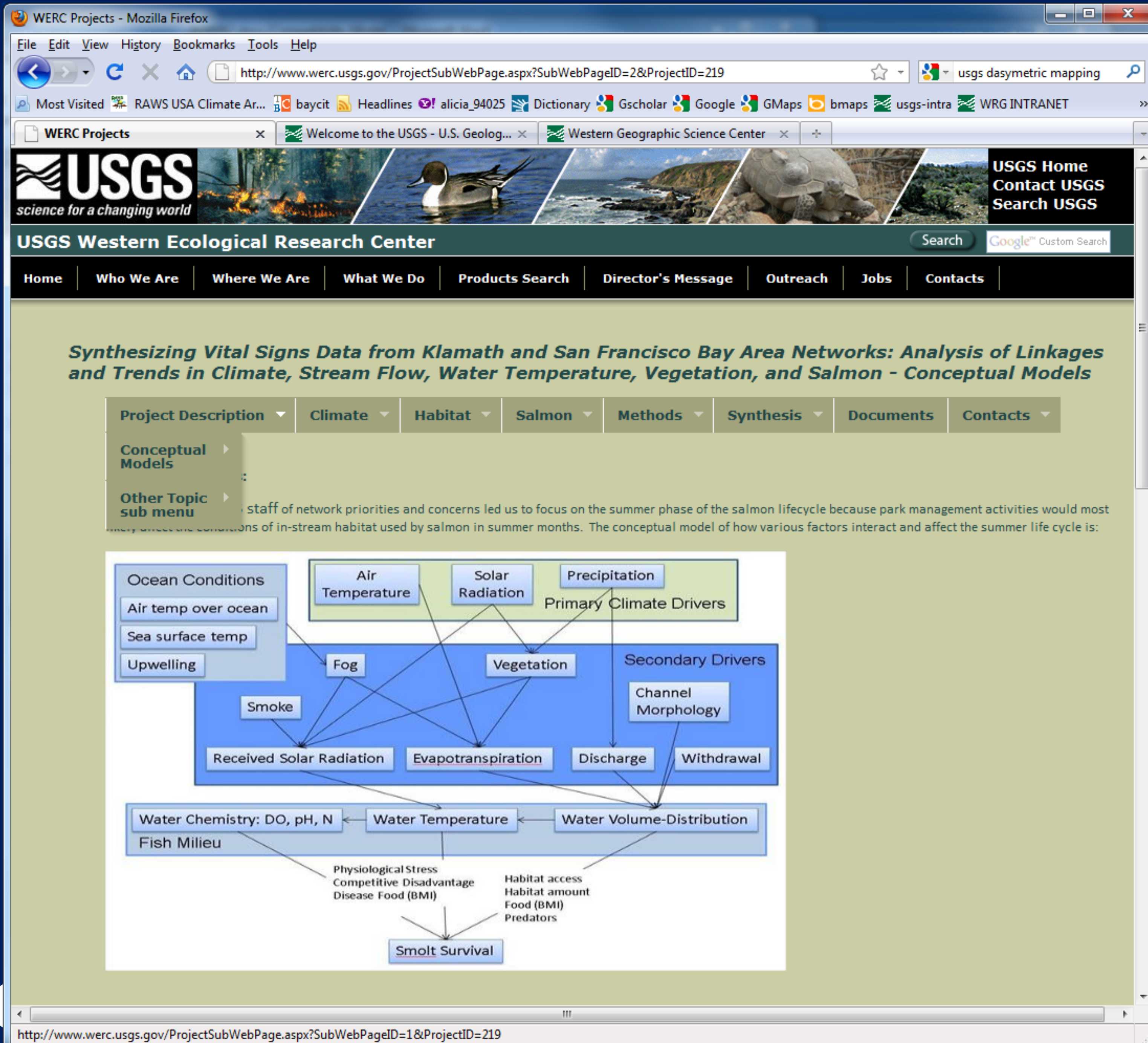
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Synthesizing Vital Signs Data from Klamath and San Francisco Bay Area Networks: Analysis of Linkages and Trends in Climate, Stream Flow, Water Temperature, Vegetation, and Salmon - Conceptual Models
Project Description
Climate
Habitat
Salmon
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Conceptual Models
Other Topic sub menu
staff of network priorities and concerns led us to focus on the summer phase of the salmon lifecycle because park management activities would most
ons of in-stream habitat used by salmon in summer months. The conceptual model of how various factors interact and affect the summer life cycle is:
Ocean Conditions
Air temp over ocean
Sea surface temp
Upwelling
Air Temperature
Solar Radiation
Precipitation
Primary Climate Drivers
Secondary Drivers
Fog
Vegetation
Smoke
Channel Morphology
Received Solar Radiation
Evapotranspiration
Discharge
Withdrawal
Water Chemistry: DO, pH, N
Water Temperature
Water Volume-Distribution
Fish Milieu
Physiological Stress
Competitive Disadvantage
Disease Food (BMI)
Habitat access
Habitat amount
Food (BMI)
Predators
Smolt Survival
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- Streams
  - Flow (Discharge)
    - Mean Daily Discharge
    - SF Mean Monthly Discharge
    - Redwood Mean Monthly Discharge
    - Mean annual runoff and peak flows
    - Cumulative Departure from Mean Annual Runoff
    - Timing of runoff(10, 25, 50, 75 and 90th percentiles of annual runoff)
    - 7-day, 30-day, and
  - Withdrawals
  - Stream Temperature
  - Water Quality (link to other sites)
  - Channel Morphology
- Estuaries
- Land
- Ocean(links to other sites)

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the exact nature of the linkages betwe
indirect effect on habitats and species
addition, the question of climate chang
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National Park Service's vital signs mon
temperature, fog distribution, precipit
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Take Home Messages

- The NPS Vital Signs Program protocols focus on rigorous monitoring of individual indicators
- However, ecosystems are complex with dynamic interacting components
- Synthesizing monitoring data leads to a deeper understanding of the relationships in this complex, multivariate system and consequently a stronger foundation for resource decisions

And a big thank you for data development, logistical support & insight to:

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