



United States  
Department of  
Agriculture

Forest  
Service

# Streamflow Trends in the Coast Range, Northern California

## Caspar Creek Experimental Watersheds

Elizabeth Keppeler, Pacific Southwest Research Station

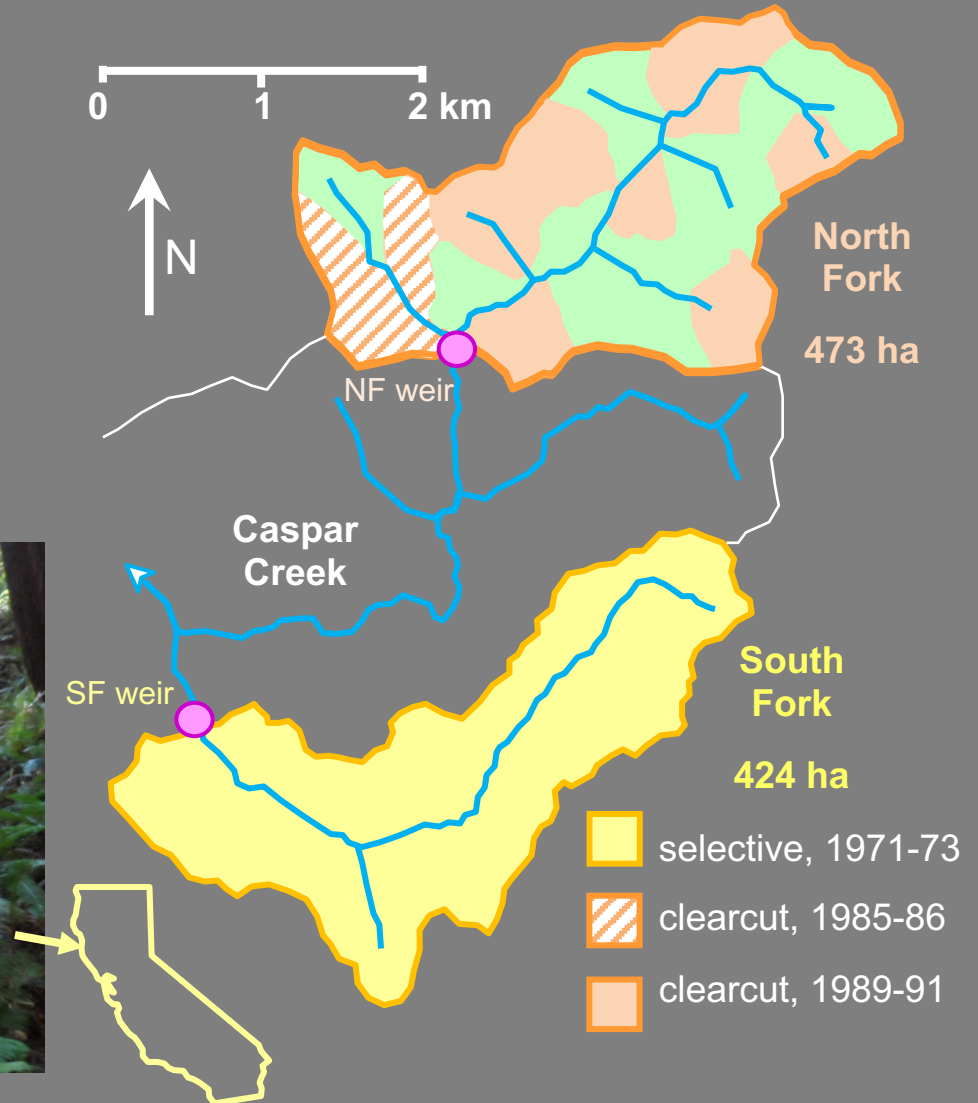
# Today...

- background on Caspar Creek
- prior results
- update on summer flow trends
- additional considerations

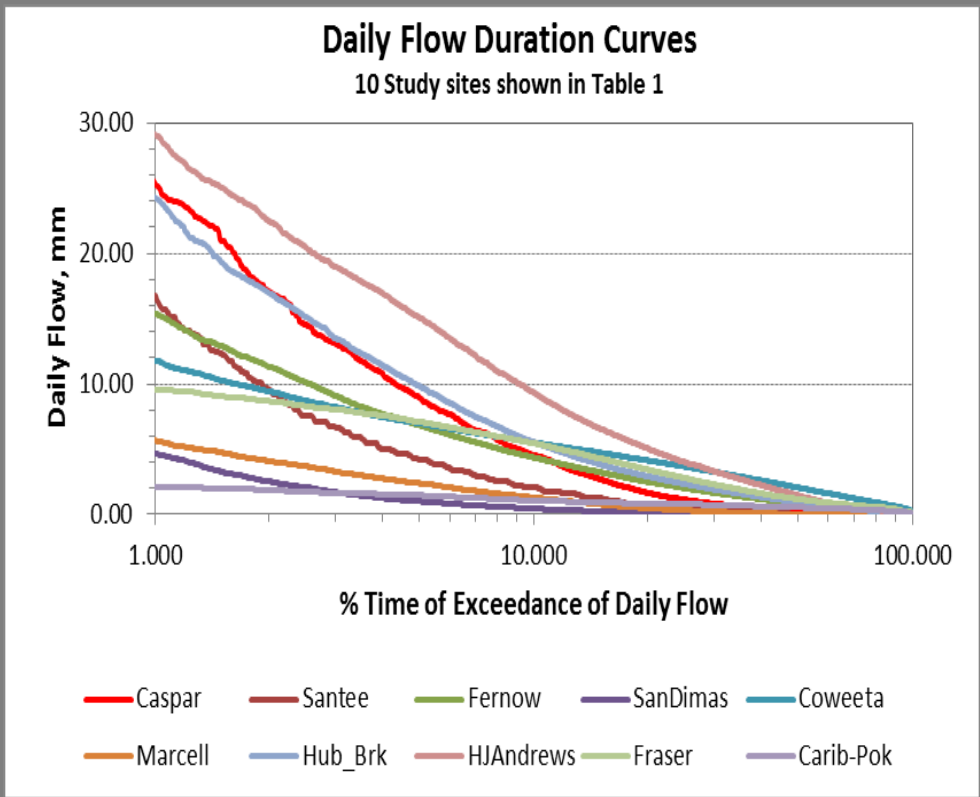
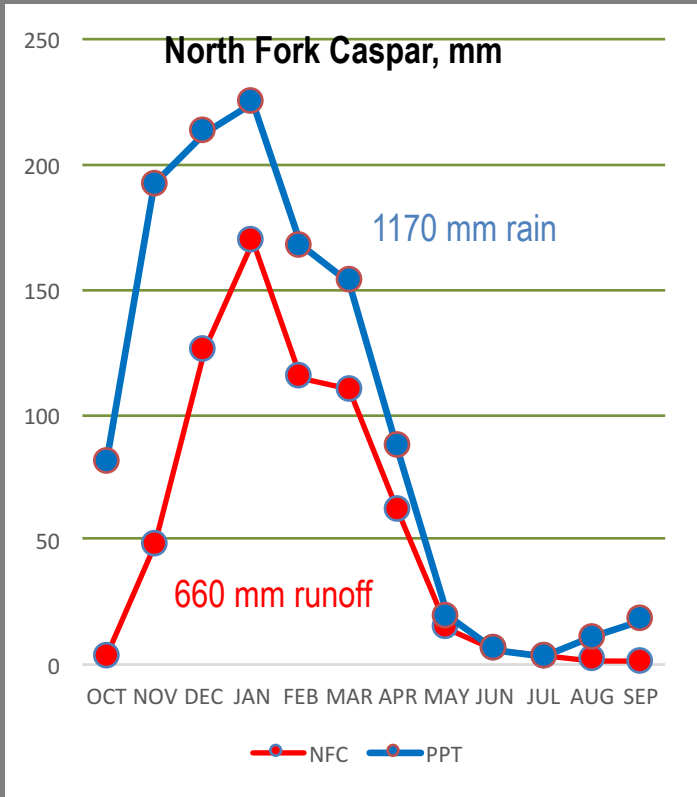


# Caspar Creek Experimental Watersheds

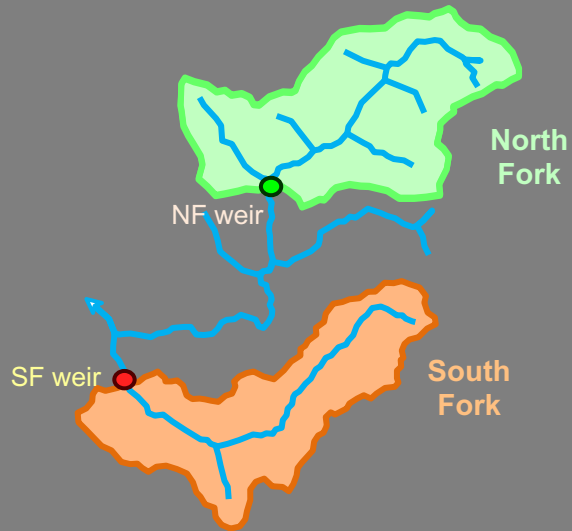
- *coastal, low elevation*
- *sandstone & shale*
- *redwood & Douglas-fir*
- *old growth logged 1865-1905*



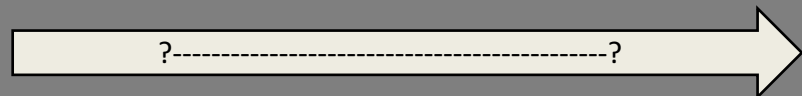
# Hydrology



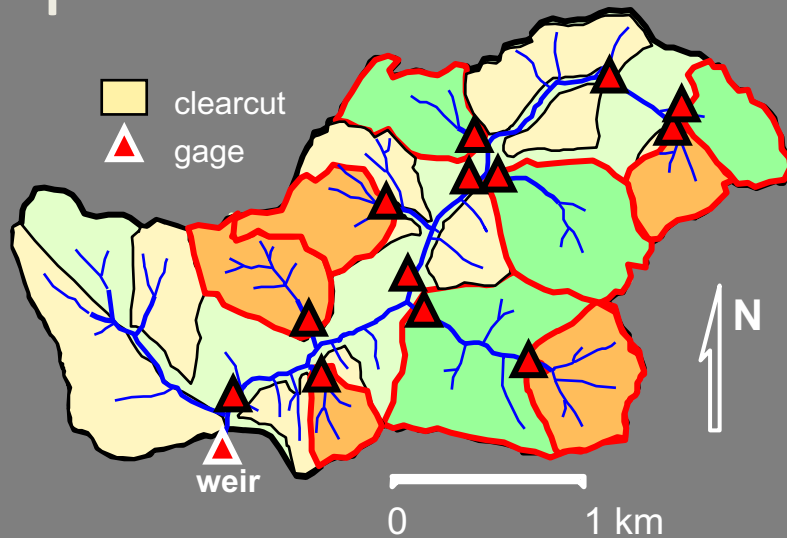
# Experiment 1: South Fork selective logging



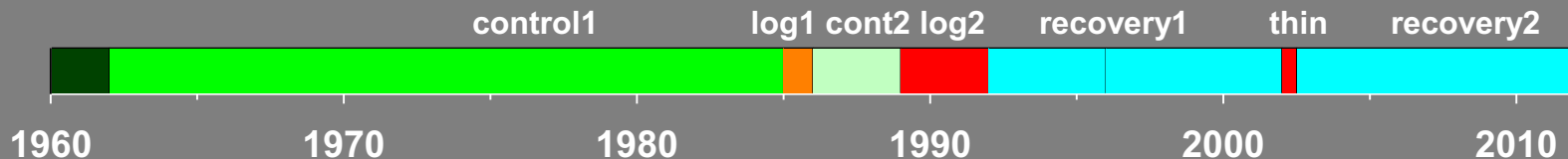
- *Road 1967*
- *67% selection 1971-1973*
- *Tractor yarded*
- *Paired control*



# Experiment 2: North Fork clearcut logging



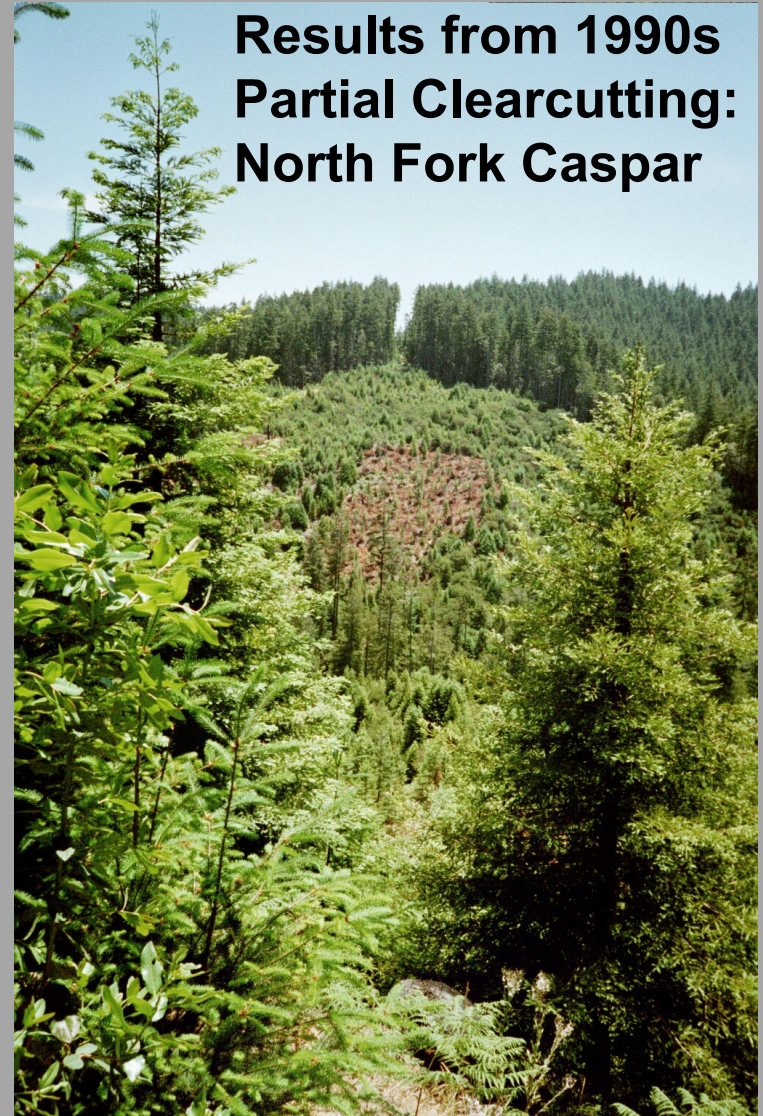
*13 new gages*  
*13% preliminary clearcut*  
*37% clearcut 1989-1992*  
*Mostly cable yarded*  
*Internal controls*



## Results from 1970s Selection Harvest: South Fork Caspar

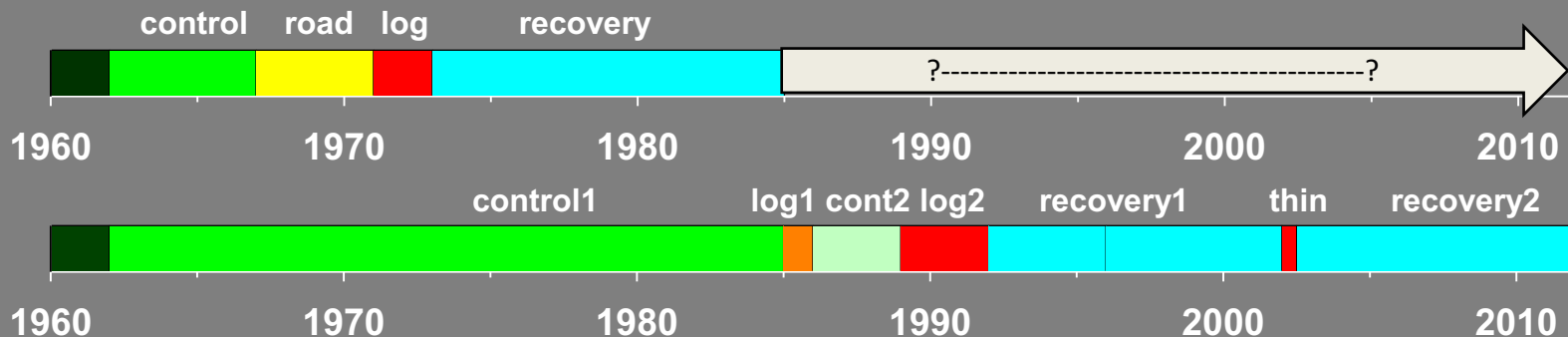


## Results from 1990s Partial Clearcutting: North Fork Caspar

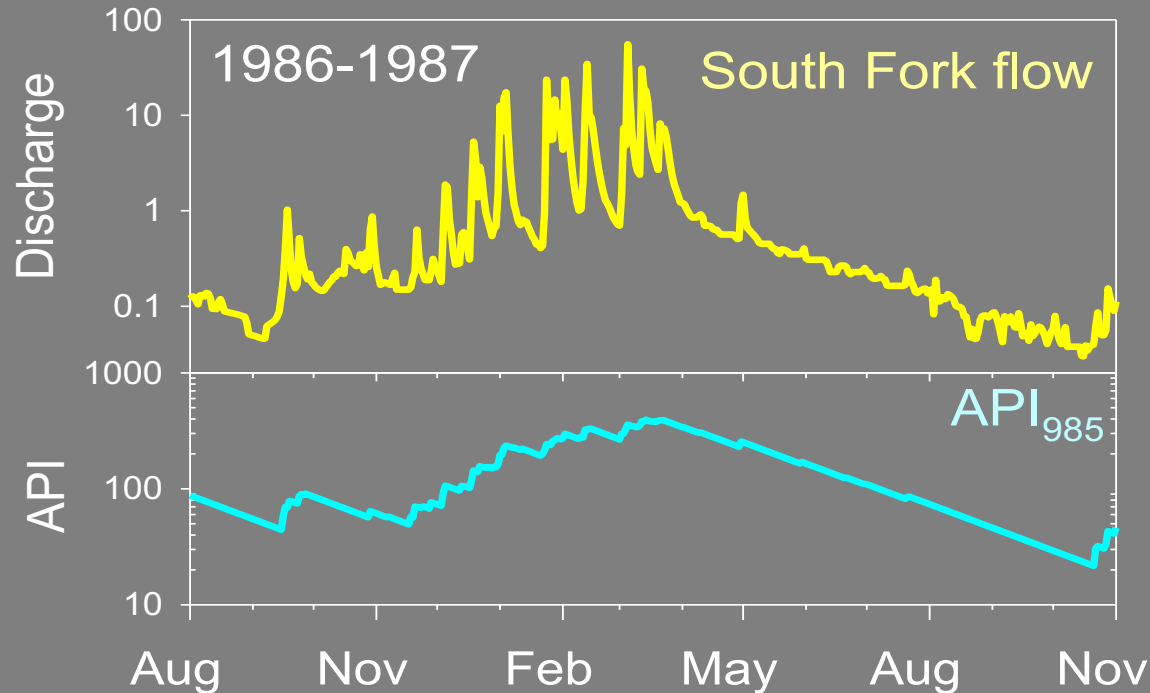


# Assessing longer term trends...

- No control for South Fork after 1985
  - *1985 North Fork logging*
- No control for North Fork weir after 1971
  - *Assumed South Fork recovered by 1985?*
  - *Internal controls lack adequate resolution for low flows*



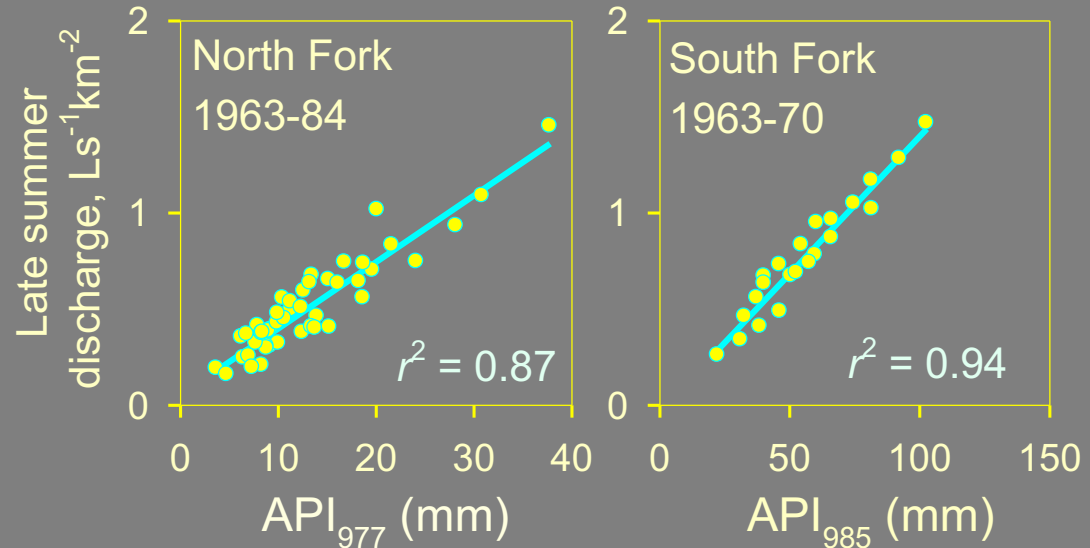
# Antecedent Precipitation Index



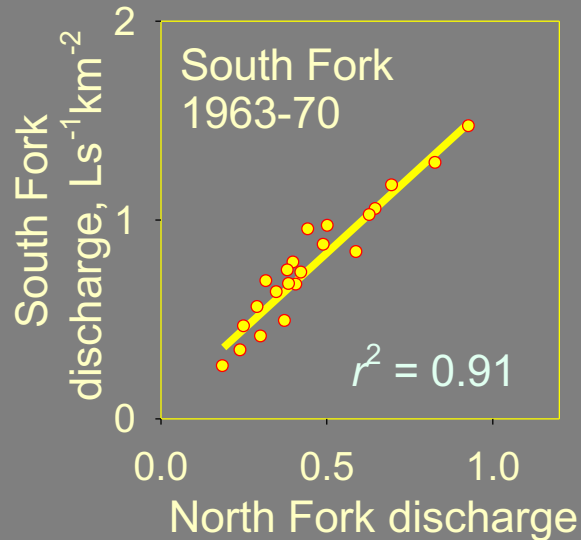
$$API_{\text{today}} = C * API_{\text{yesterday}} + \text{Rain}_{\text{today}}$$

# Calculating expected Aug-Sep flow

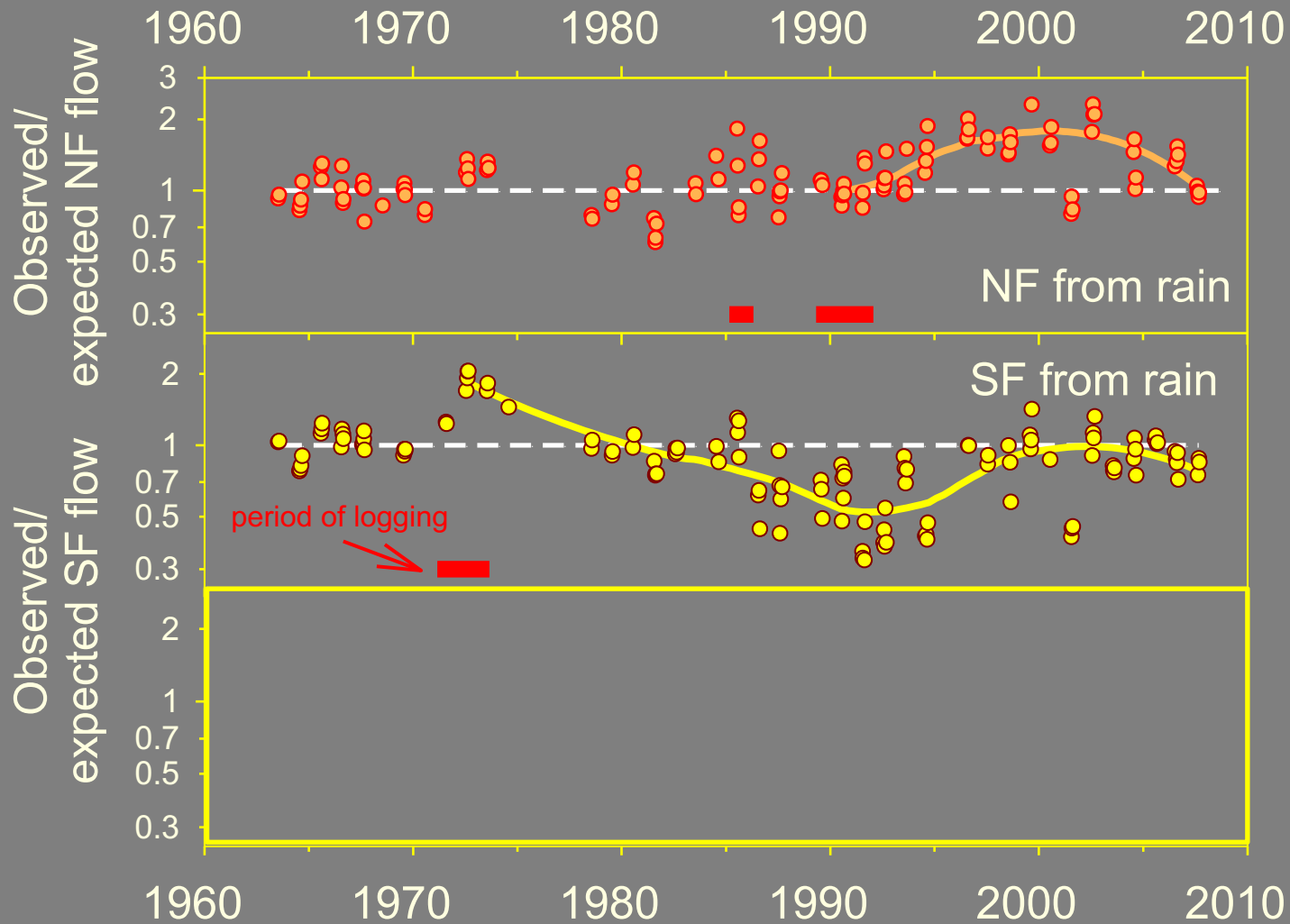
North &  
South Forks  
from API:



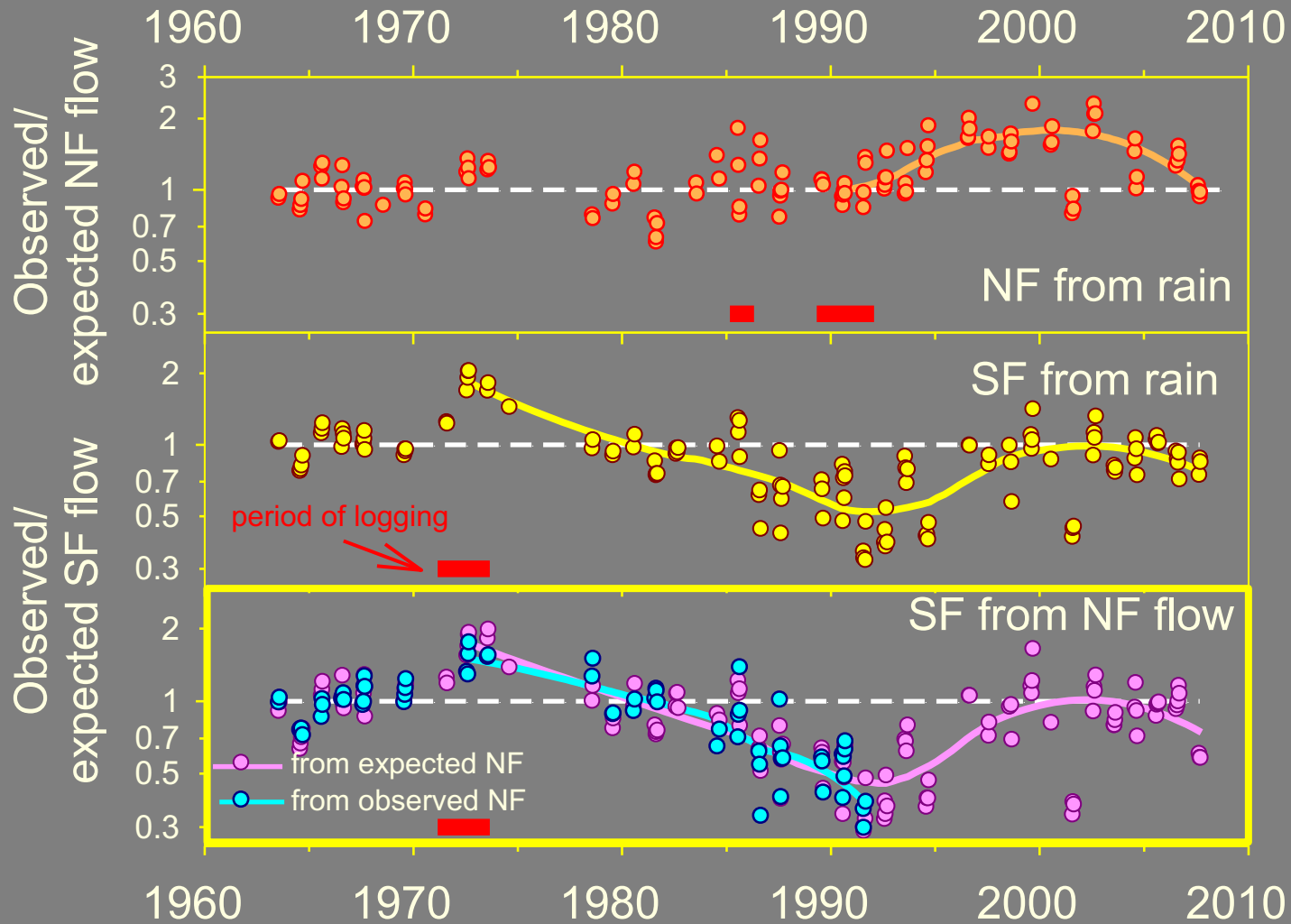
South Fork from  
North Fork:



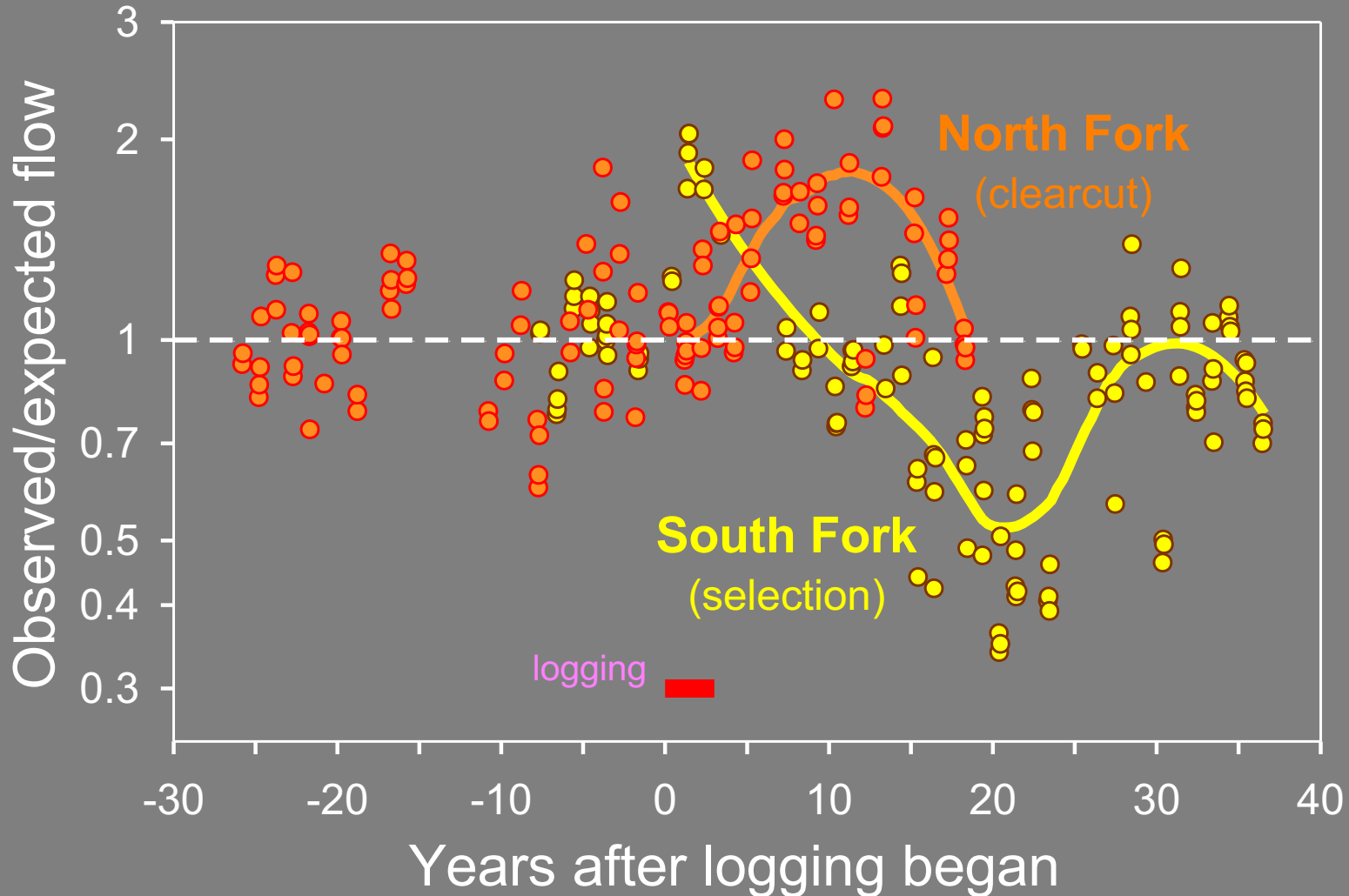
# Comparing summer flow predictions



# Comparing summer flow predictions



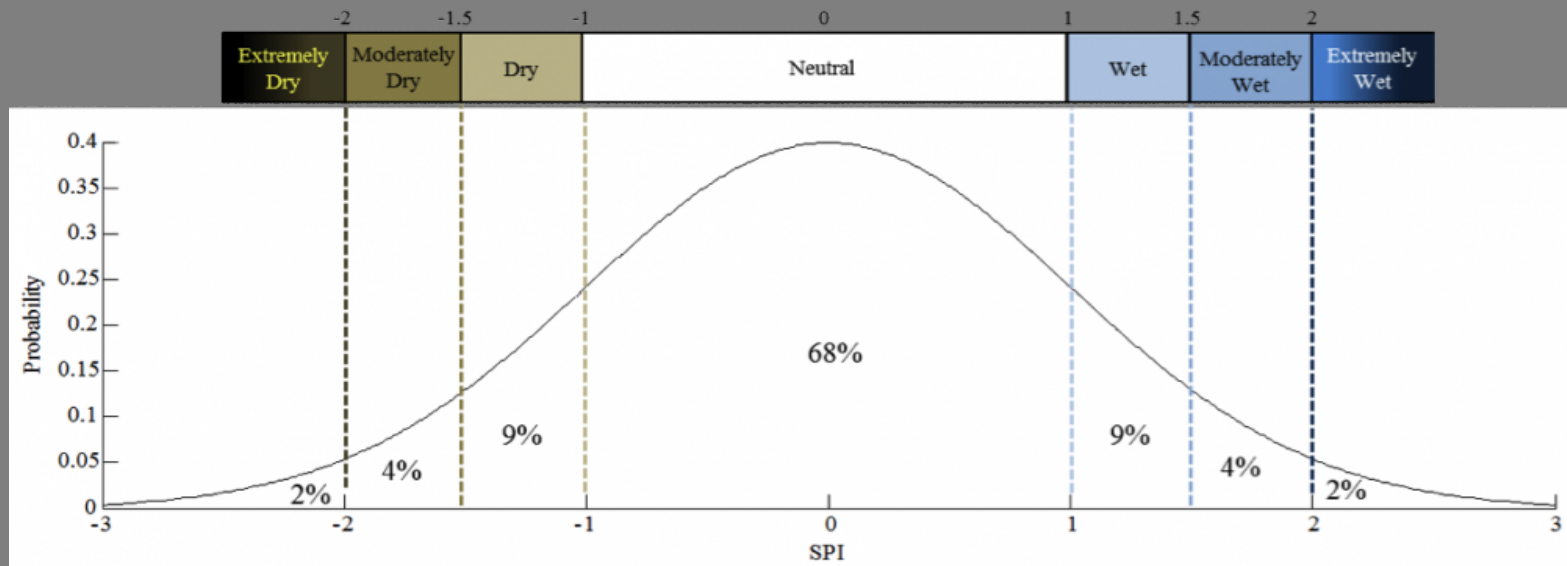
# Comparing summer flow response



# Standardized Precipitation Index

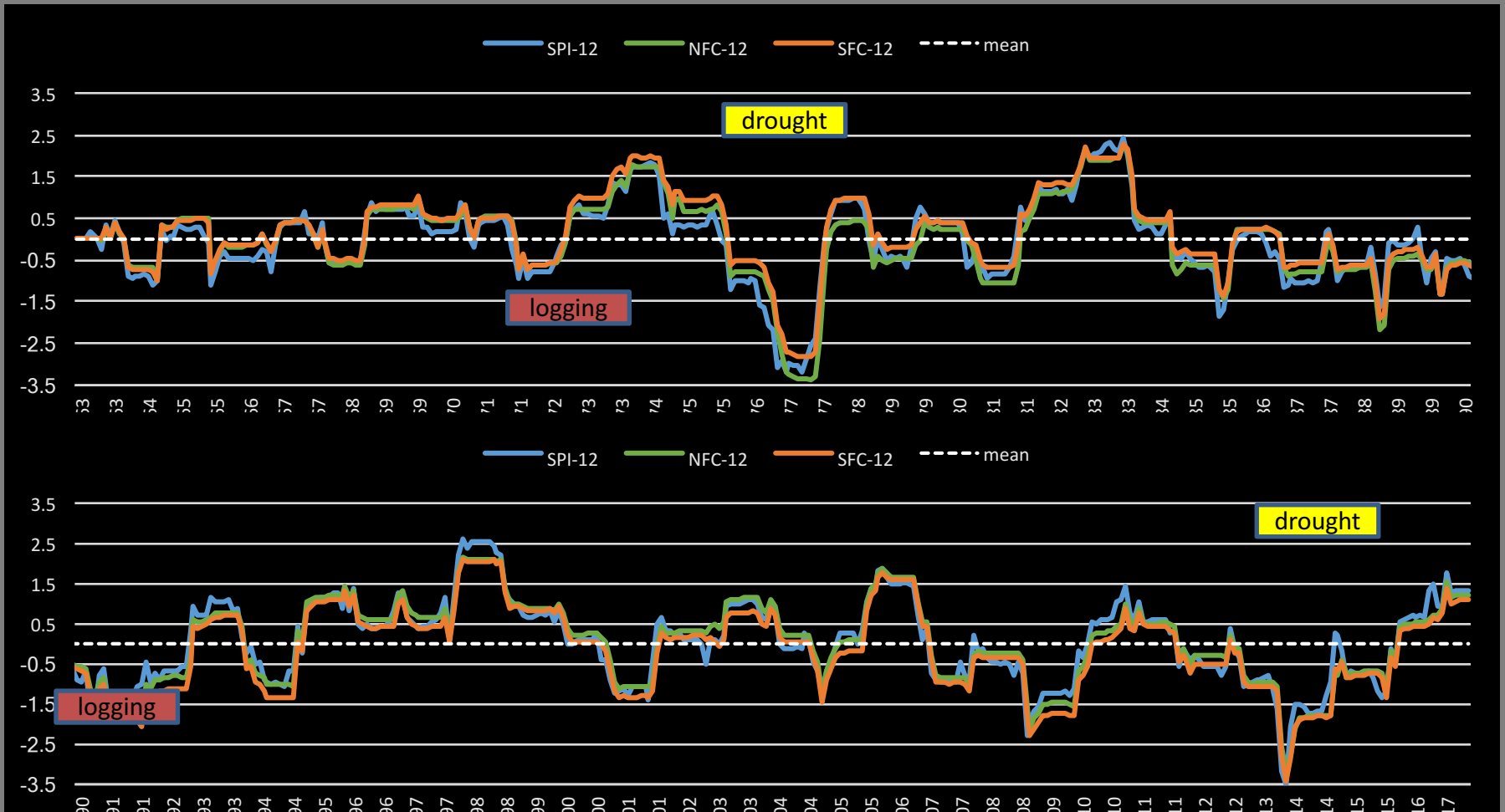
The SPI calculation for any location is based on the long-term monthly precipitation record fitted to a probability distribution, which is then transformed into a normal distribution with a mean of 0 and a standard deviation of 1.

Edwards and McKee, 1997



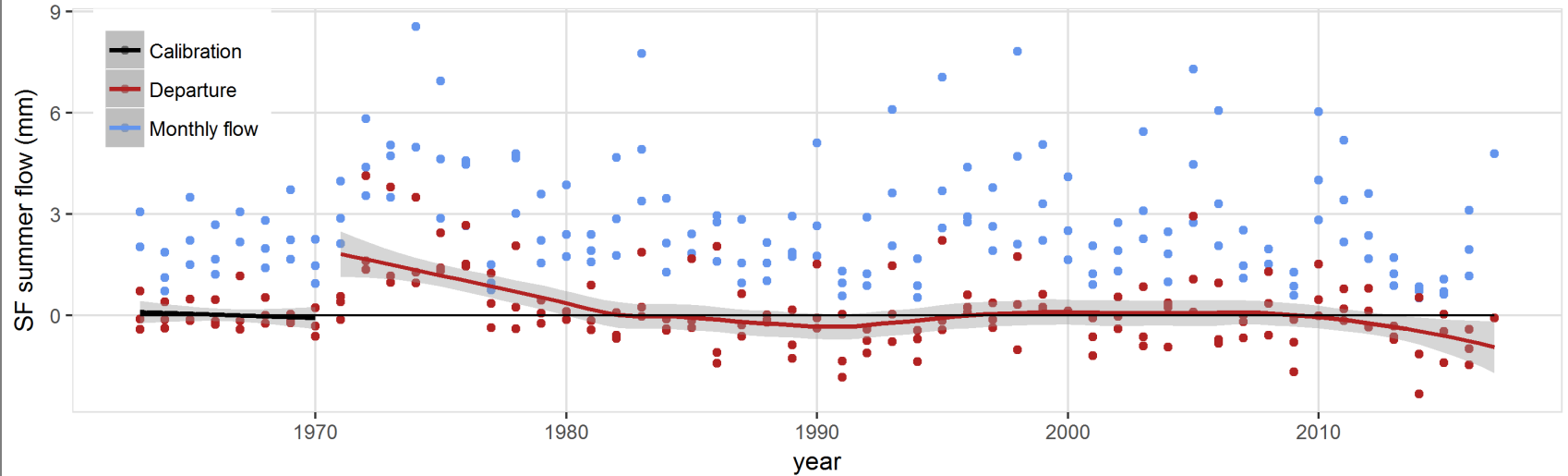
Keyantash, 2018

# SPI and Standardized Runoff Indices for North Fork and South Fork Caspar

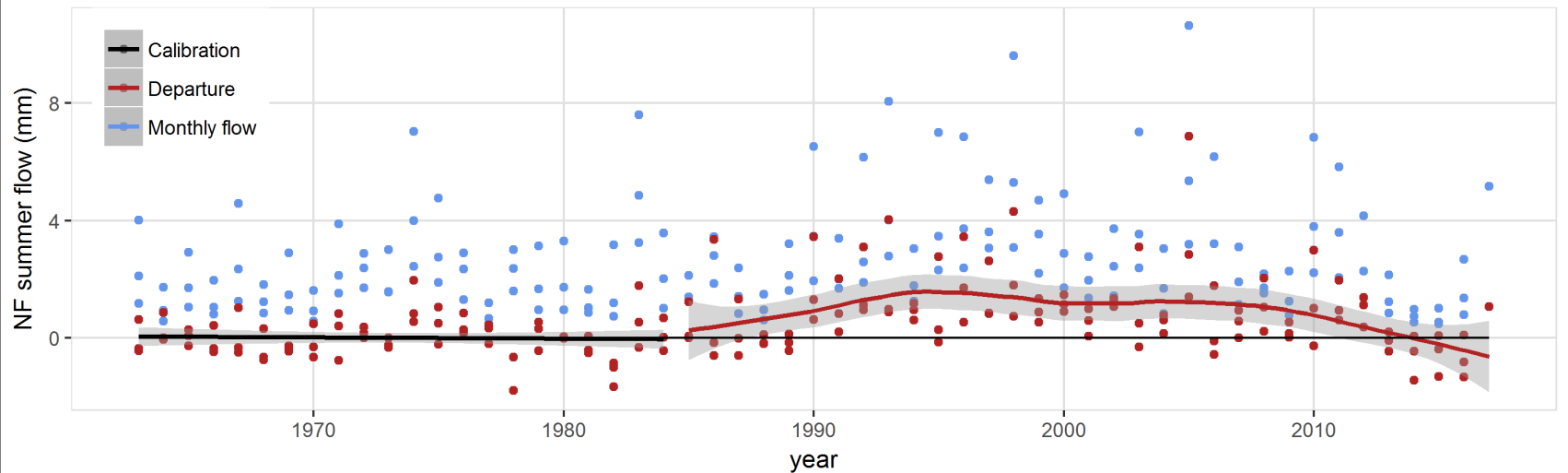


# Updated Summer flow trends: JUL-AUG-SEP

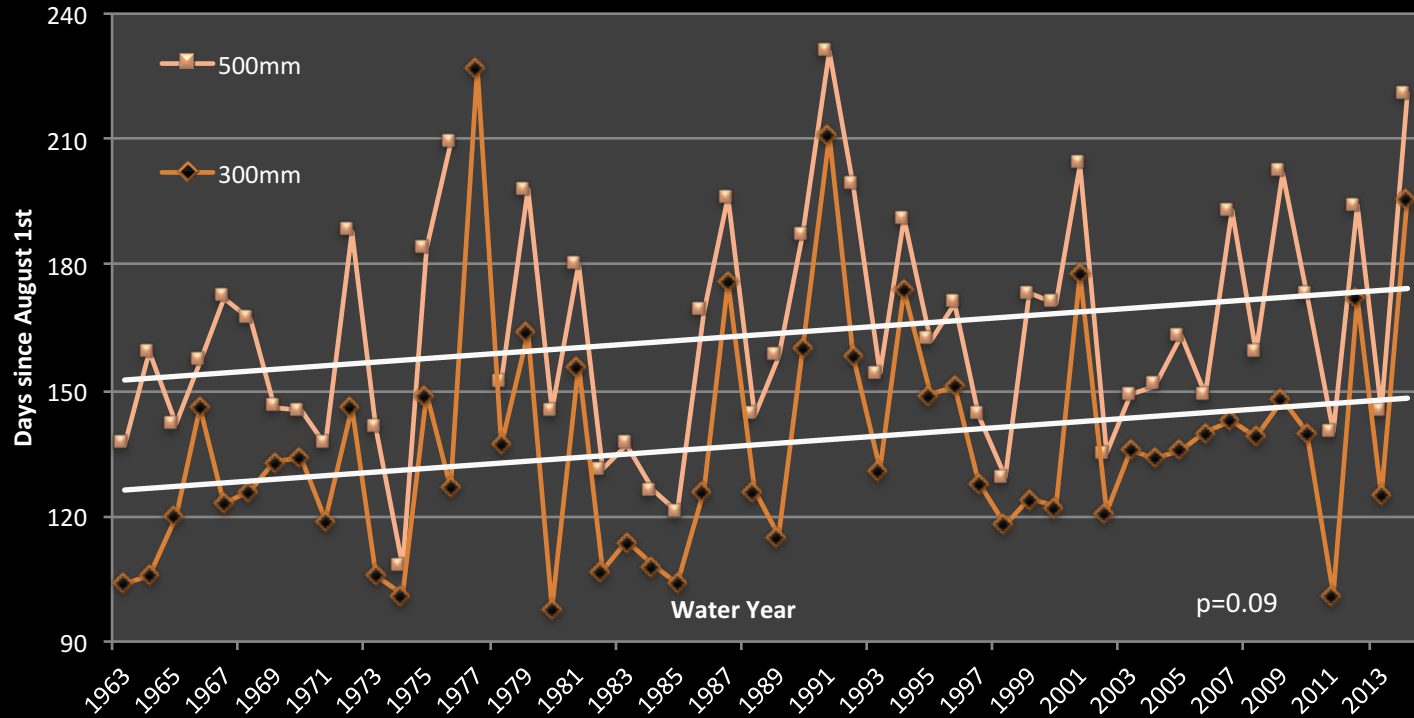
## South Fork Summer Monthly Flows: calibration 1963-70



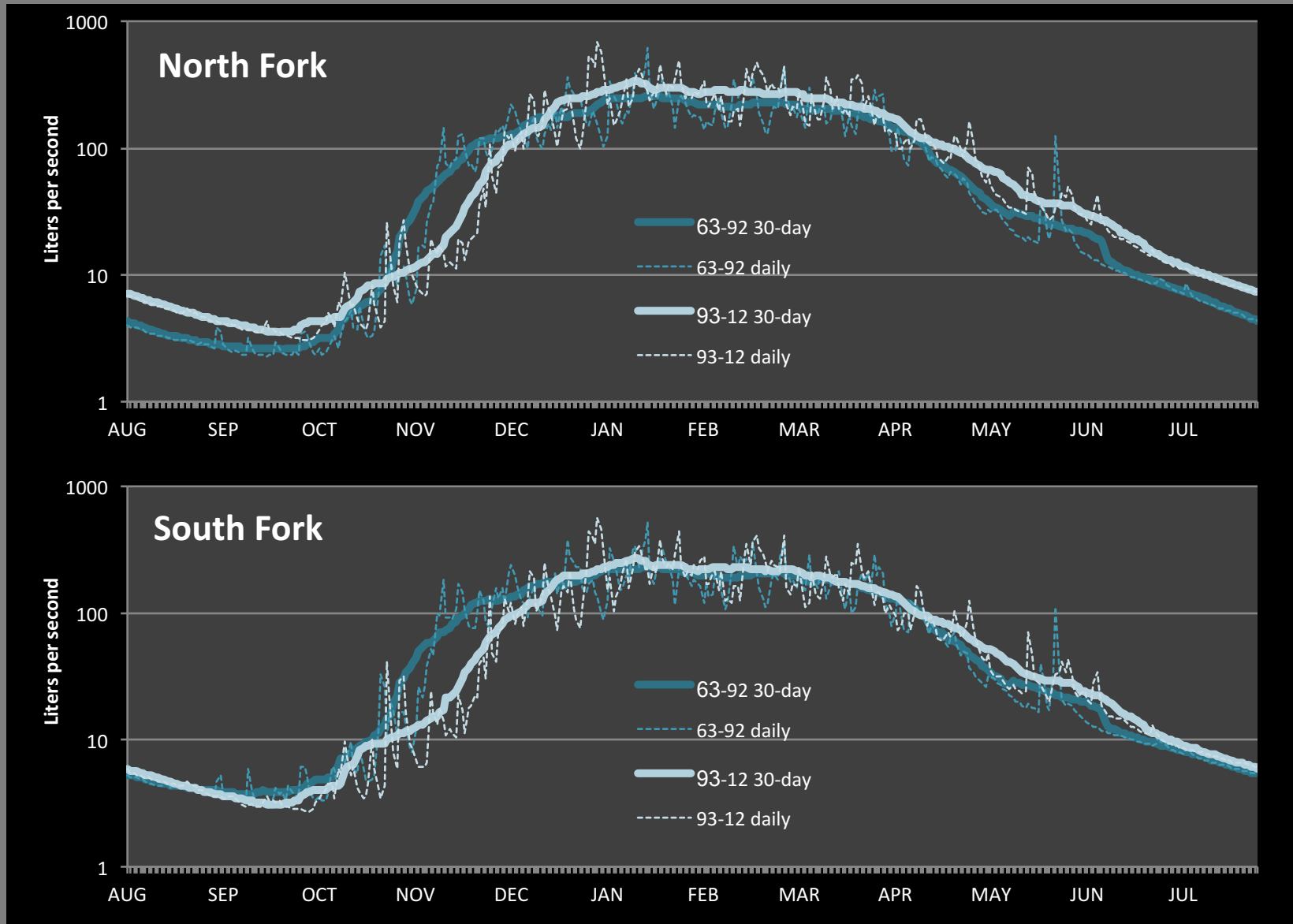
## North Fork Summer Monthly Flows: calibration 1963-84



# A shift in seasonal rainfall ?



# A shift in seasonal flow regime?



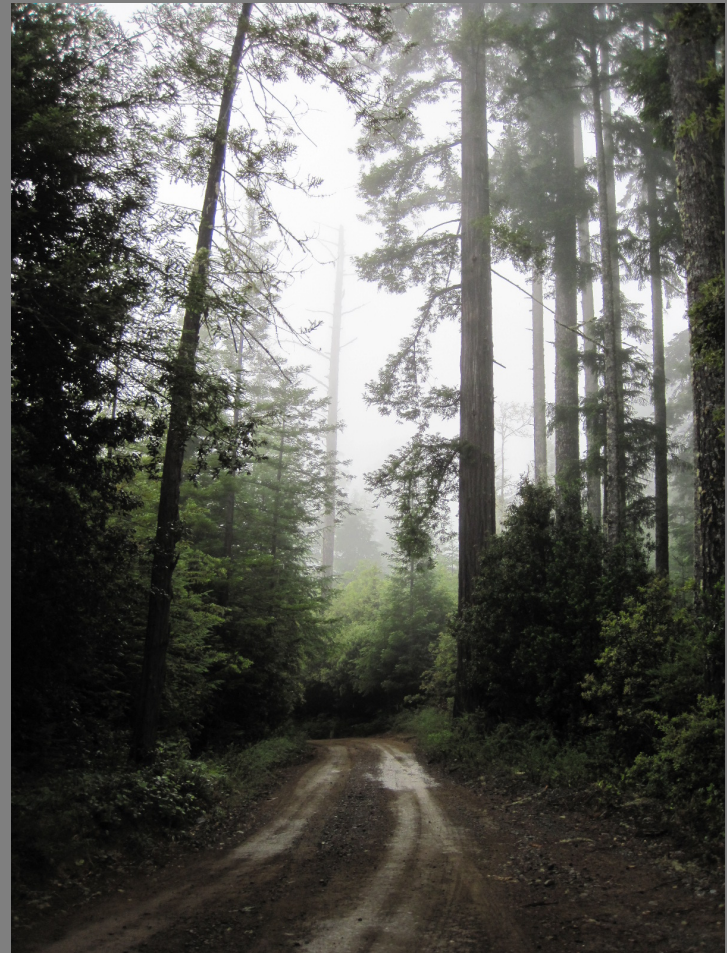
# Regional climate trends...



- Temperature increases of 1°, reduced September rainfall, reduced low flows in north coastal parks (Madej, 2011)
- Decreasing September rainfall and declining JUL-SEP streamflow at numerous sites (Asarian and Walker, 2014)
- 33% reduction in fog frequency since early 20th century (Johnstone and Dawson 2010)

# Fog in the redwoods...

- Sap flow reversals in mature redwoods during fog events  
(Burgess and Dawson 2004)
- Fog inputs of ~1000 mm/season, infiltration to 23 cm in Santa Cruz Mtns  
(Sawaske and Fryberg 2014)
- Fog throughfall of 10-30mm and ET suppression of 125 mm equated to dry-season water deficit reductions of 25% (Chung et al 2016)
- At Caspar Creek, fog drip < 100mm/season and highly localized (Keppeler 2007)



# In summary...

- Differences in silviculture influence the magnitude and duration of post-harvest streamflow changes and recovery.
- A return to pre-treatment flows is not necessarily the same as recovery.
- Precipitation-based models effectively describe low flow trends.
- Disentangling shifts in climatic conditions (seasonal rainfall, temperature, fog) from management impacts is of critical importance to sustainable forest management.





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**Thank you!**

**CAL FIRE**

**Jackson Demonstration State Forest  
Joe Wagenbrenner & Leslie Reid**

**Elizabeth Keppeler, Pacific Southwest Research Station**