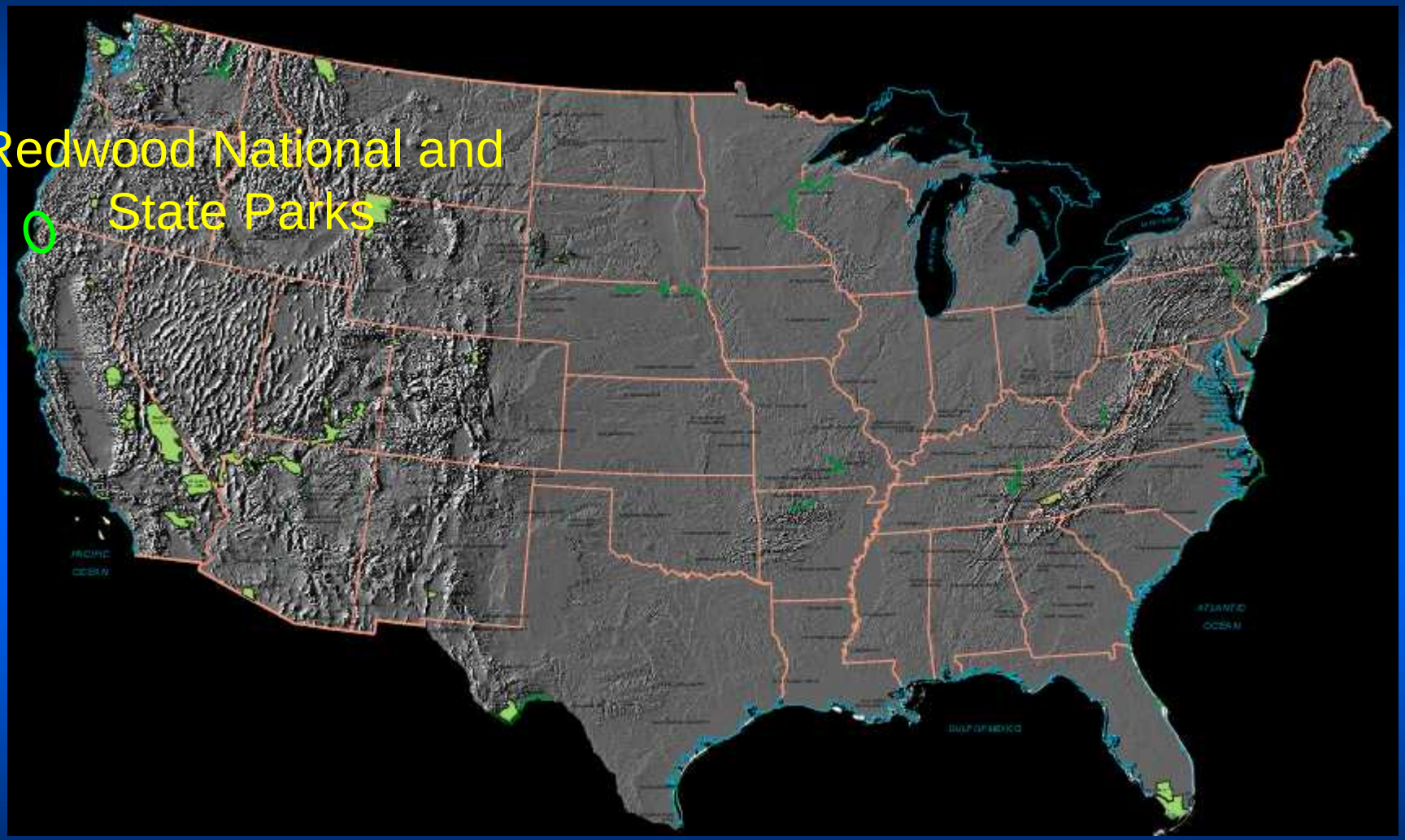
Channel response to large floods and impacts to aquatic ecosystems Redwood Creek, California.

Vicki Ozaki
Redwood National and State Parks

REDWOOD NATIONAL & STATE PARKS


Redwood National and
State Parks

Redwood Creek

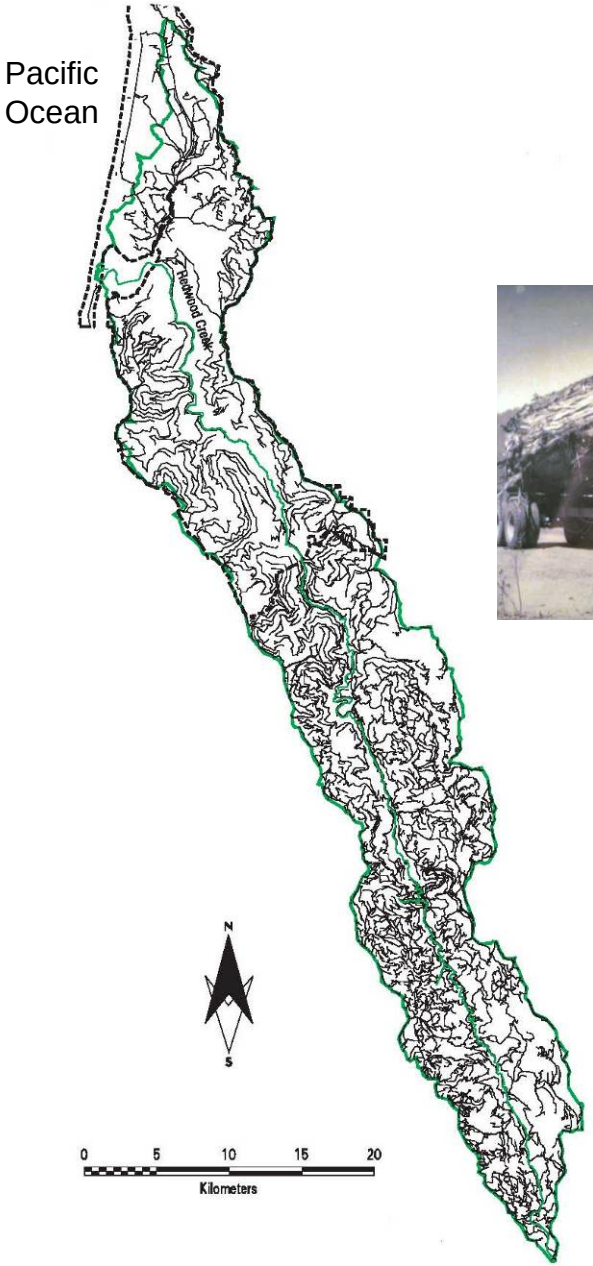
- D.A. 282 mi^2
- Length 70 mi

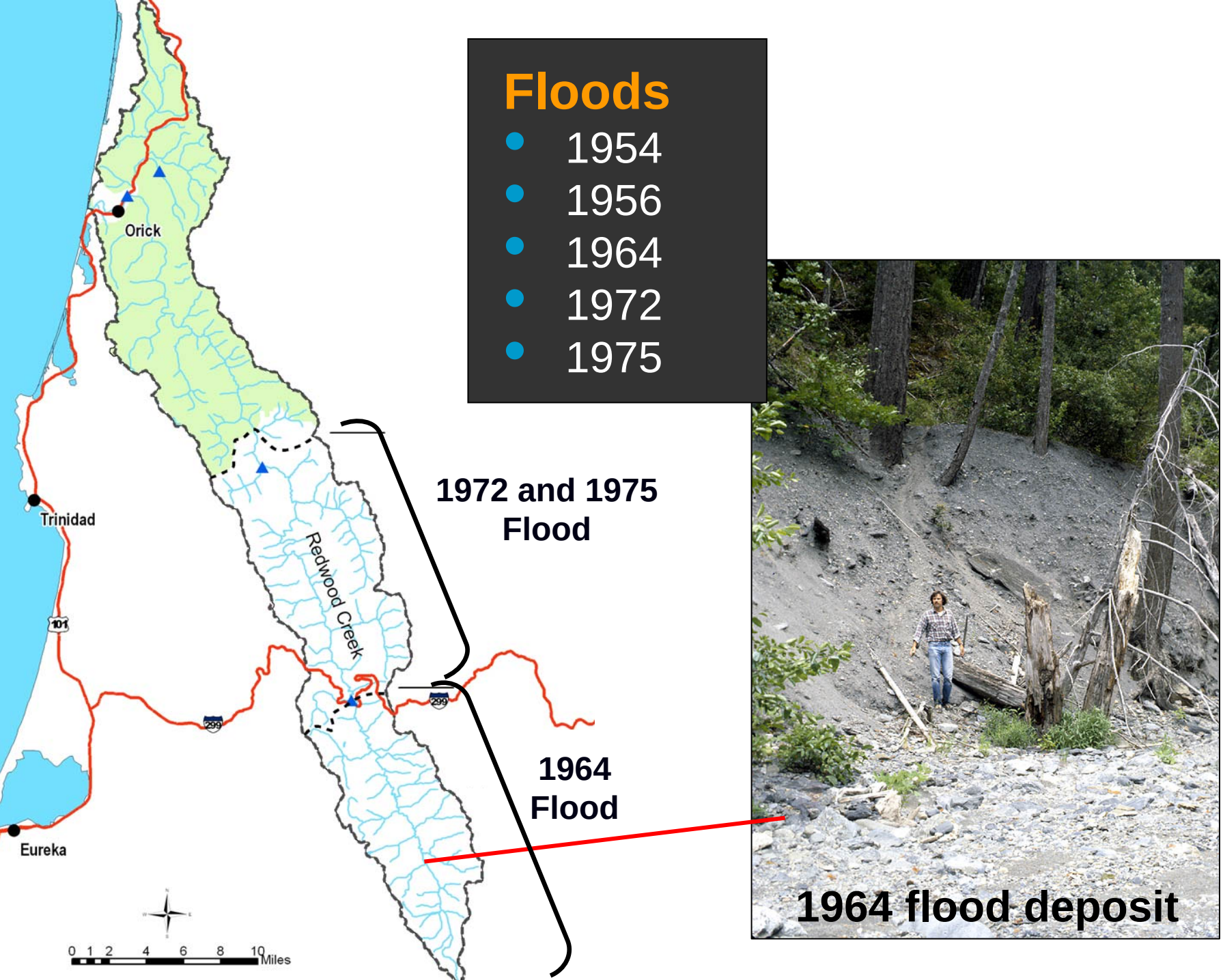
Land Ownership

54% Private lands

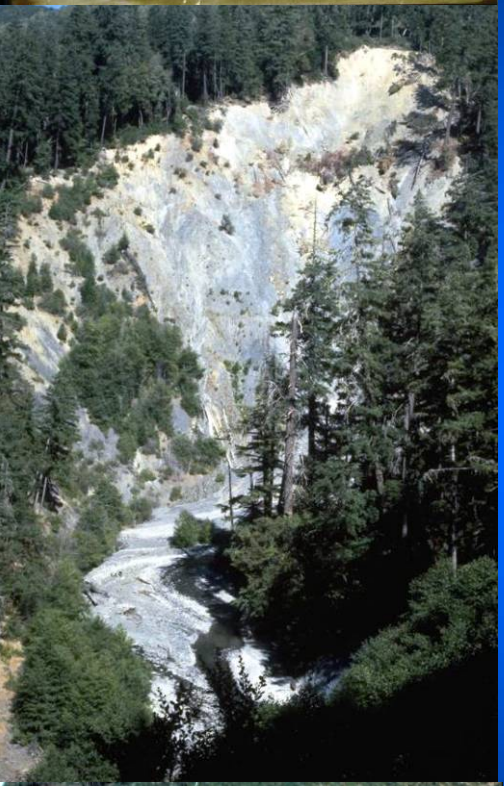
46% Public lands

1978 Road Network In Redwood Creek




Floods
1954
1956
1964
1972
1975
Orick
Trinidad
Eureka
Redwood Creek
101
299
299
1972 and 1975
Flood
1964
Flood
0 1 2 4 6 8 10 Miles
1964 flood deposit


Palm Café, 1950



Landscape susceptible to erosion

- steep, mountainous terrain
- unstable bedrock
- extensive logging road networks
- heavy intense rainfall – floods

Redwood Creek
Clean Water Act (303d List) -

- Sediment Impaired
- Temperature Impaired

Endangered Species Act –

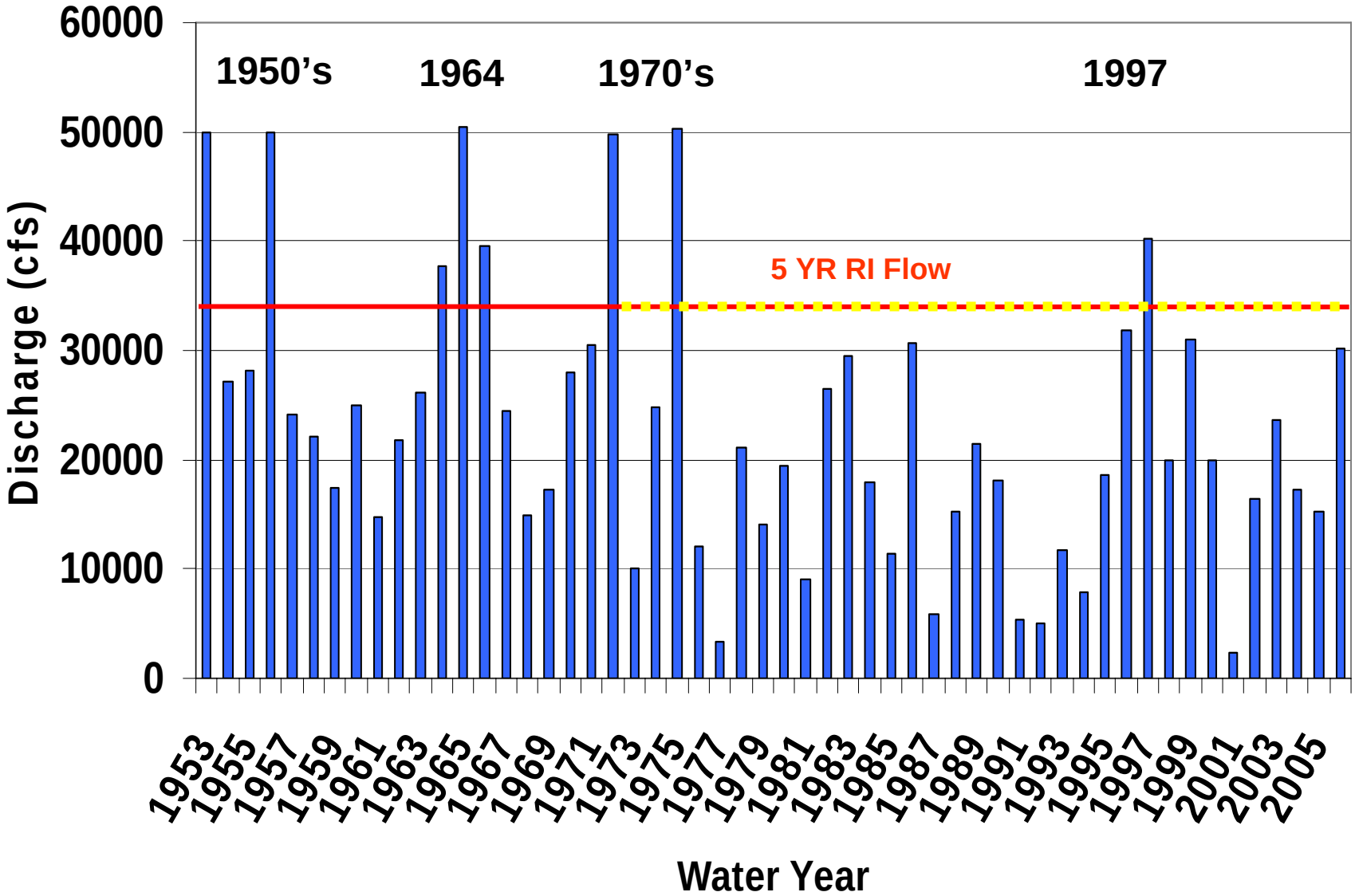
- 3 out of 4 salmonid species listed as Threatened (Coho and Chinook salmon, Steelhead trout)

Key Monitoring Programs

Tiered to watershed listings
Conducted in cooperation with the USGS

- Channel response studies
- Stream temperature monitoring
- Hydrologic studies and sediment transport

Peak Flows in Redwood Creek at Orick, California



Redwood Creek Channel Studies

Channel Studies

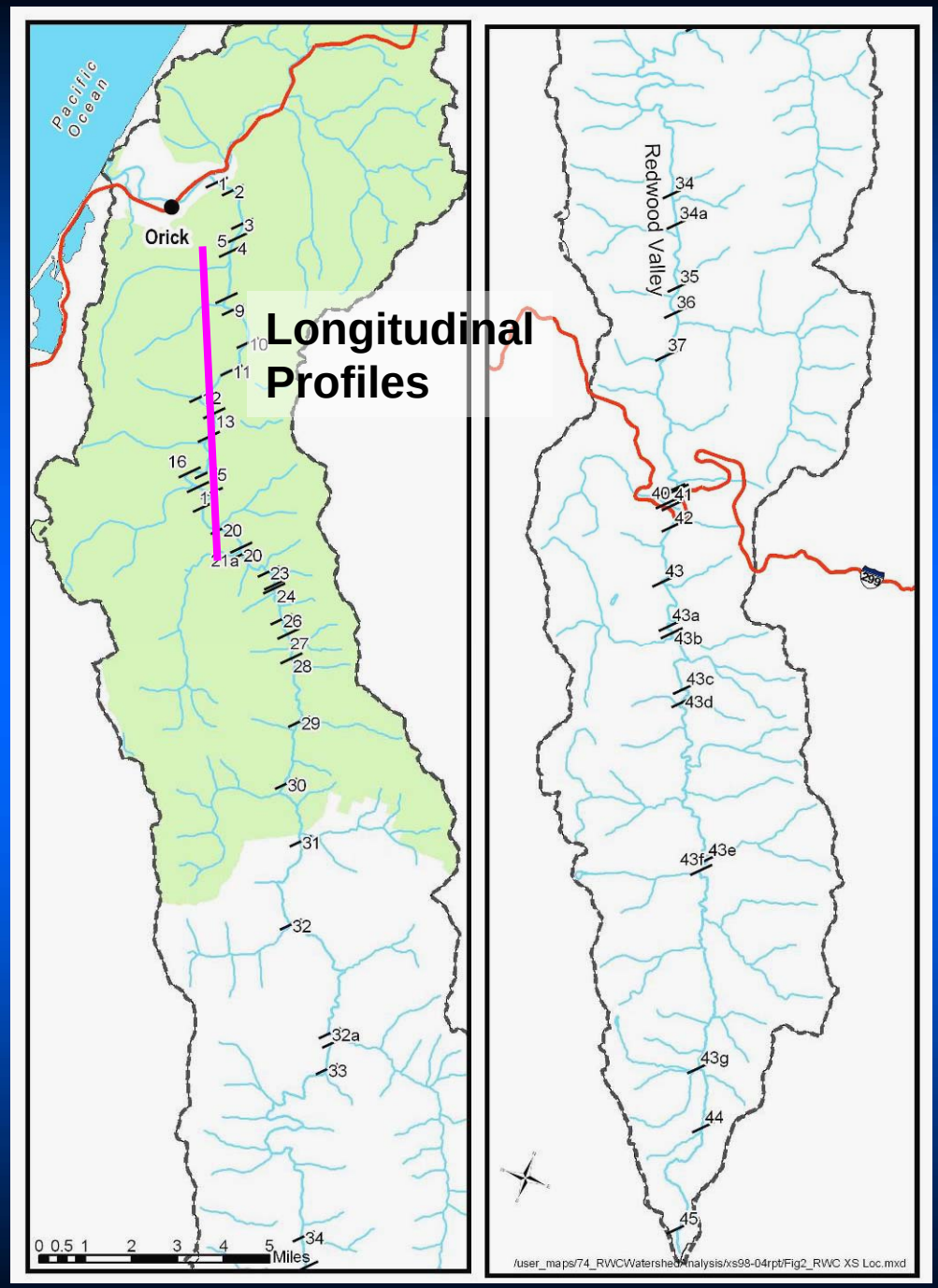
Purpose:

Evaluate long-term channel response and trends

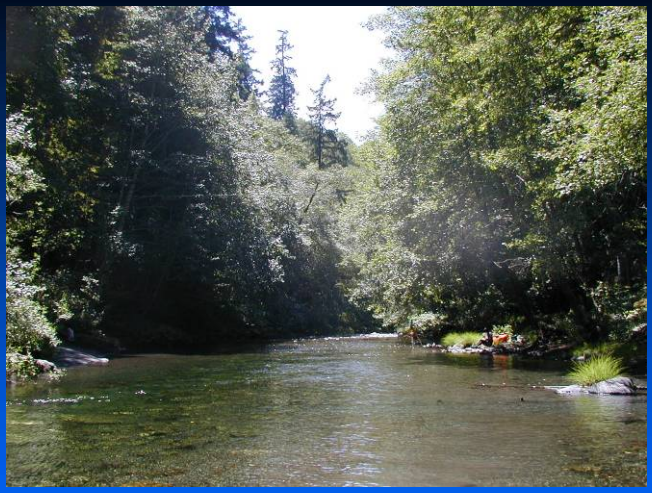
- **Cross Section Network**
  58 cross sections
  Established 1973

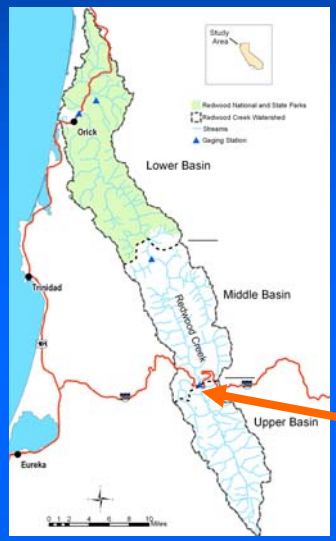
- **Longitudinal Profiles**

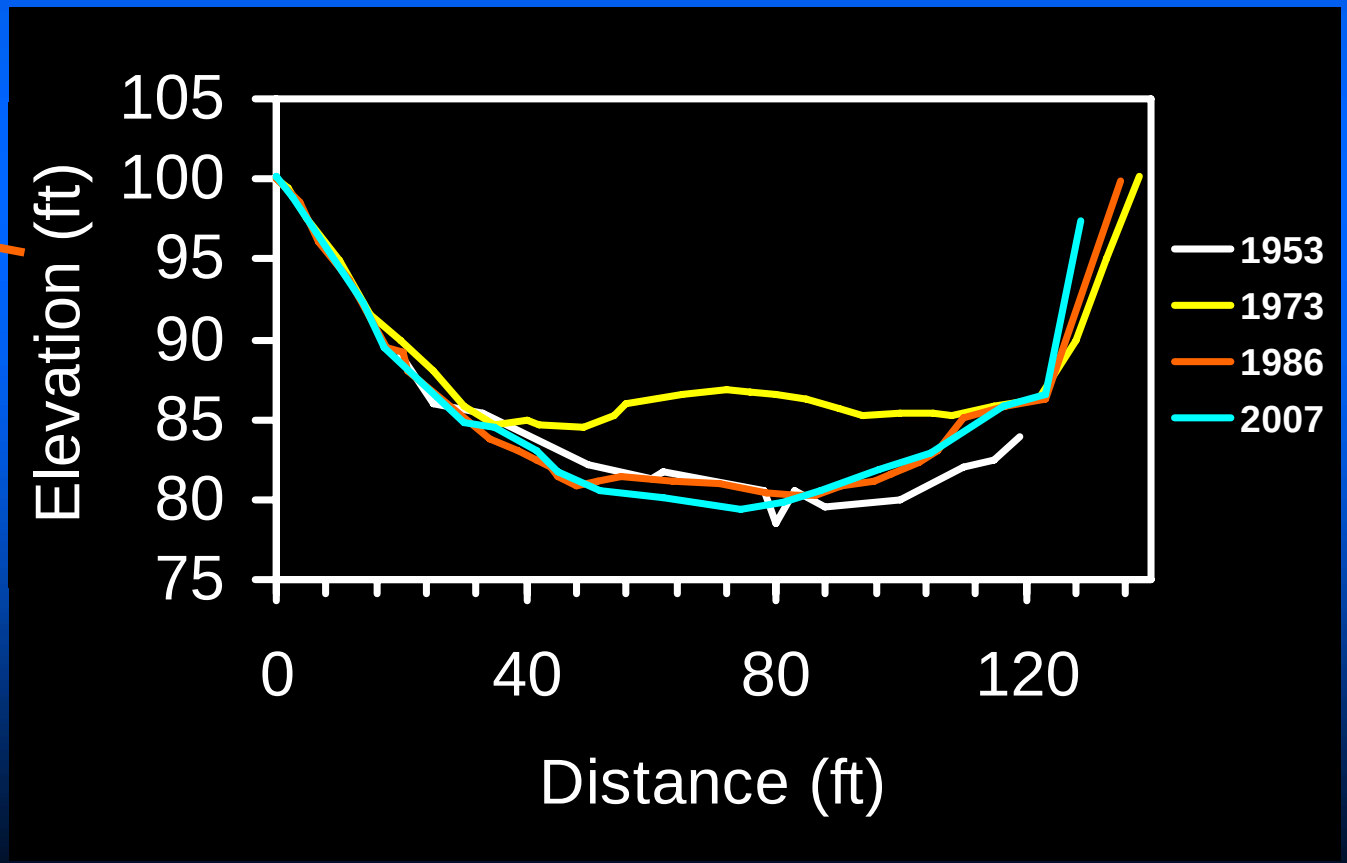
Over 30 years of monitoring



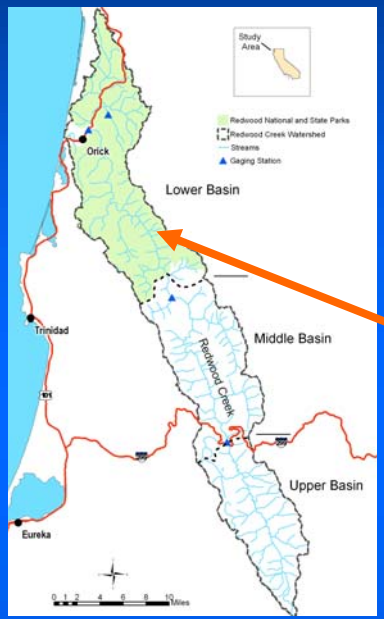
Cross Section 40
(below HWY 299)

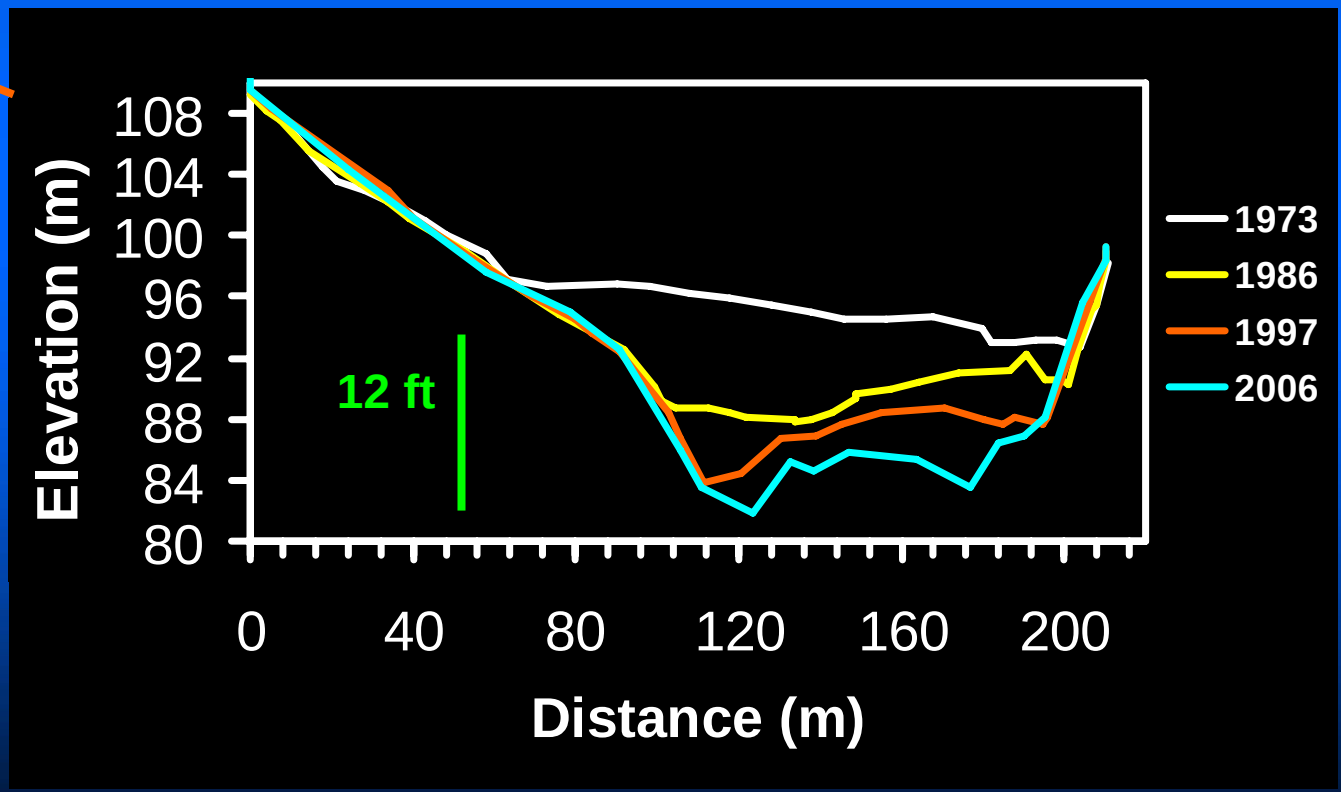




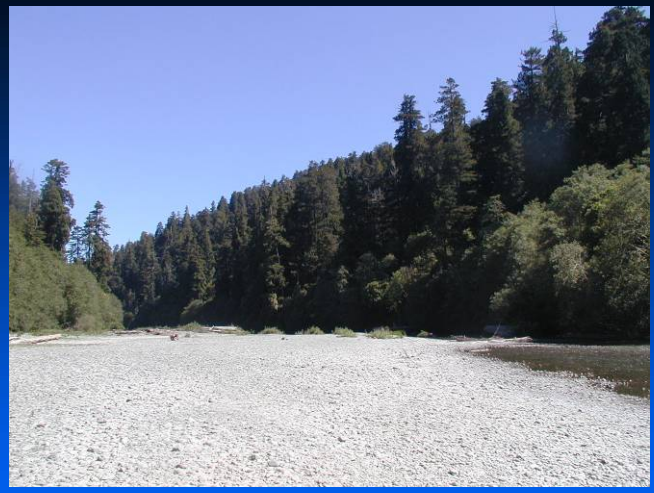


Lower Basin
Cross Section 25

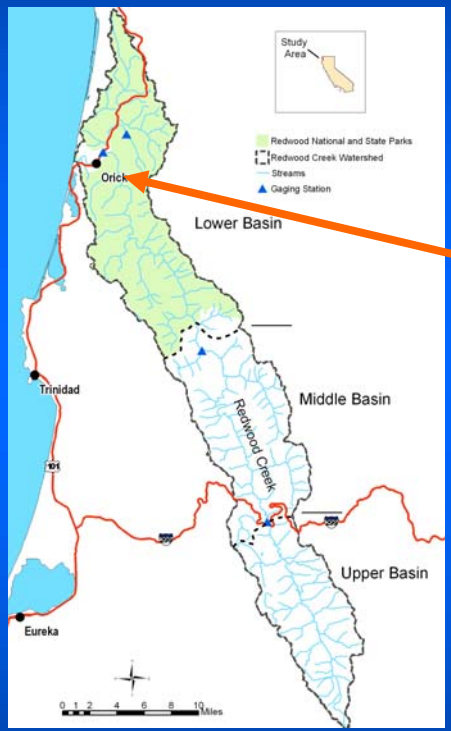


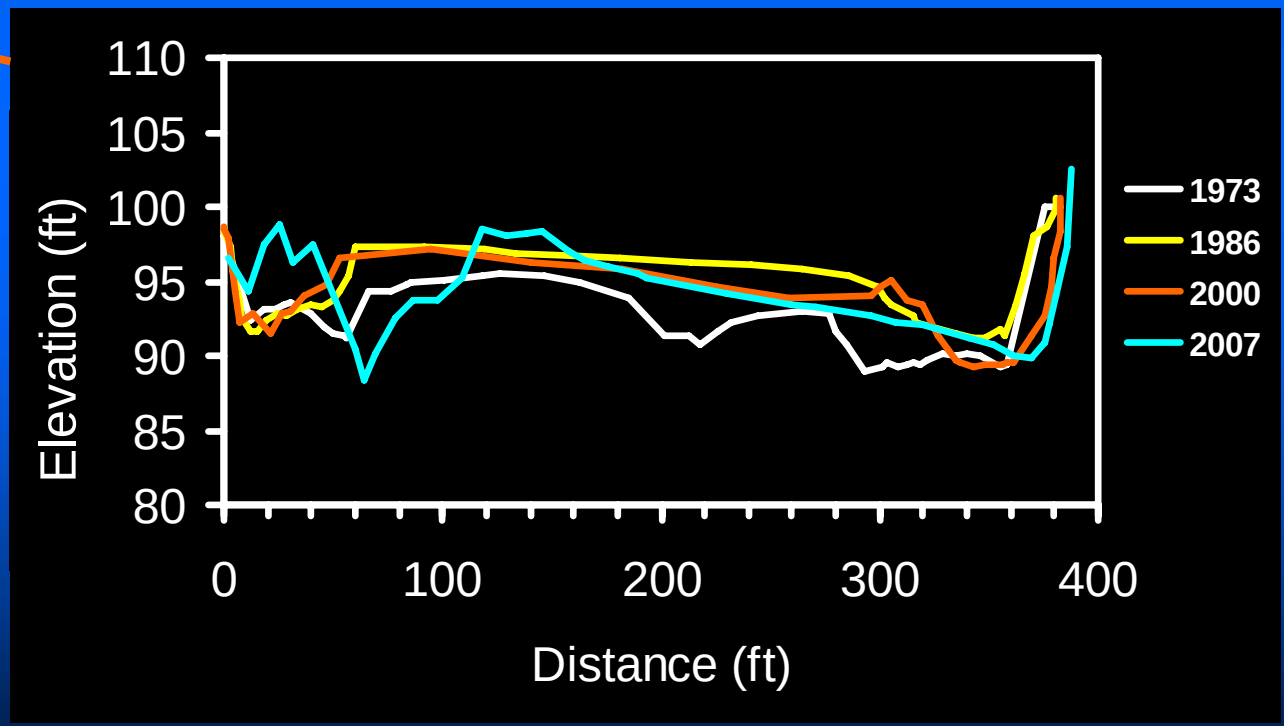


Cross Section 6
(below Elam Creek)

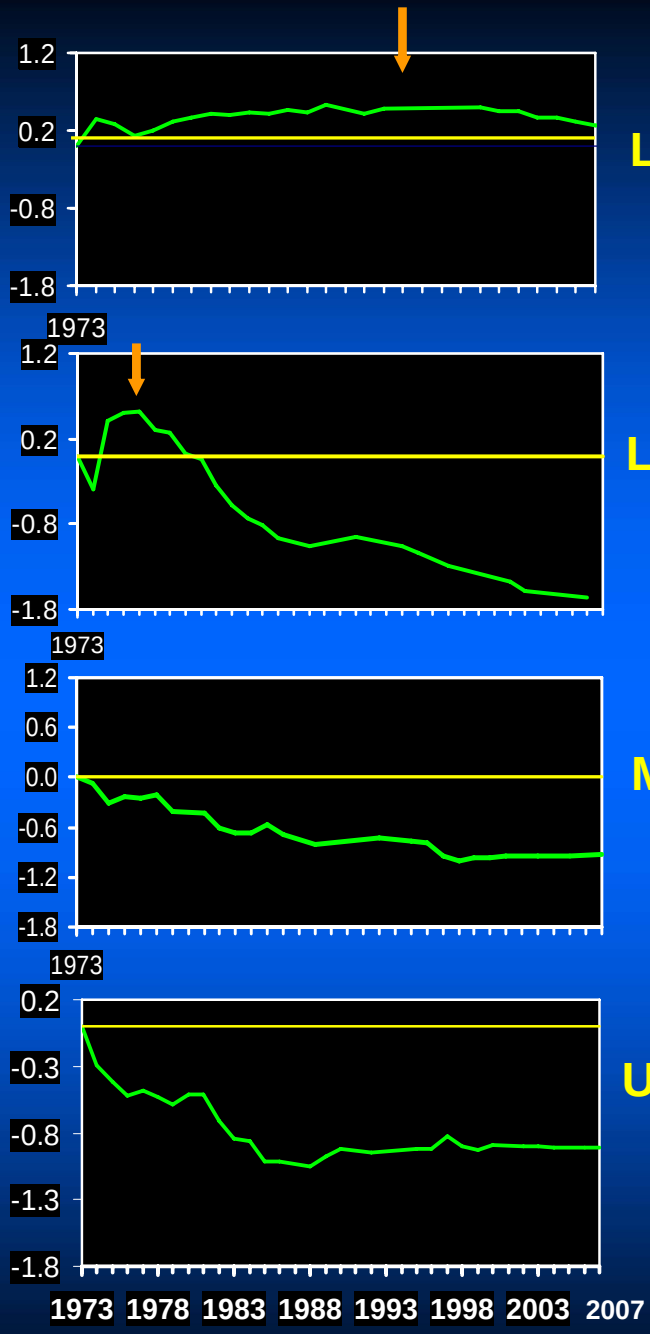


Pebble Wave





Mean Streambed Elevation (m)



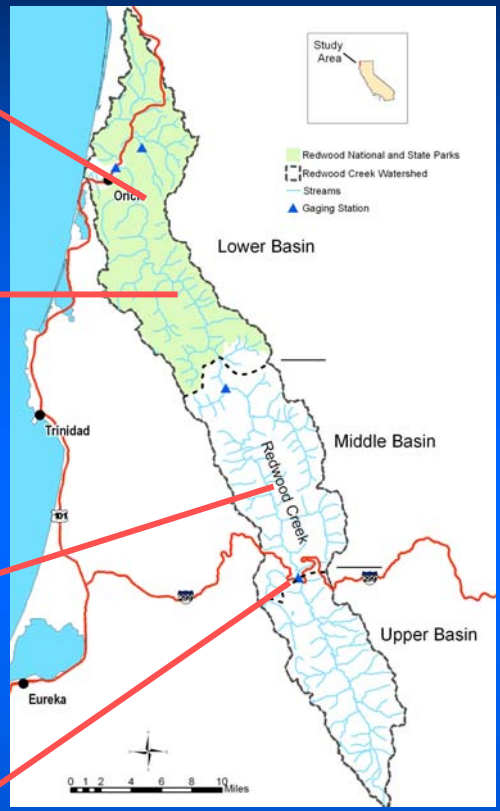
Year

Lower Basin
XS 6

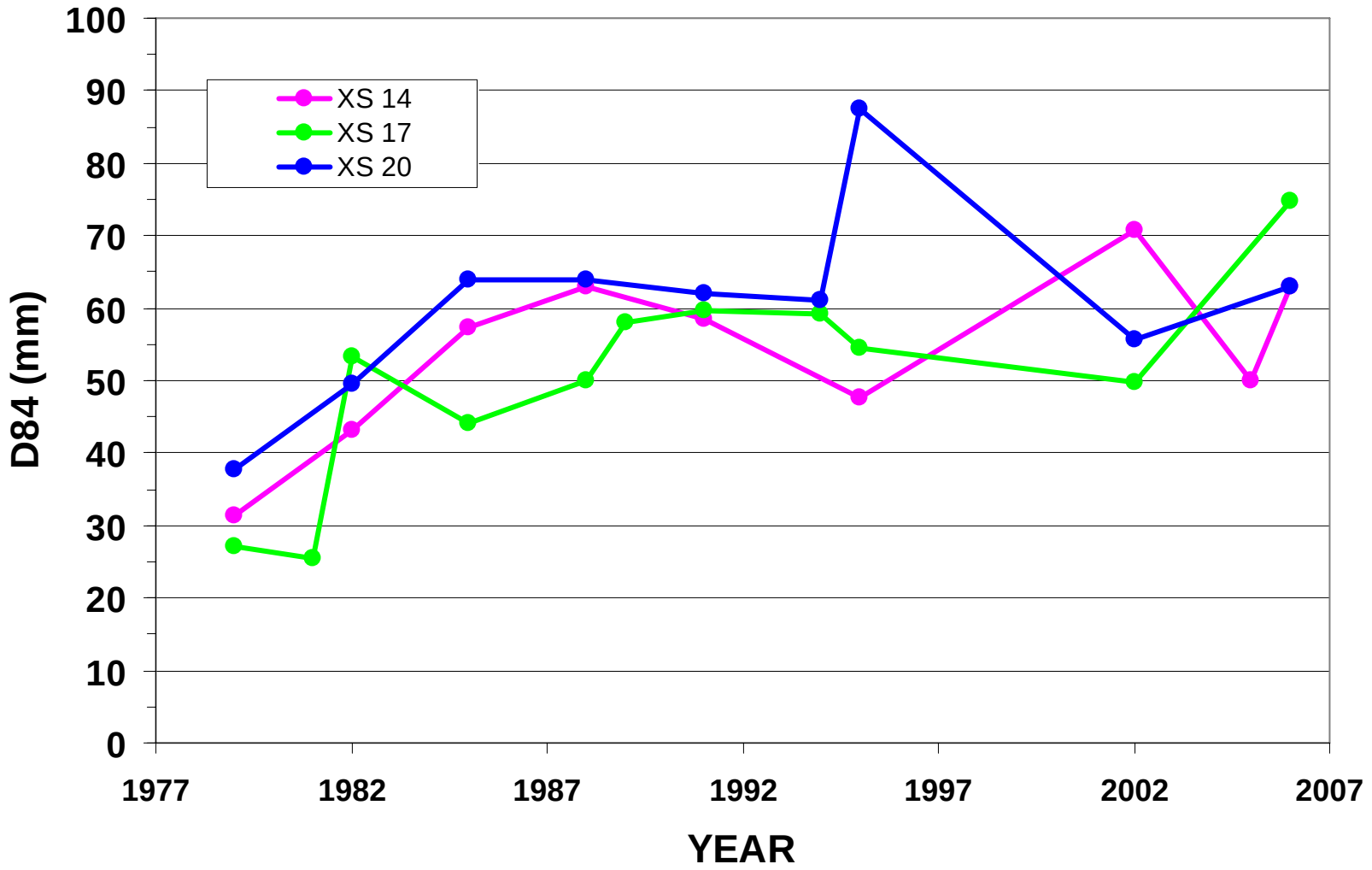
Lower Basin
XS 25

Middle Basin
XS 43

Upper Basin
XS 40

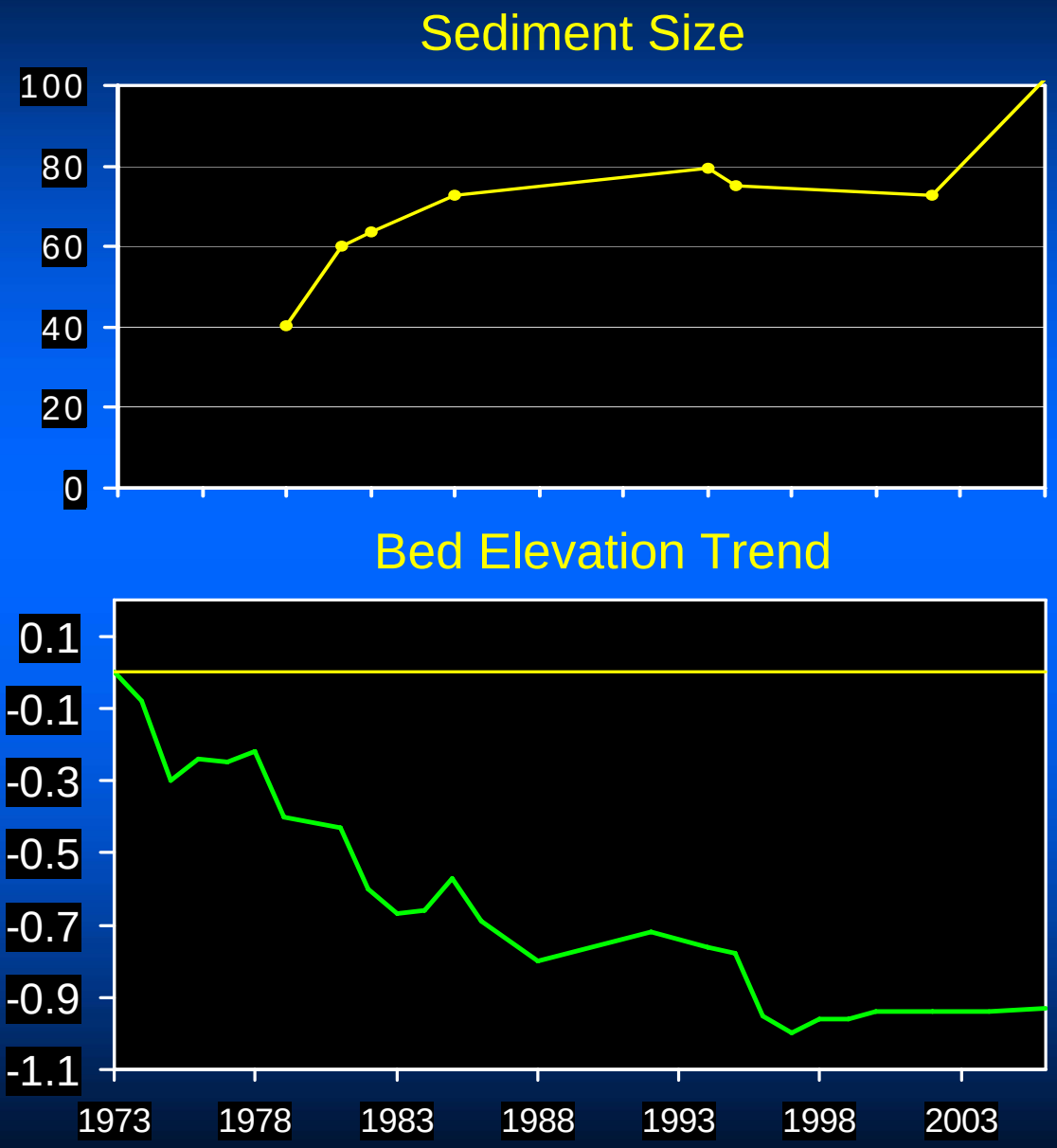


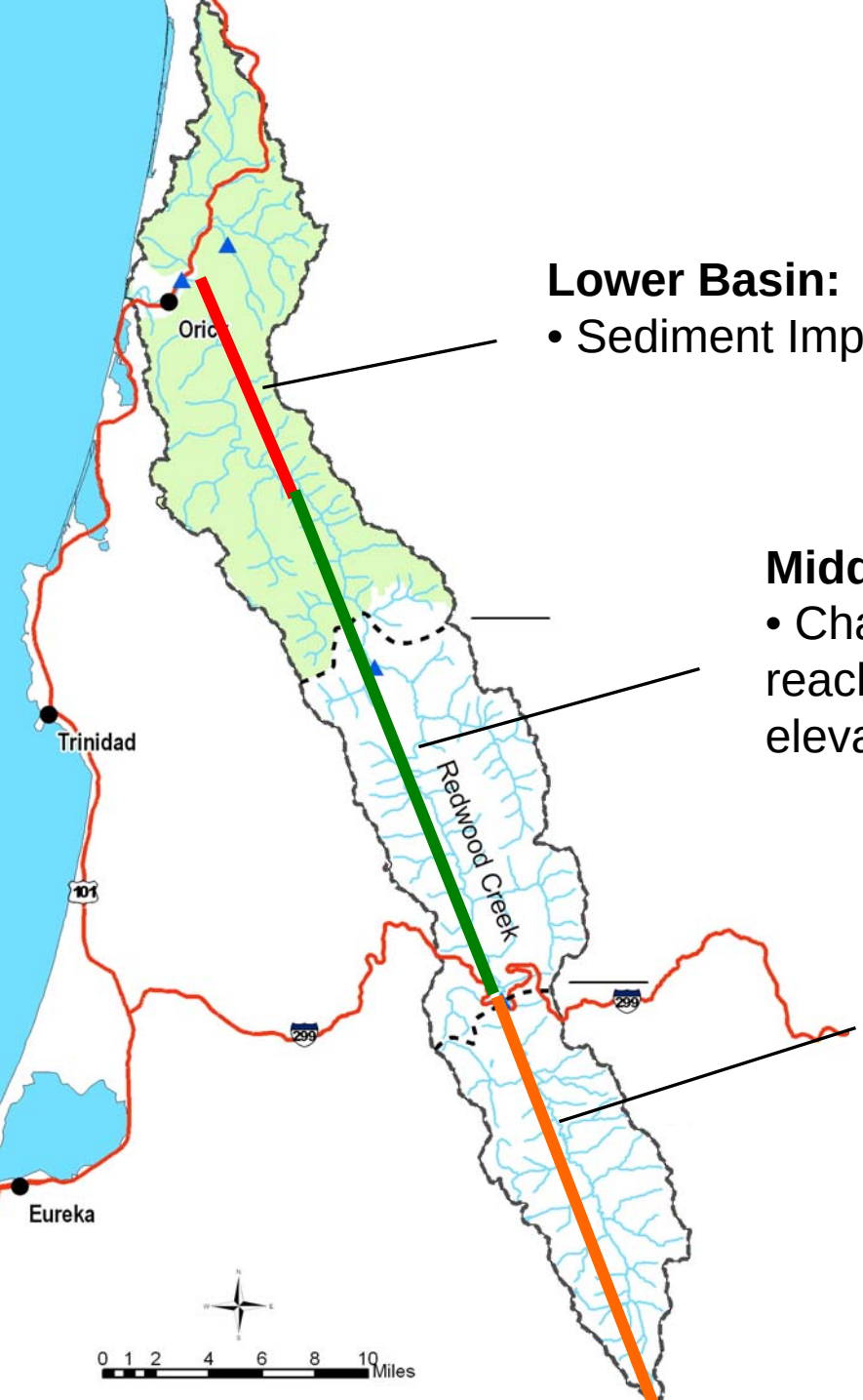
Change in D84 on Lower Redwood Creek



Response in Sediment Size to Channel Change

Middle Basin





Lower Basin:
• Sediment Impacted Reach

Middle Basin:
• Channel scouring or reached stable bed elevation

Upper Basin:
• Reached stable bed elevation
• Strongly Armored
• Bedrock exposed

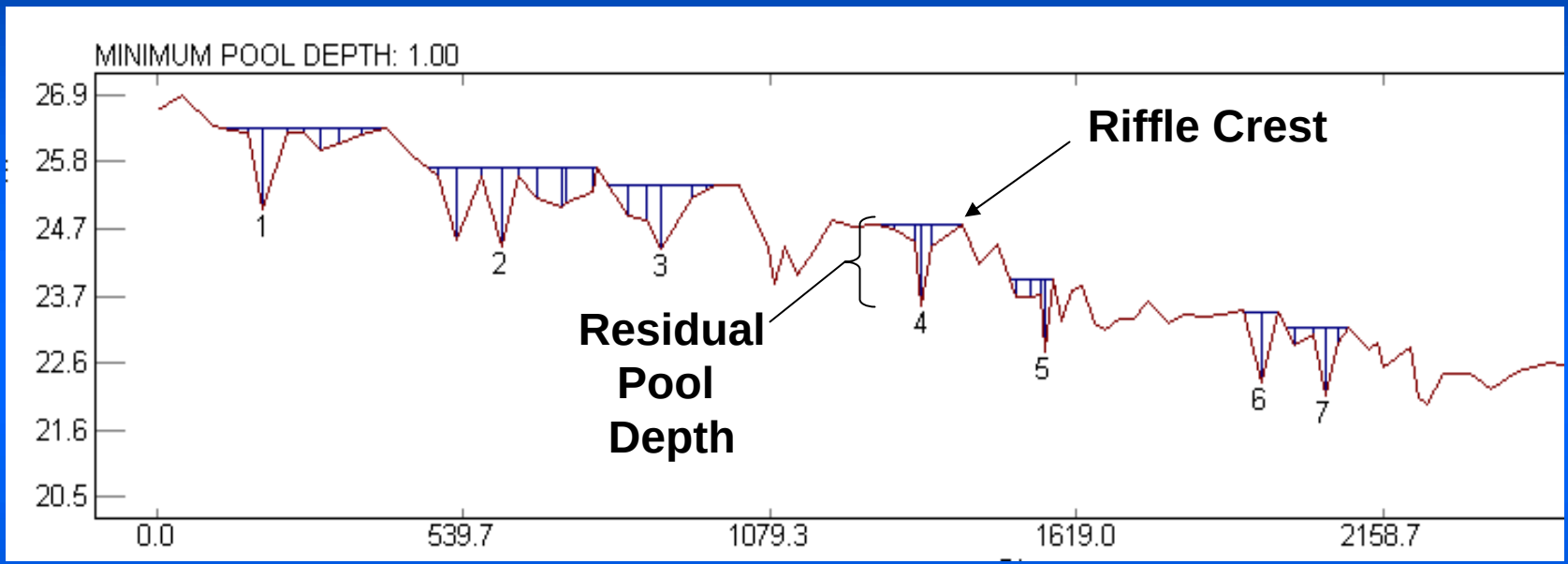
Longitudinal Streambed Profiles

Lower Redwood Creek

- 1977
- 1983
- 1986
- 1995
- 1997
- 2007

Longitudinal Profiles of Redwood Creek

Residual Pool Depths



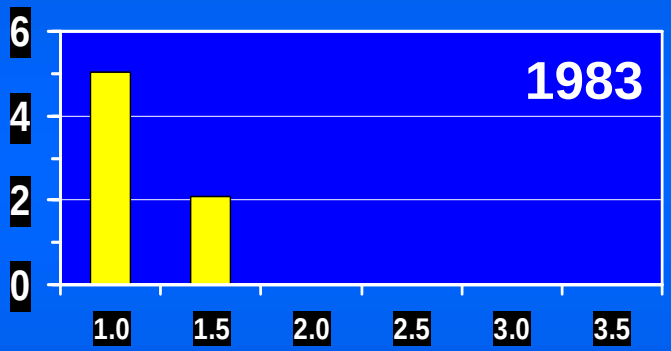
Elevation (m)

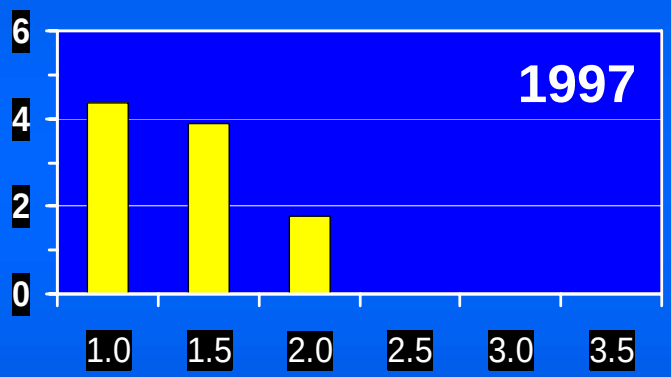
Distance (m)

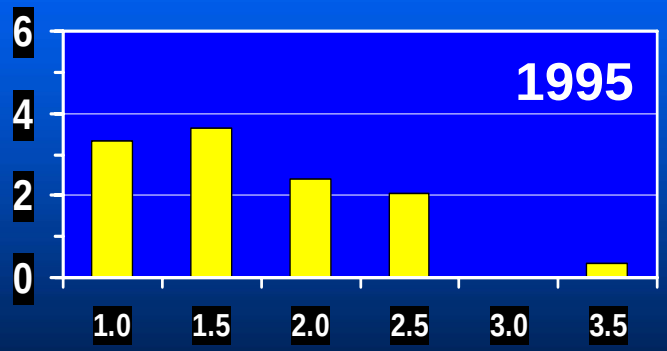
Frequency of Pools in Lower Redwood Creek

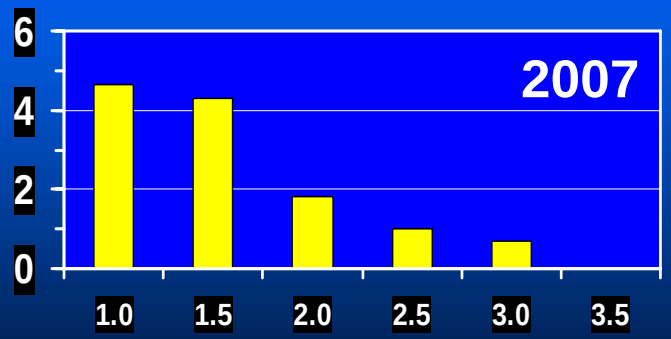
1997 Flood
10 year RI

Number of Pools per Km









Residual Pool Depth (m)

Residual Pool Depth (m)

Channel Monitoring Lessons Learned

- Sediment delivered to stream channels during large flood events
  - *persists for more than 3 decades*
  - *impacts multiple lifecycles of salmon and steelhead*
- Redwood Creek is in process of recovering. Small floods set back recovery.
- Prevent erosion and sediment delivery to channels important … rather than trying to mitigate for damages later.
- Channel bed elevation and pools are one measure of recovery, but sediment loads, riparian condition, LWD, stream temperature remain impaired on Redwood Creek.

Redwood Creek
Stream Temperature Monitoring

Living in the Hot Zone:

Evaluating effects of stream temperature on
juvenile coho salmon distribution in Redwood Creek

REDW concerned about effects of summer water temperature on juvenile salmonids.

- Juvenile coho and steelhead reside in stream at least 1 year. Require cool water during summer.
- Juvenile salmon prefer 12-14^{o}C and avoid temp > 15^{o}C
- Extended exposure of temp above 25^{o}C may be lethal
- About 18-20^{o}C growth stops/slows down

Stream Temperature Monitoring

- Ground-based measurements
  (in-stream data loggers)
- Remote sensing technique
  (thermal infrared imaging)

Thermal Infrared Imaging

Redwood Creek

- Remote sensing tool
- Used to evaluate surface water temperature
- Covers many stream miles, short amount time

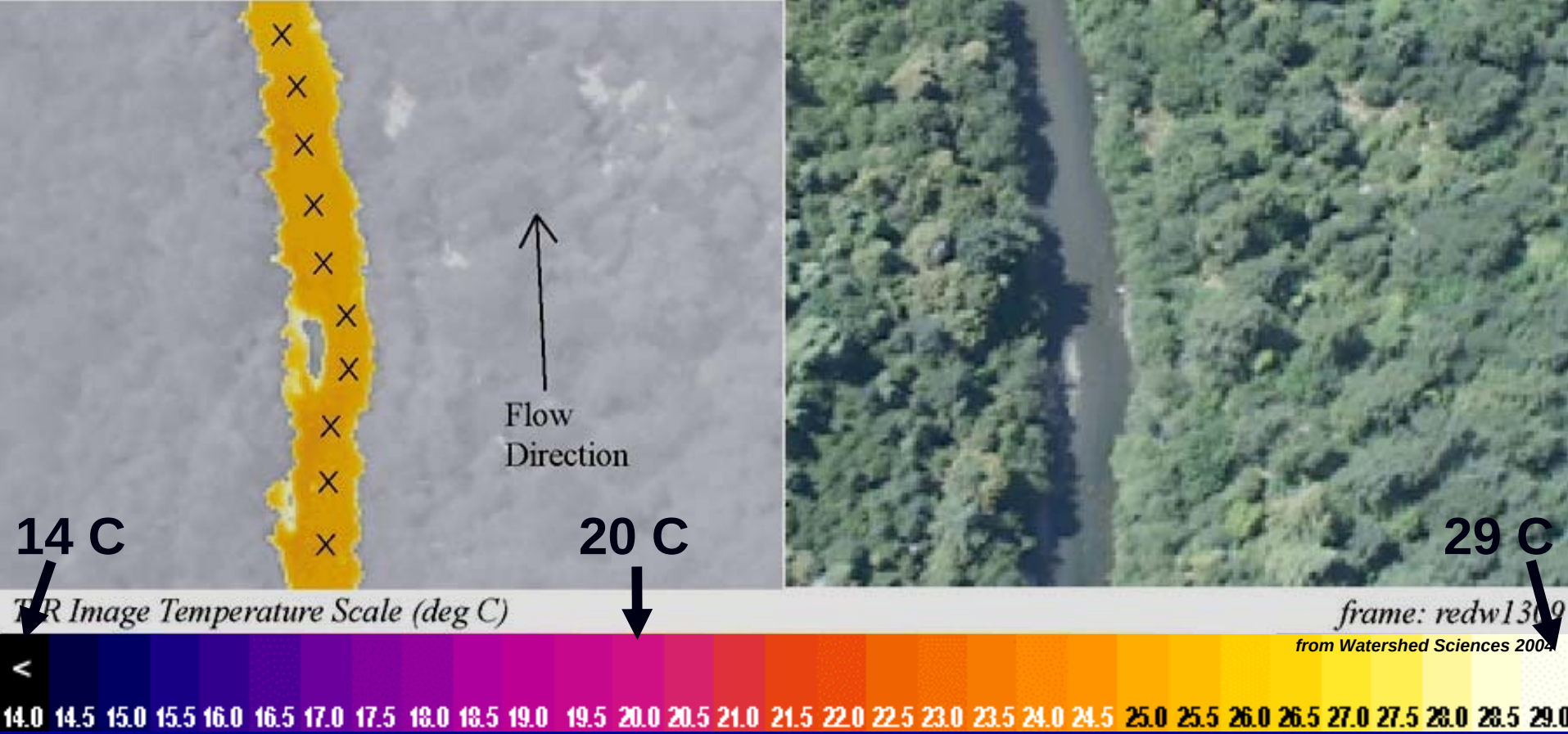
Purpose

- Evaluate spatial distribution of surface water temperature
- Identify thermal characteristics
  - warm versus cool reaches
- Validate in-stream temperature monitoring locations
- Determine presence/absence of juvenile coho

Thermal Infrared Data Collection

- Contracted with Watershed Sciences
- Helicopter - 1400 ft elev.
- TIR and color camera
- Digital Video
- acquired 2653 images

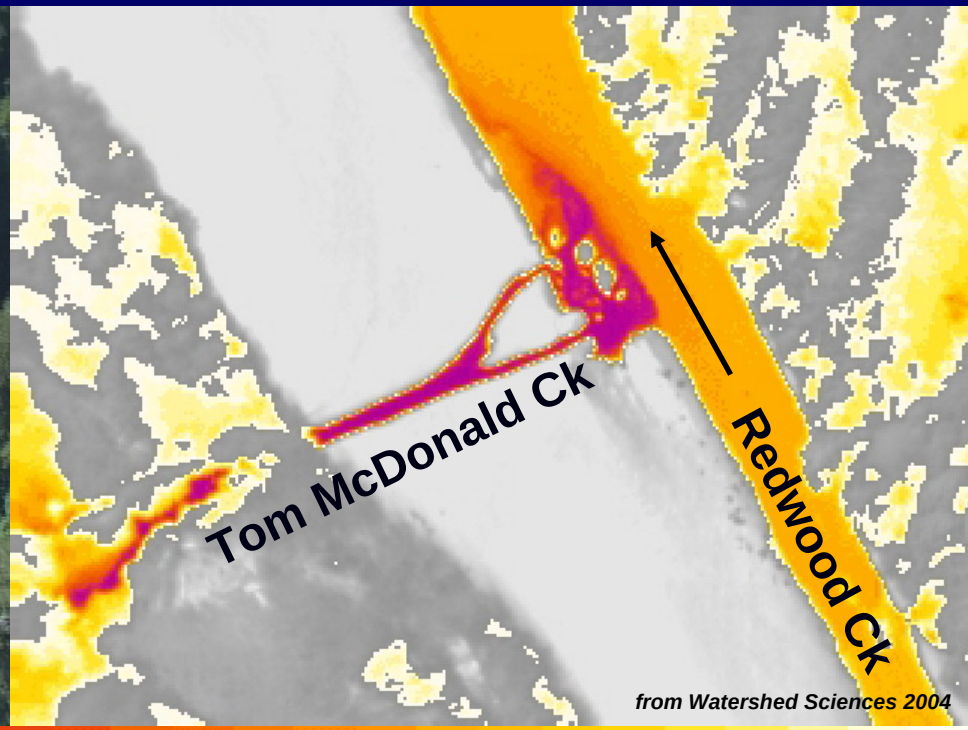
Project Funded by:
NPS Water Resources Division

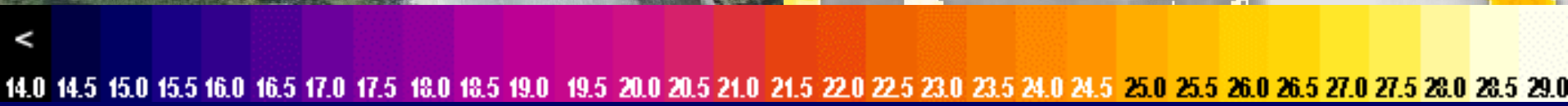


For each Image:

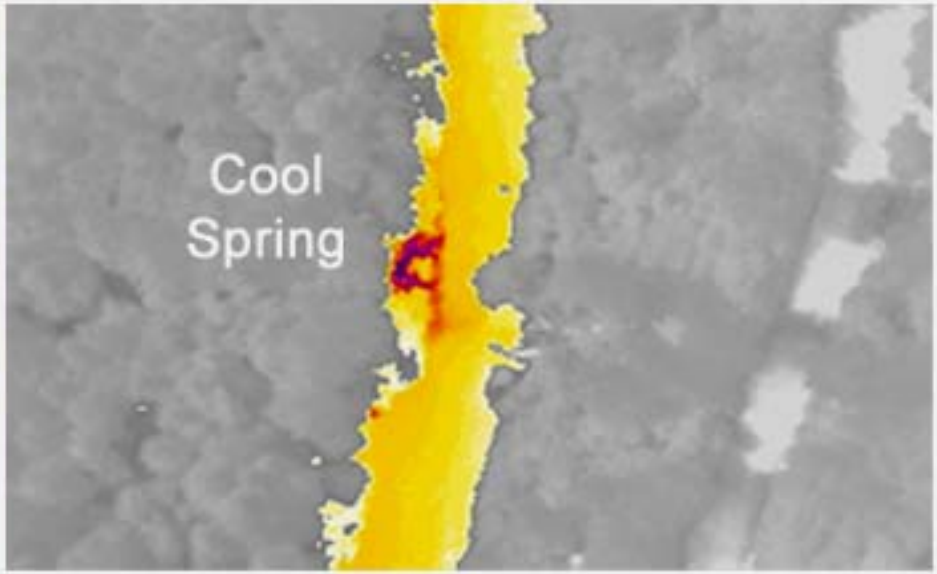
- Paired image (TIR & natural color photo)
- GPS location
- 10 sample points along center-line of channel
- Water temperature = median of sample pts

Cool Tributary Inflow





Cool Seep and Spring

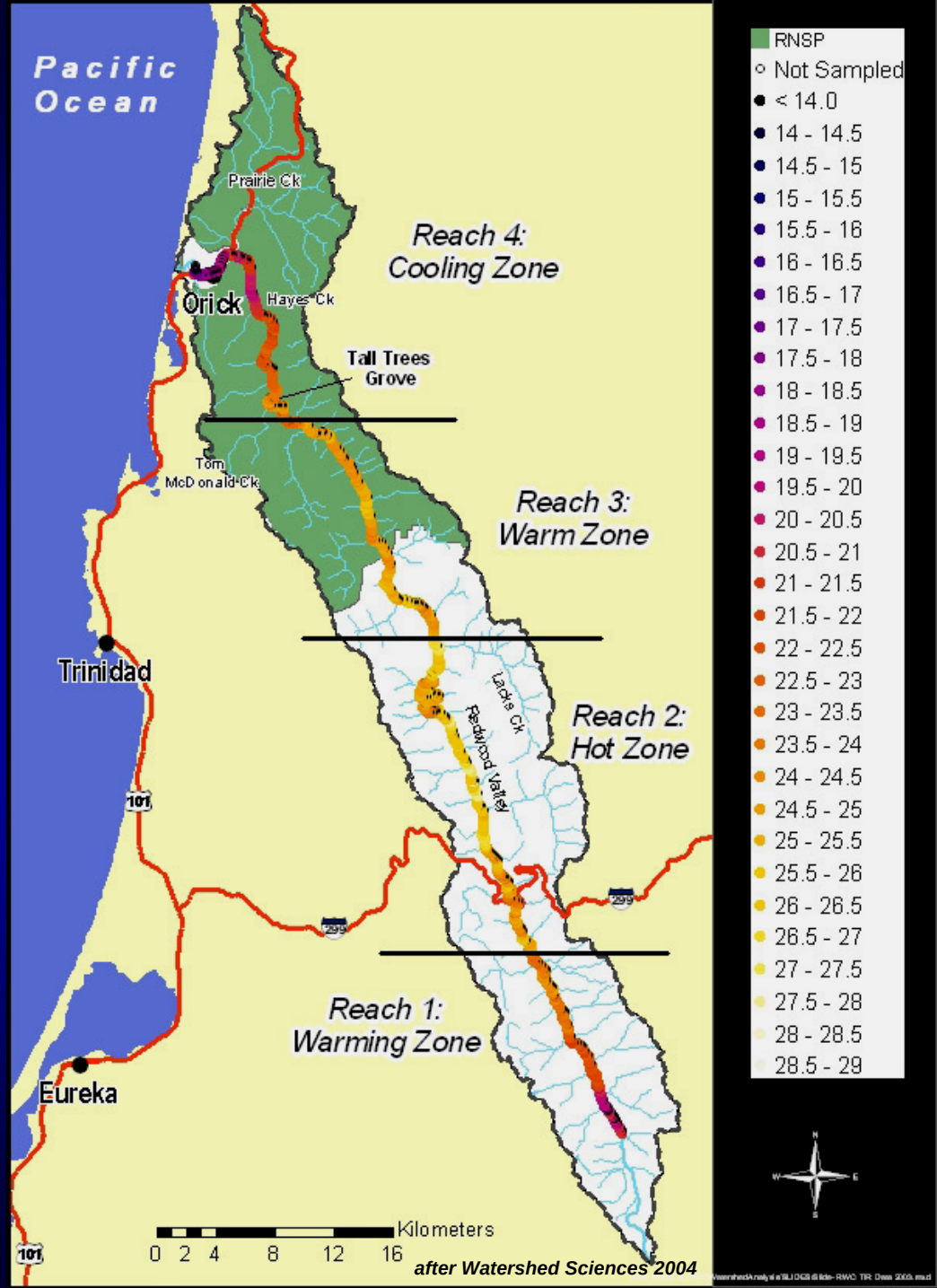


from Watershed Sciences 2004

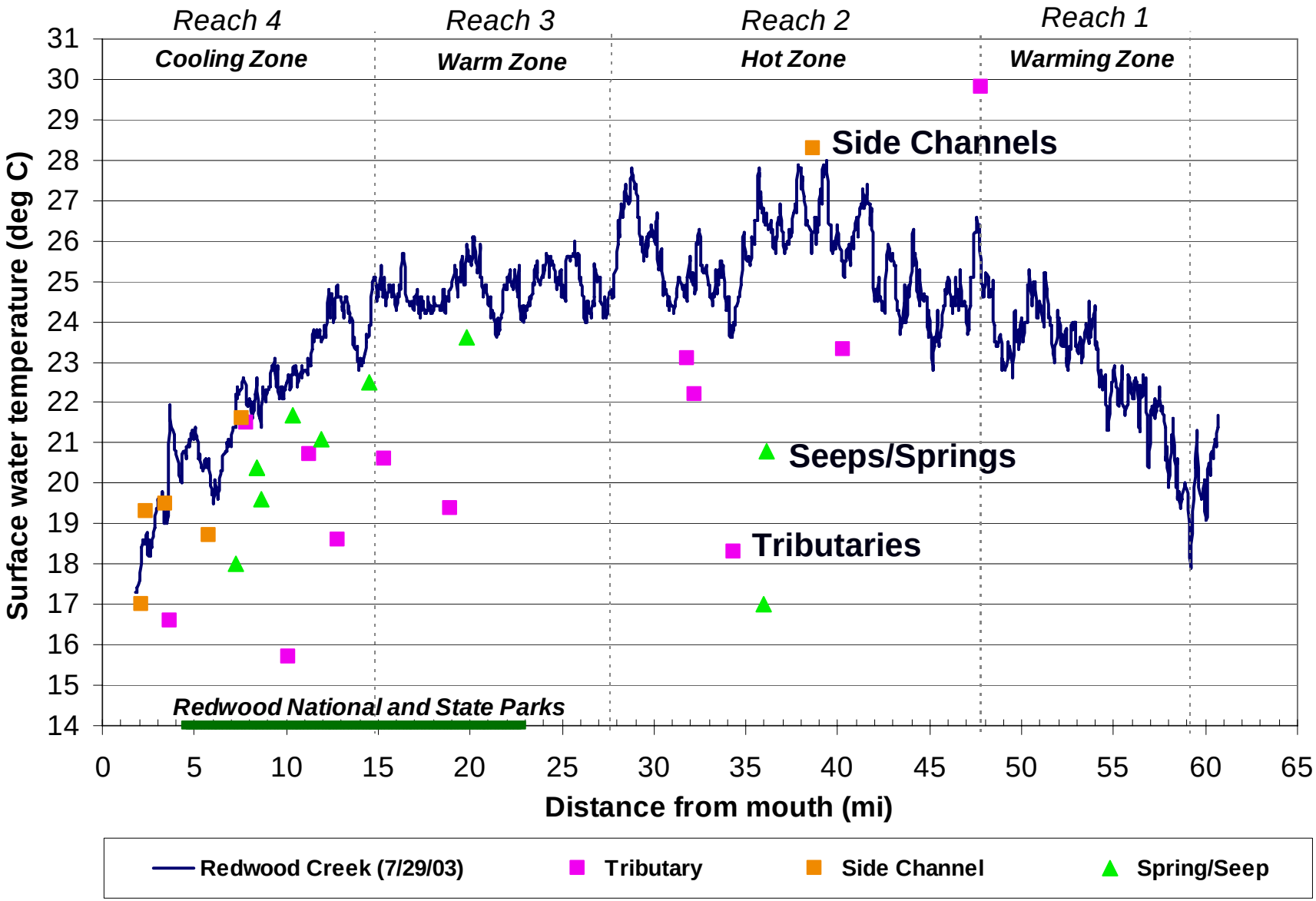
Thermal Image Temperature Scale (degrees C)

Spatial distribution of stream temperature

- **Reach 4-Cooling Zone**
  - High number of spring/seeps, side channels
- **Reach 3-Warm Zone**
  - Ave. water temp 24.8 C
- **Reach 2-Hot Zone**
  - High temp variability
  - Range 23-28 C
- **Reach 1-Warm Zone**
  - Temp incr. 18 - 25 C



Redwood Creek TIR Temperature Data



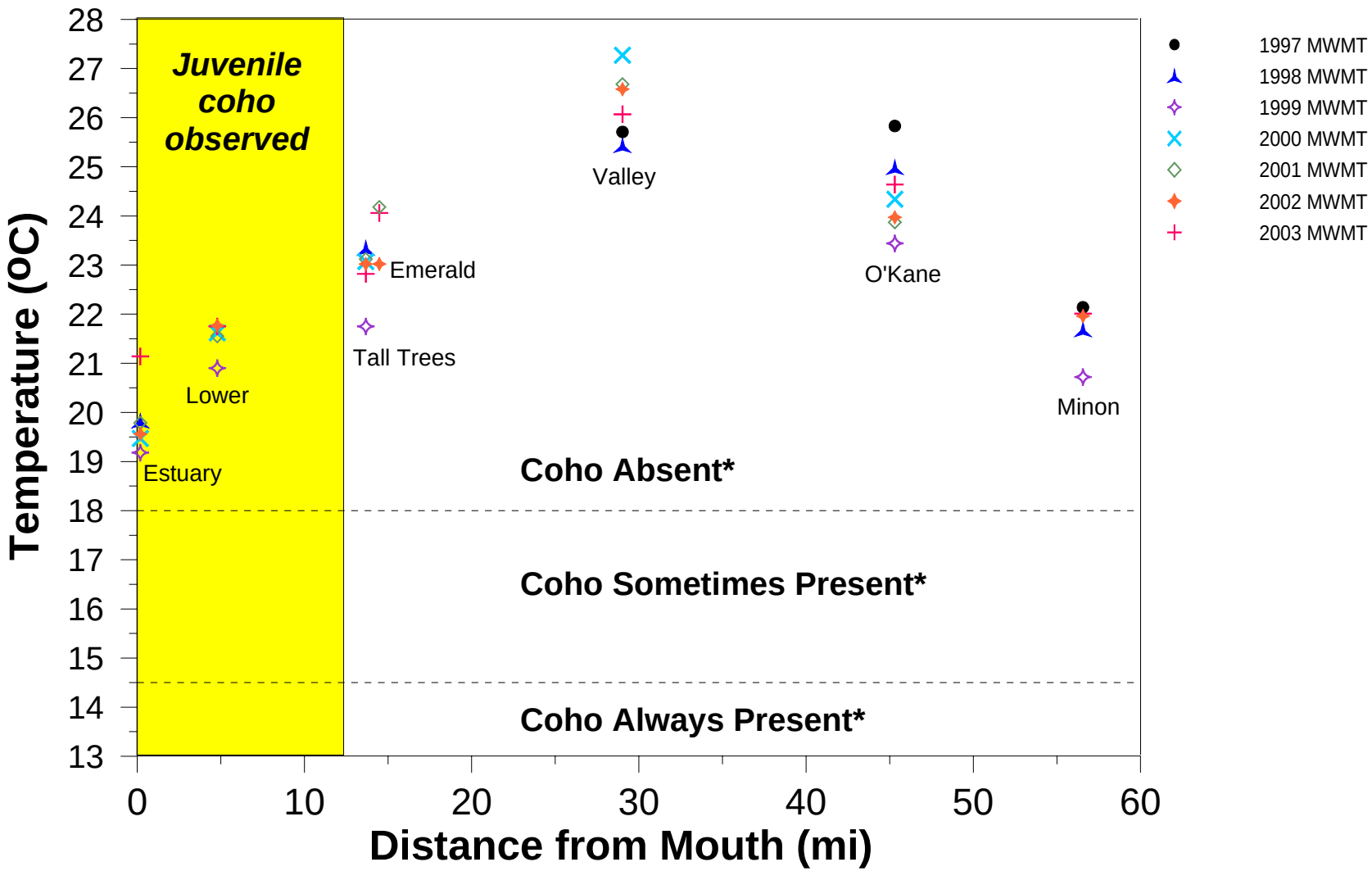
after Watershed Sciences 2004

Determining juvenile coho use of the mainstem

- Juvenile Coho Presence/Absence
- Direct Observation
- Survey 40% lower channel

- Found in only lower 13 miles
- 7 locations side pools
- 2 locations main channel
- stream temp same or cooler than mainstem
  - side pools with tributary inflow 3-6 C cooler

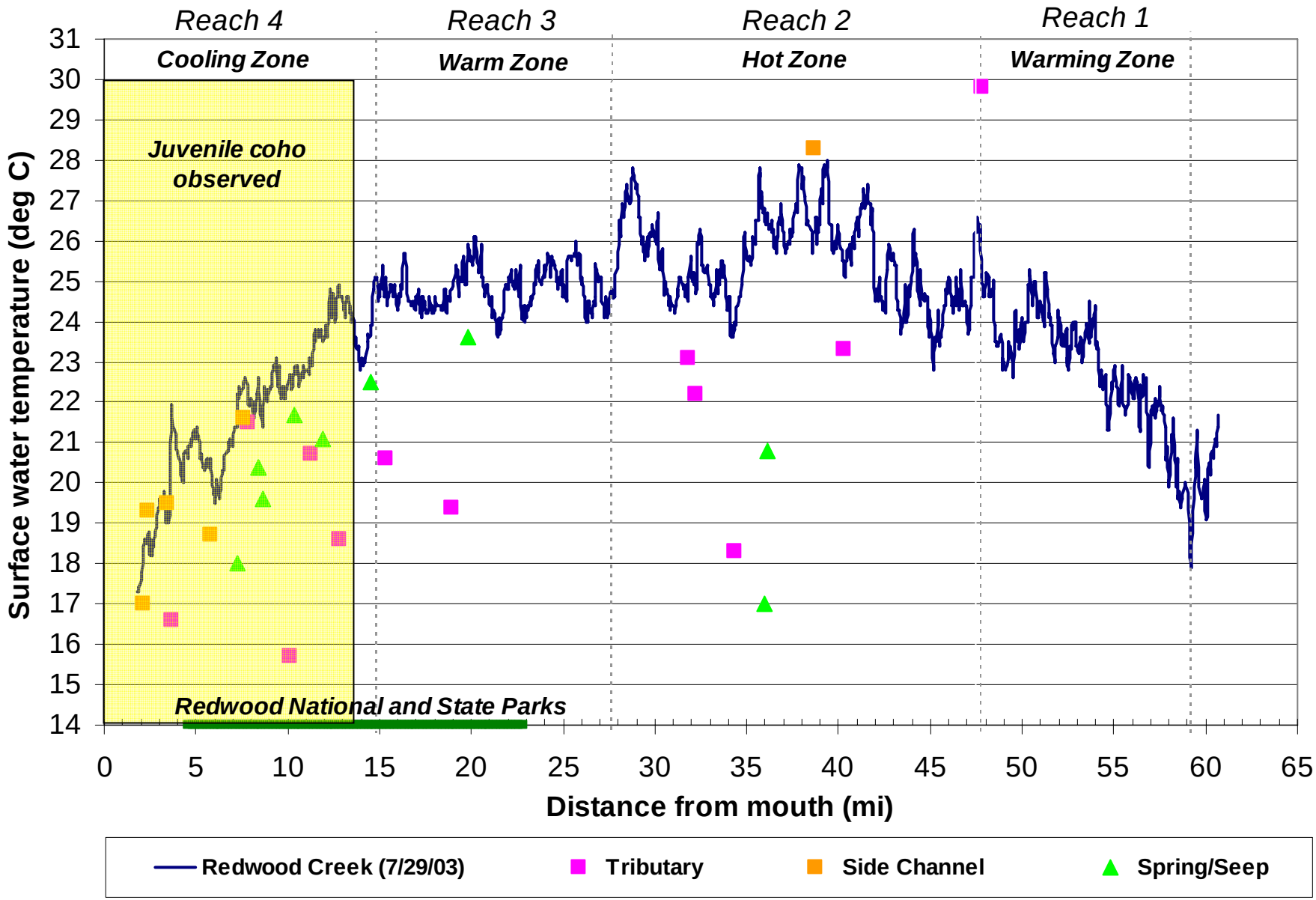
Maximum Weekly Maximum Temperature 1997-2003



* Data from Welsh *et al* 2001

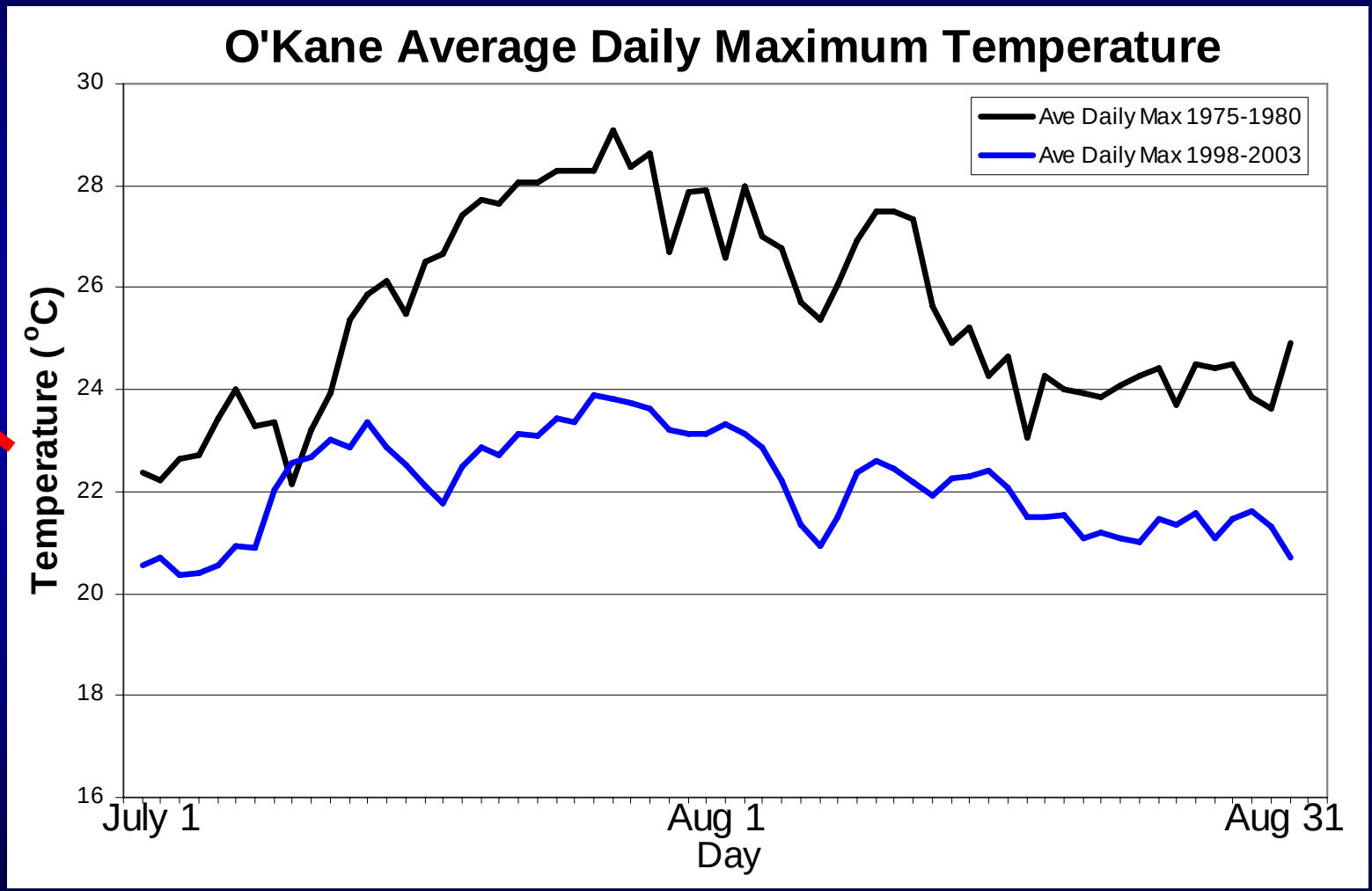
Max. Weekly Maximum Temperature: 7-day moving average of daily maximum temperature
The highest water temperatures fish exposed to - 7 consecutive days

Redwood Creek



after Watershed Sciences 2004

How has water temperatures changed over time?



Stream Monitoring Lessons Learned

- No barriers to fish movement.
- < 20% of the main channel used by rearing juvenile coho
- Mainstem exceeds optimal water temperatures
- Stream temp appears to influences juvenile coho distribution
- Cool water refugia important

Stream monitoring data used to support

- Trend monitoring/watershed response
- Provide baseline watershed information
- Watershed level planning and initiatives
- Restoration planning
- Fisheries studies

Questions?