

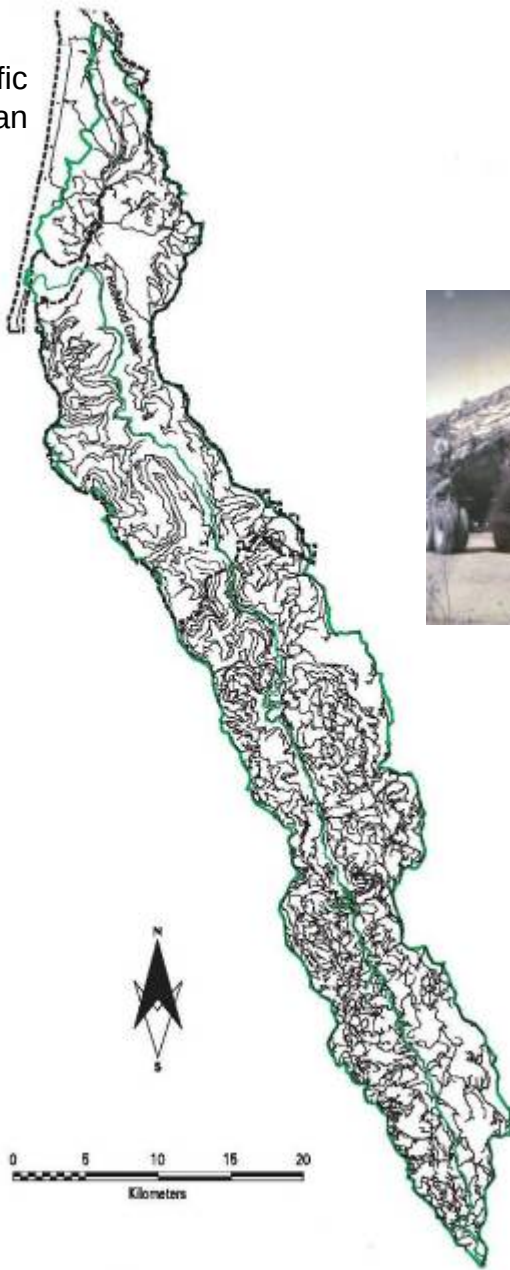


Long-term Monitoring in Redwood Creek, California, (USGS and RNSP)

Hydrology and sediment transport
Channel form
Stream temperature
Aquatic Biota

1978 Road Network In Redwood Creek

Pacific
Ocean





Gaging stations in the Redwood Creek Basin

2 Mainstem Redwood
12 Tributaries

Measure:

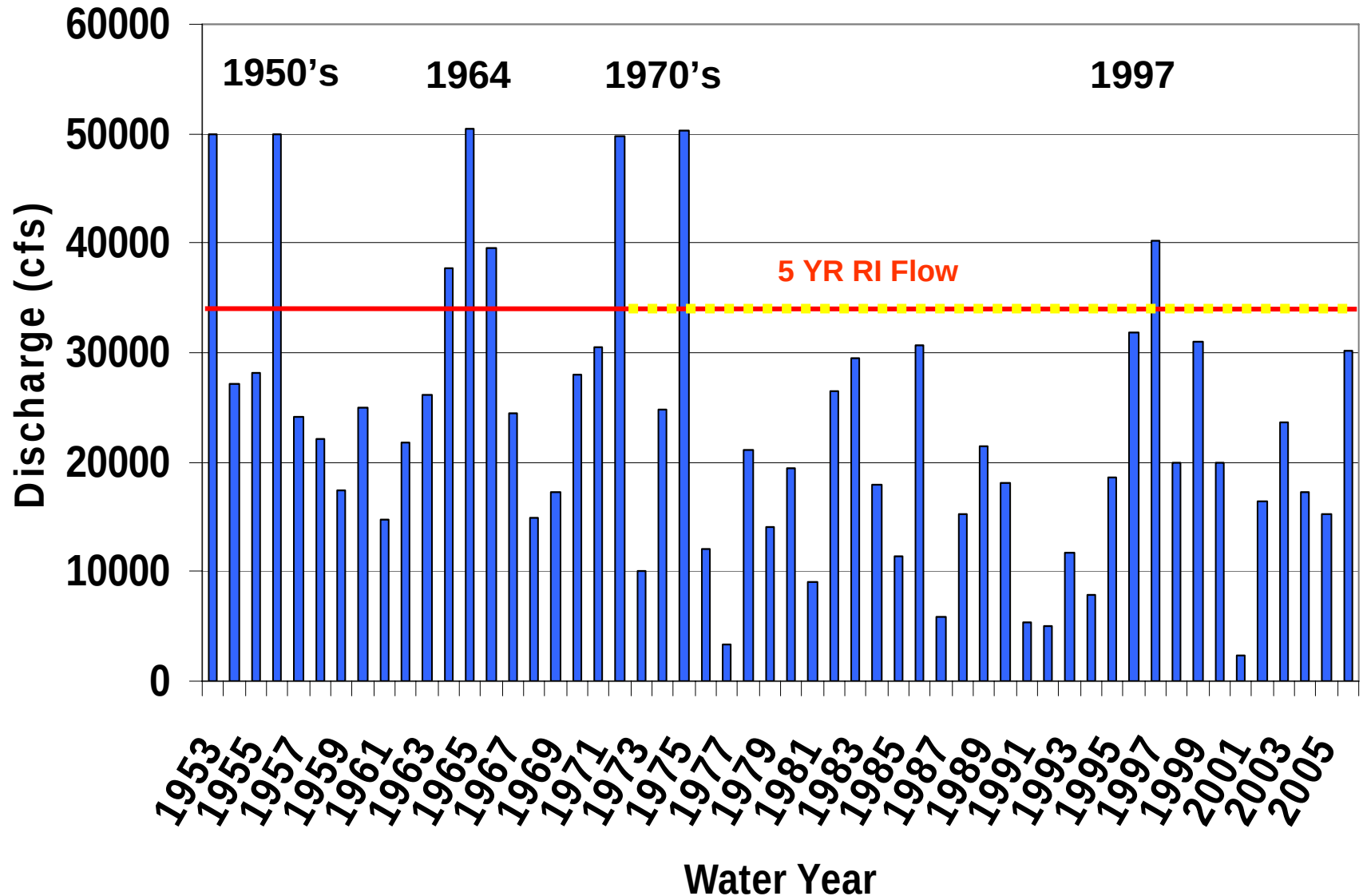
Flow

Suspended Sediment

Turbidity

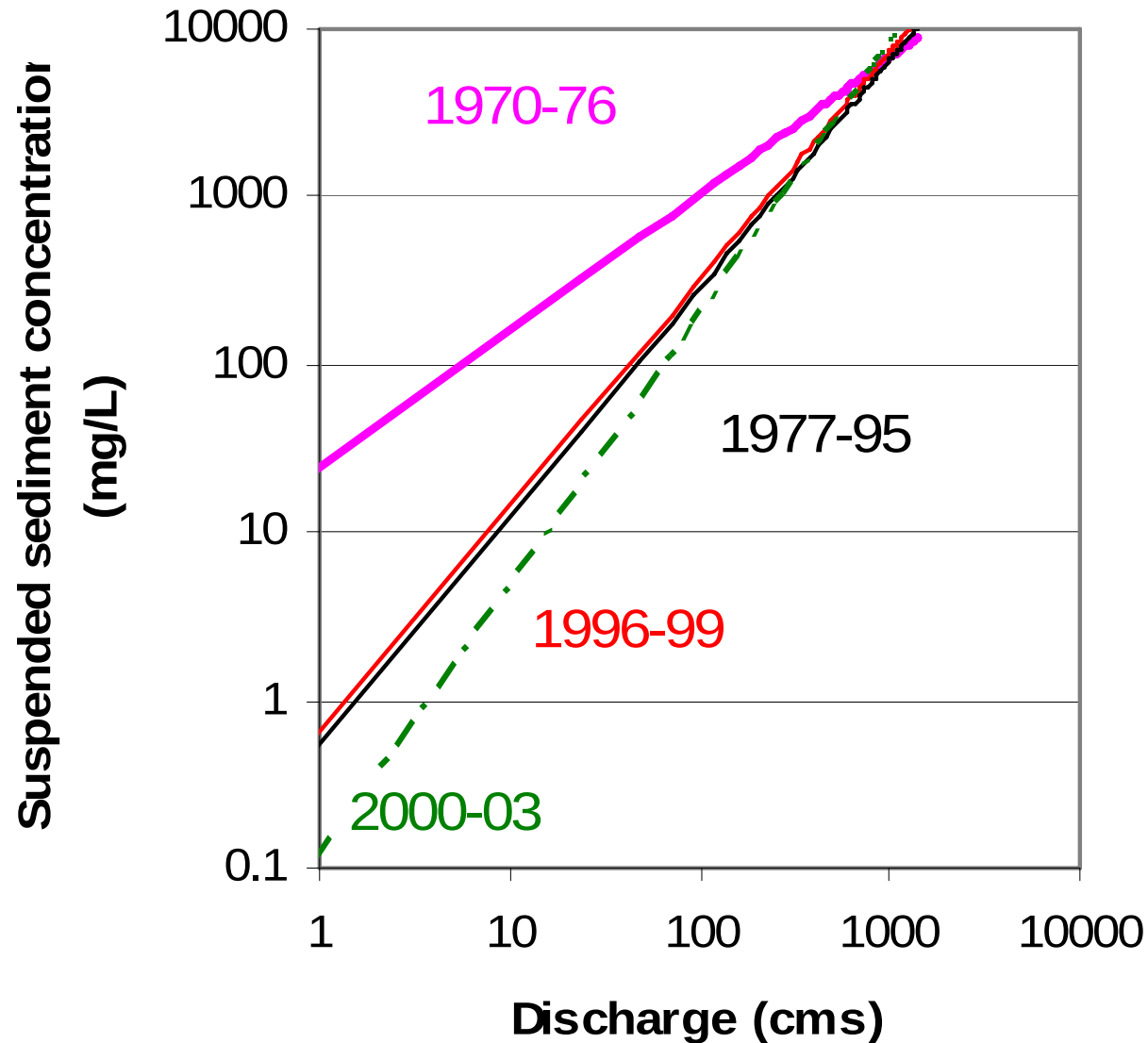
Bedload

Peak Flows in Redwood Creek at Orick, California



Suspended Sediment Rating Curves

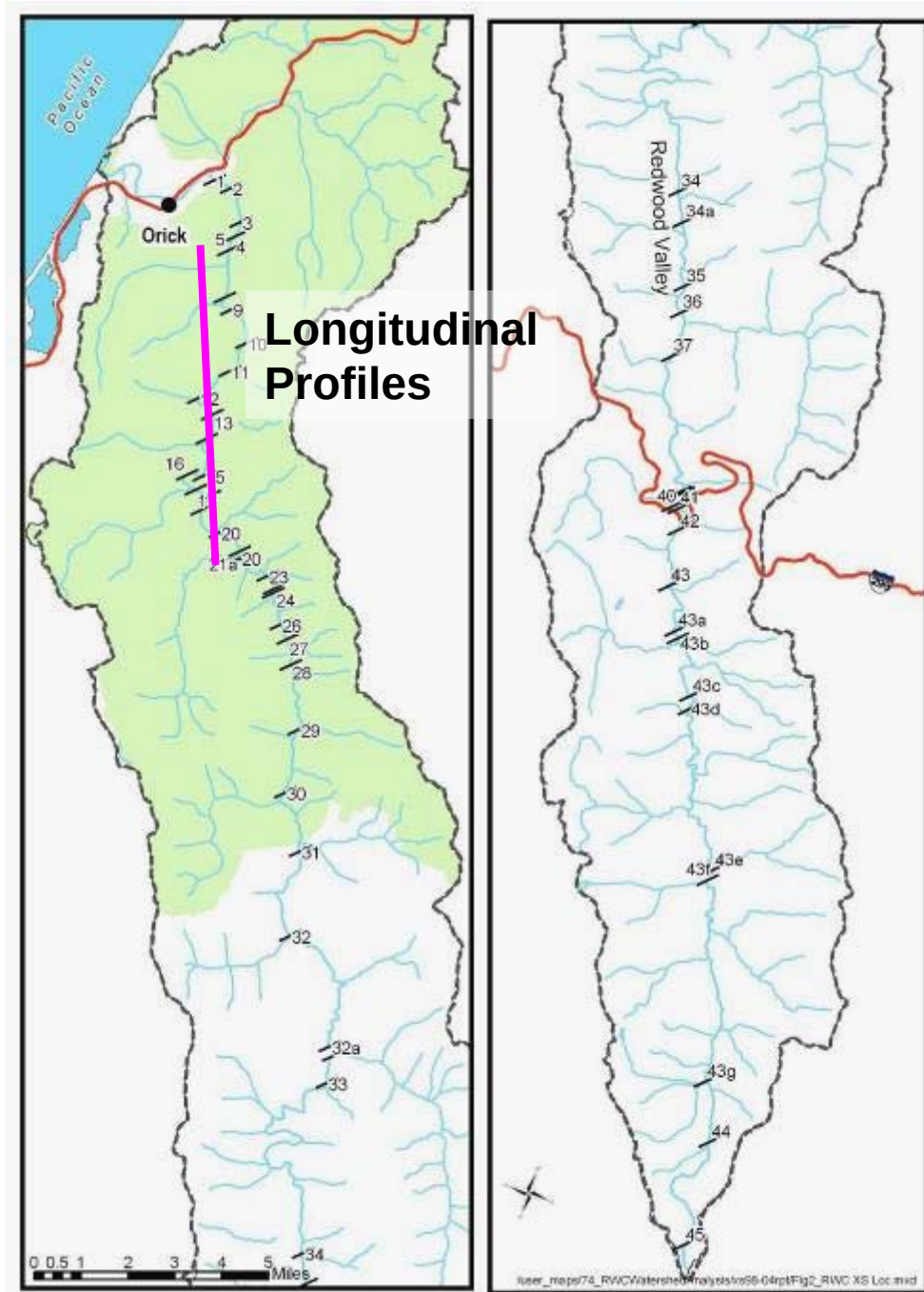
Redwood Creek at Orick, CA



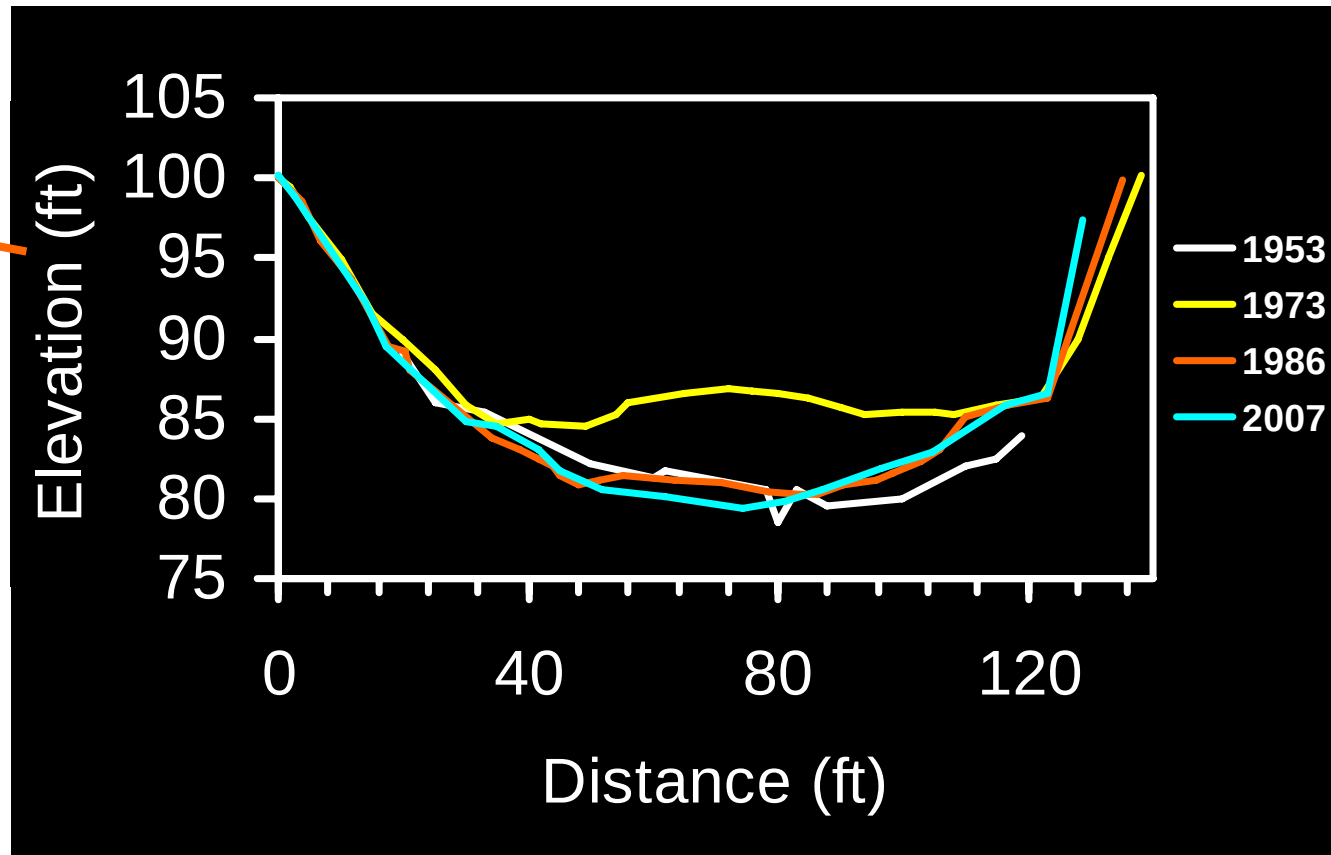
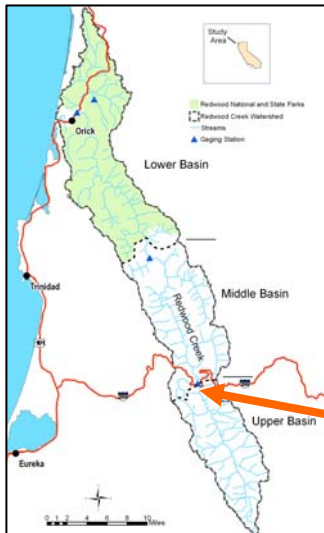
- **Cross Section Network**
58 cross sections
Established 1973

- **Longitudinal Profiles**

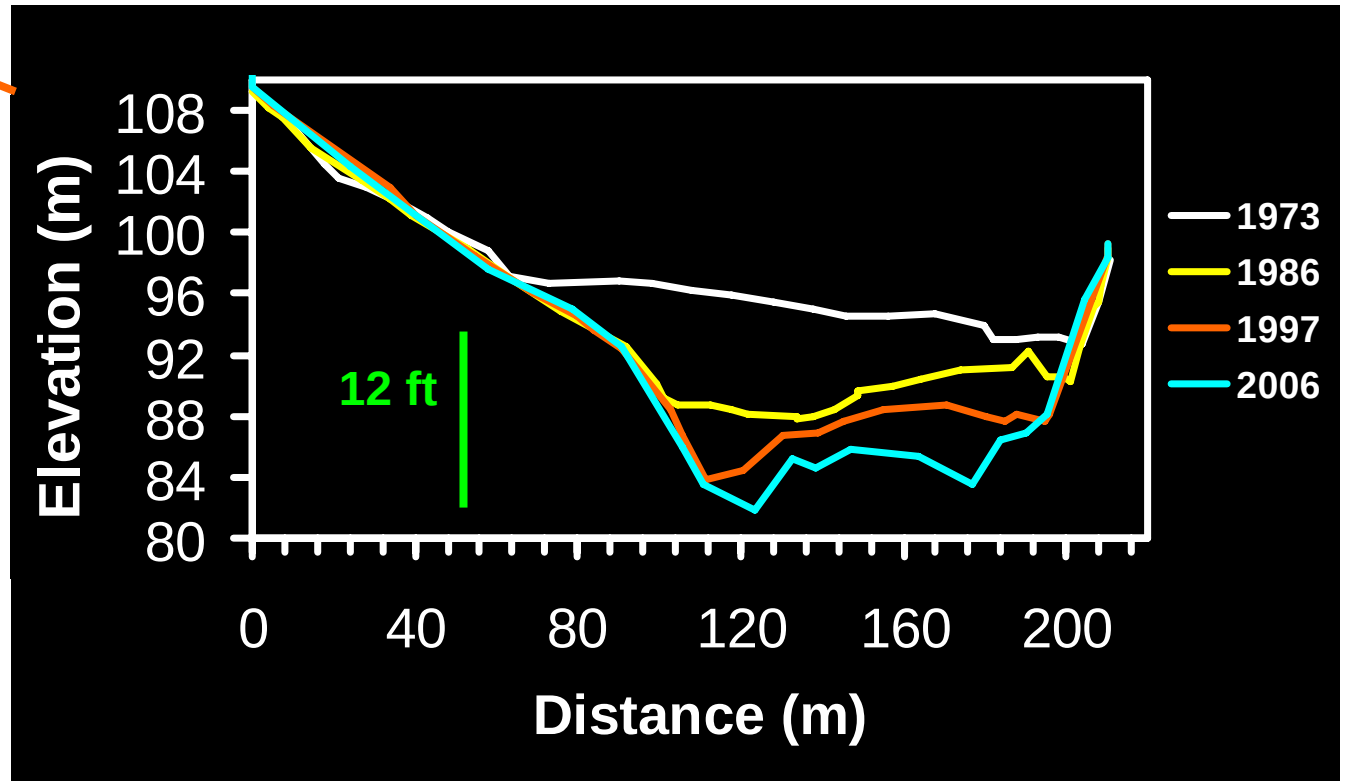
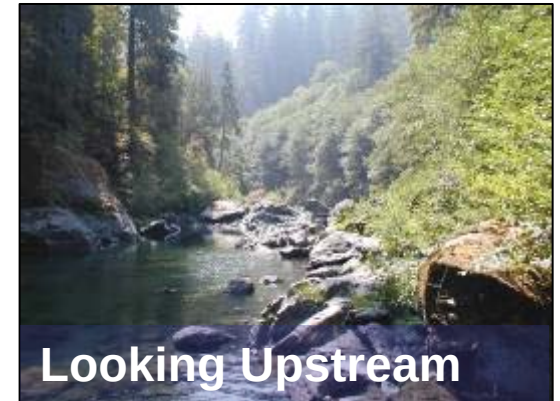
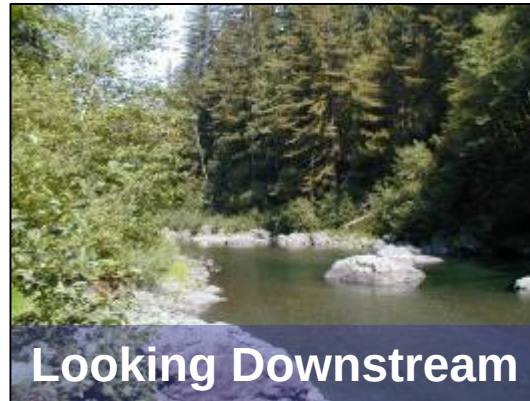
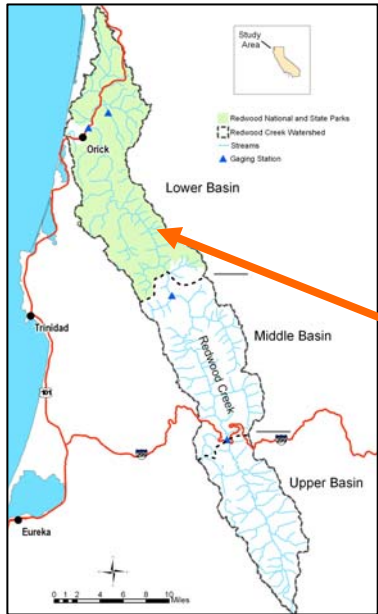
**Over 30 years of
monitoring**



Cross Section 40 (below HWY 299)



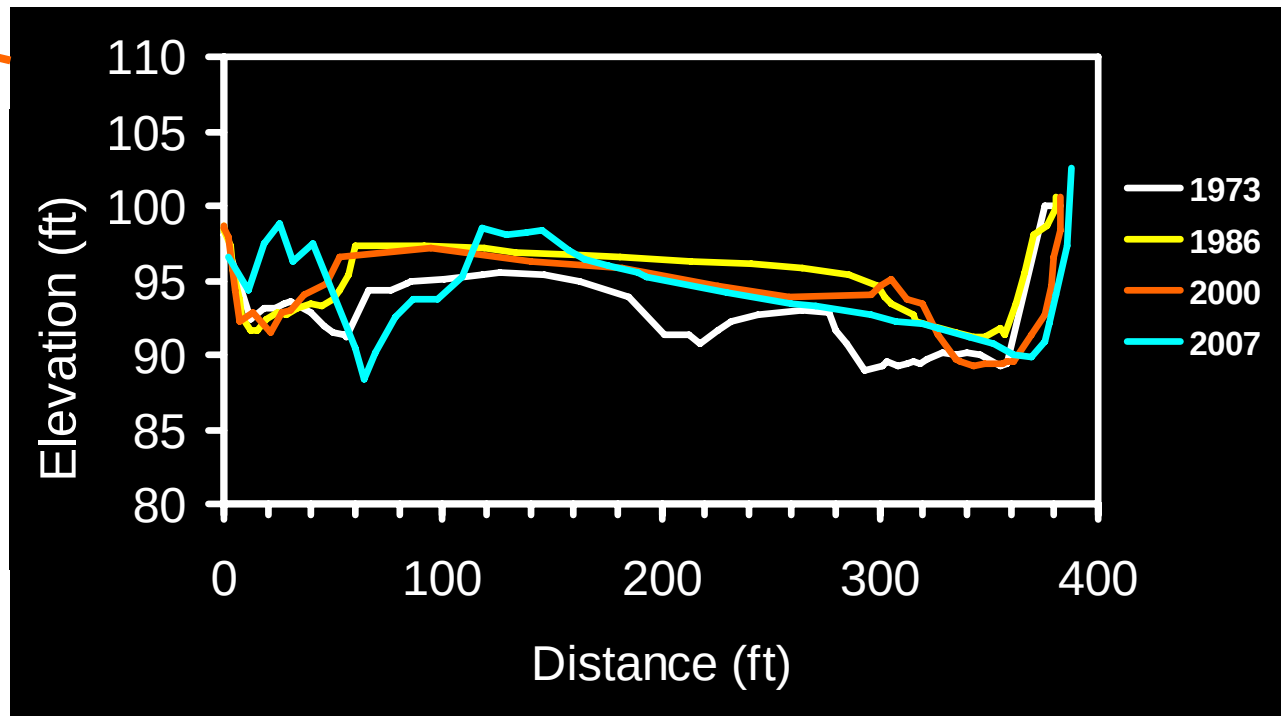
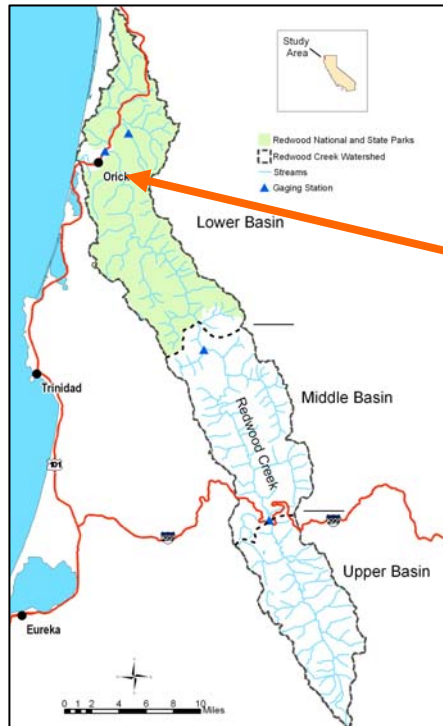
Lower Basin Cross Section 25



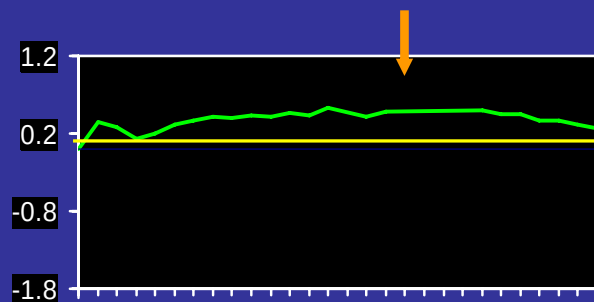
Cross Section 6 (below Elam Creek)



Pebble Wave

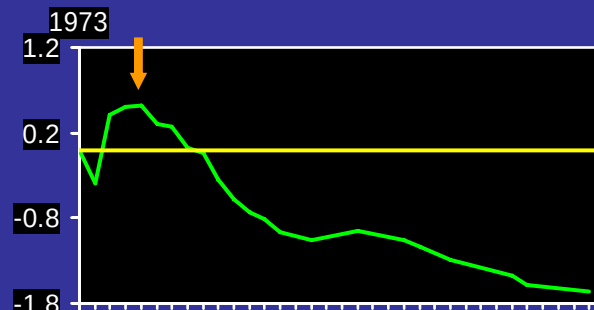


Mean
Streambed
Elevation
(m)



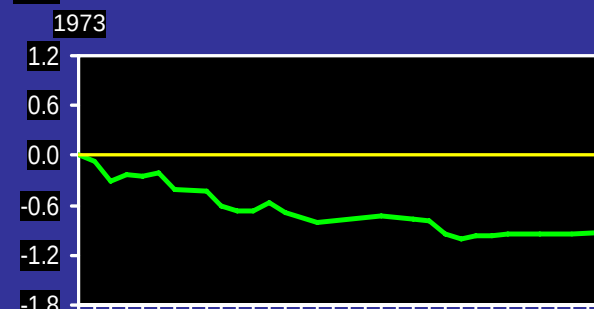
Lower Basin

XS 6



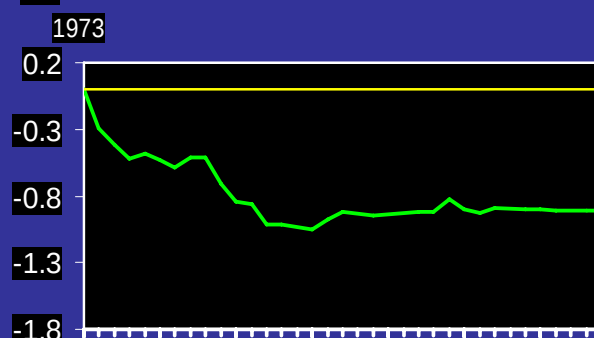
Lower Basin

XS 25



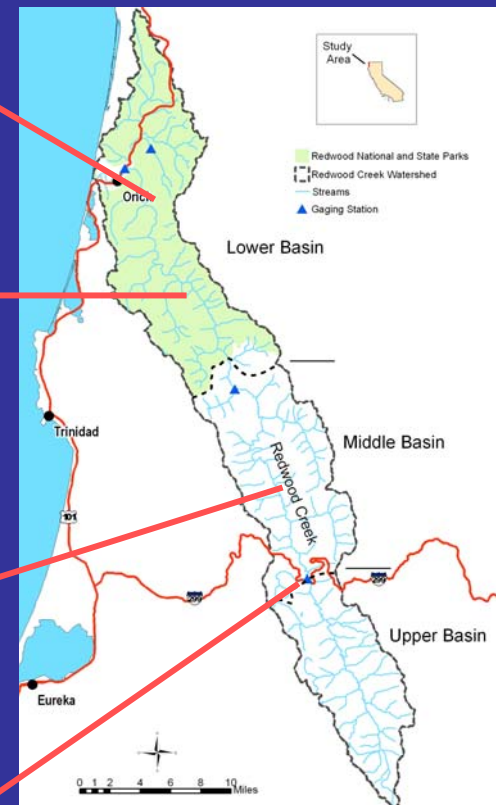
Middle Basin

XS 43



Upper Basin

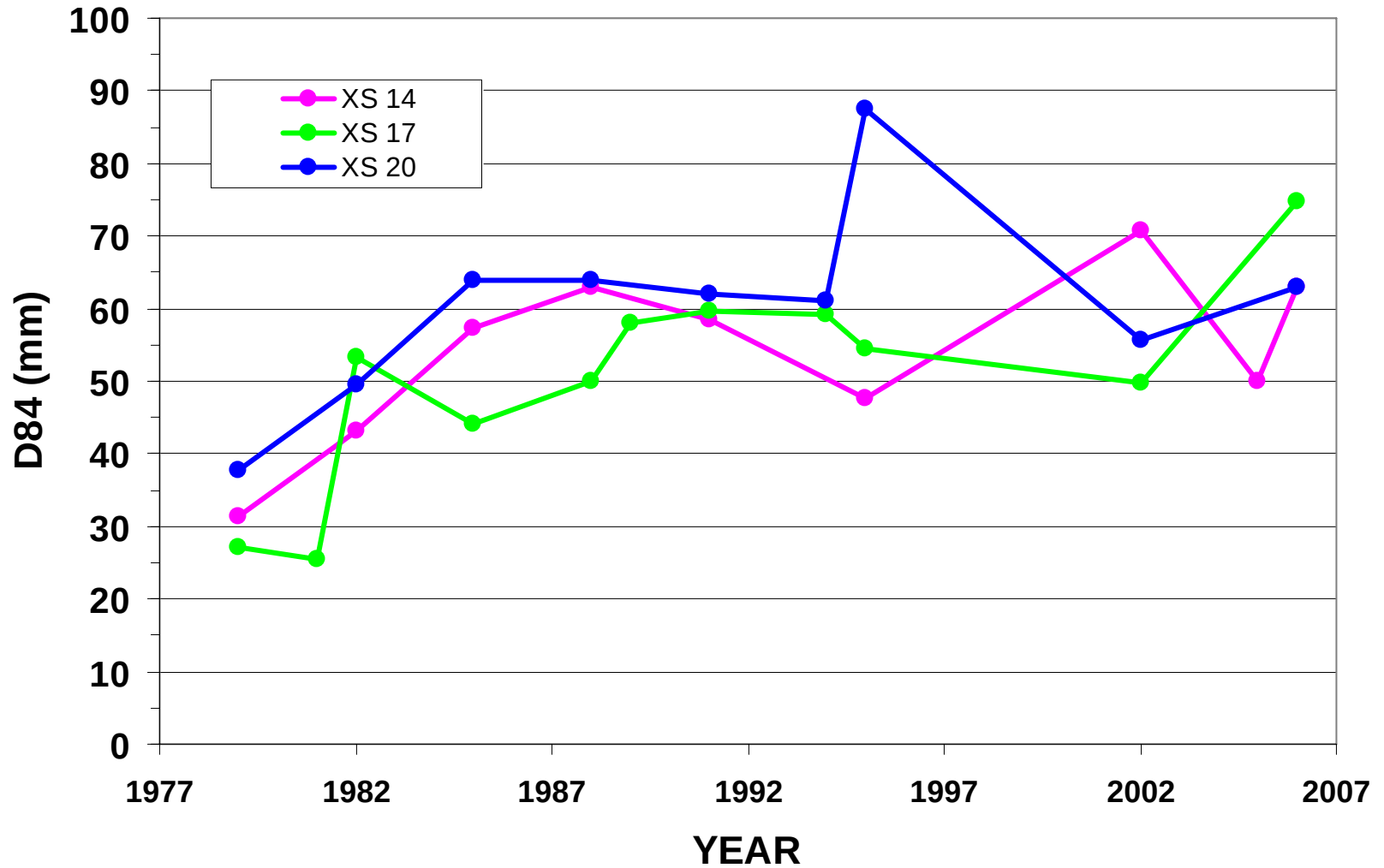
XS 40

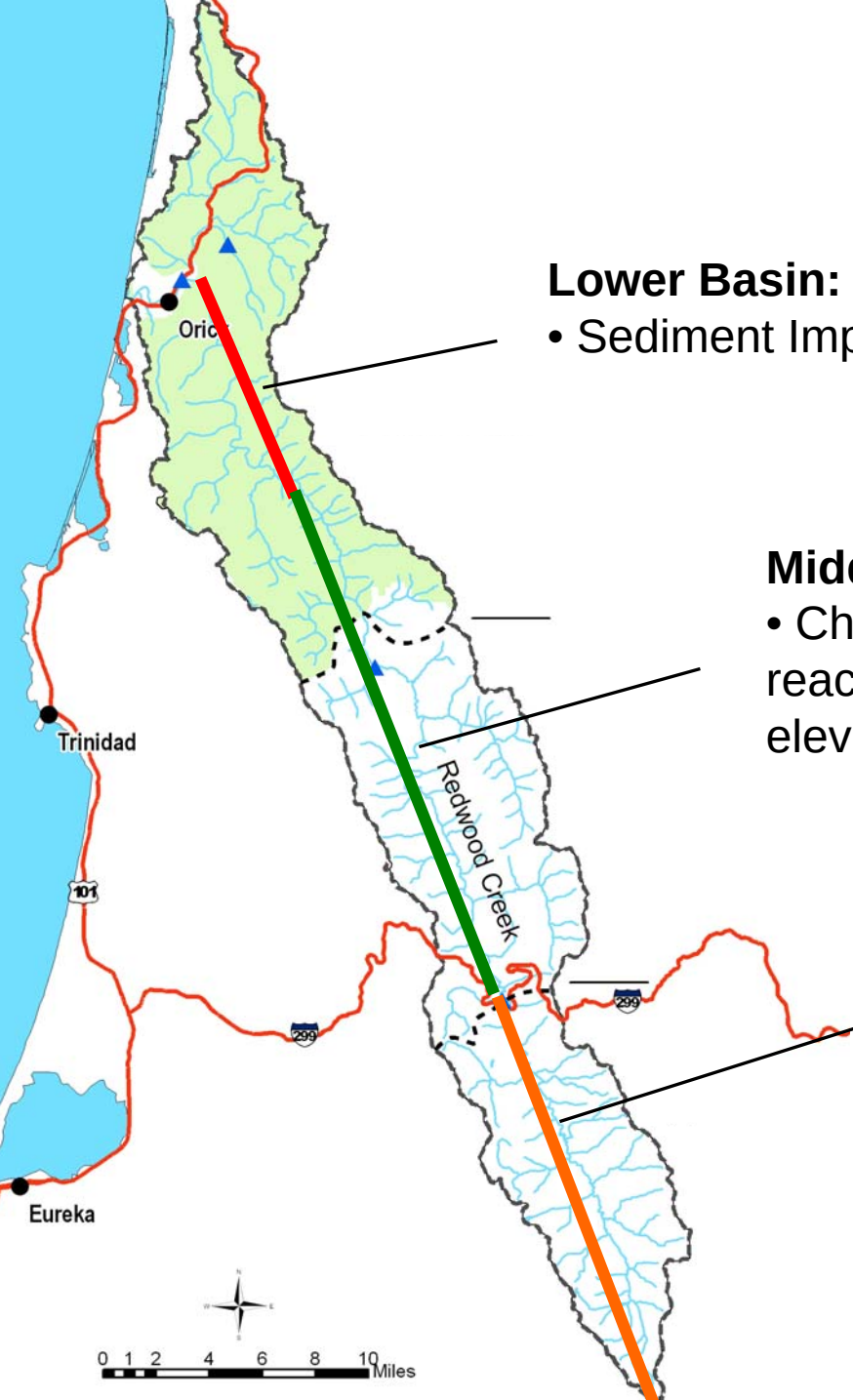


1973 1978 1983 1988 1993 1998 2003 2007

Year

Change in D84 on Lower Redwood Creek





Lower Basin:

- Sediment Impacted Reach



Middle Basin:

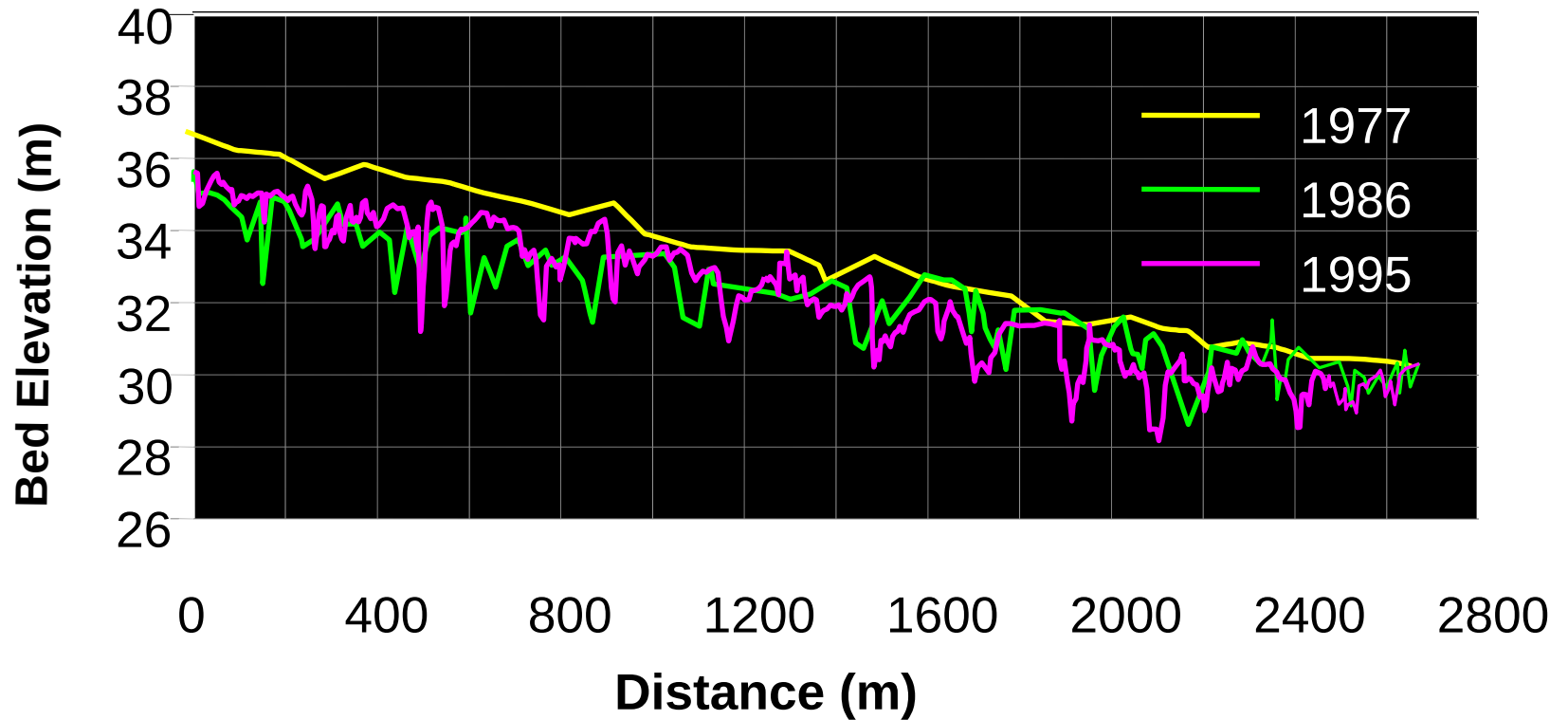
- Channel scouring or reached stable bed elevation

Upper Basin:

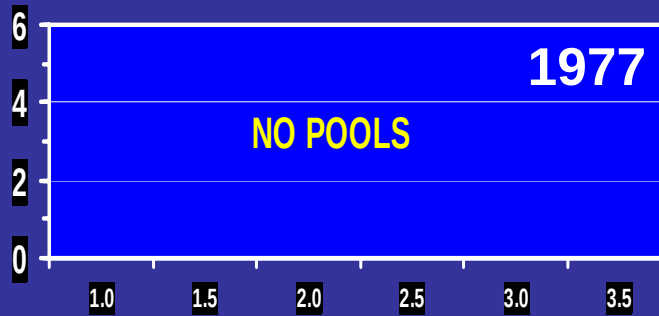
- Reached stable bed elevation
- Strongly Armored
- Bedrock exposed



Longitudinal Profiles of Redwood Creek

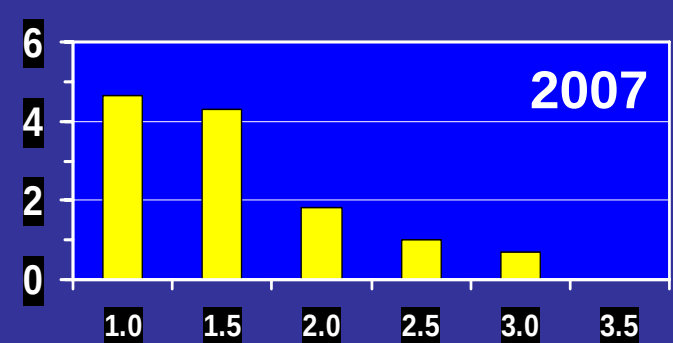
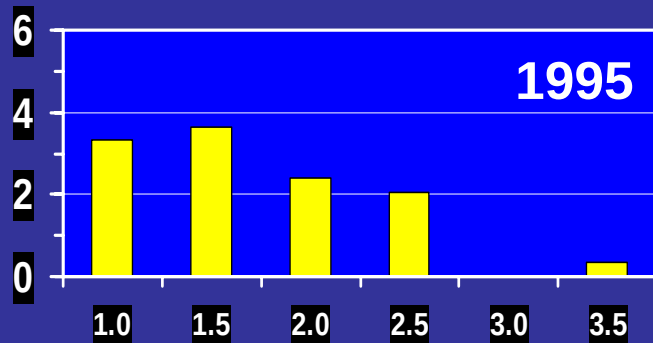
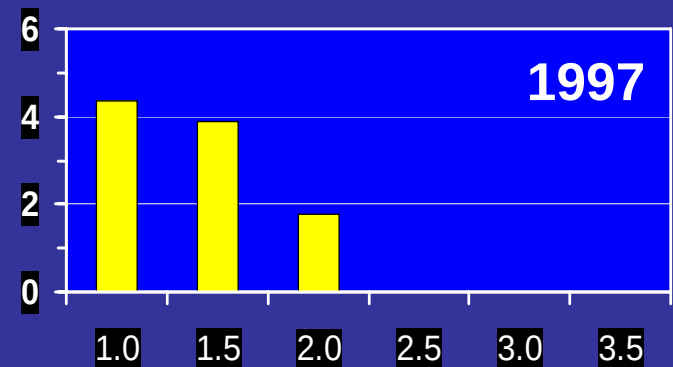
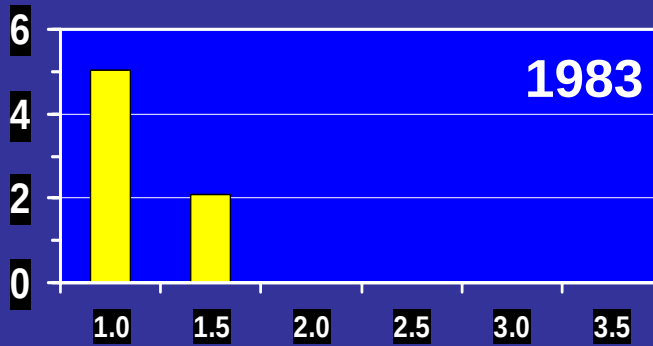


Frequency of Pools in Lower Redwood Creek



*1997 Flood
10 year RI*

Number
of Pools
per Km



Residual Pool Depth (m)

Residual Pool Depth (m)

REDW concerned about effects of summer water temperature on juvenile coho and steelhead.



- Juvenile coho and steelhead reside in the stream for at least 1 year
- Require cool water during summer
- Juvenile salmon prefer 12-14°C and avoid temp > 15°C
- Extended exposure of temp above 25°C may be lethal
- About 18-20°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
- Snapshot in time



Thermal Infrared Data Collection



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

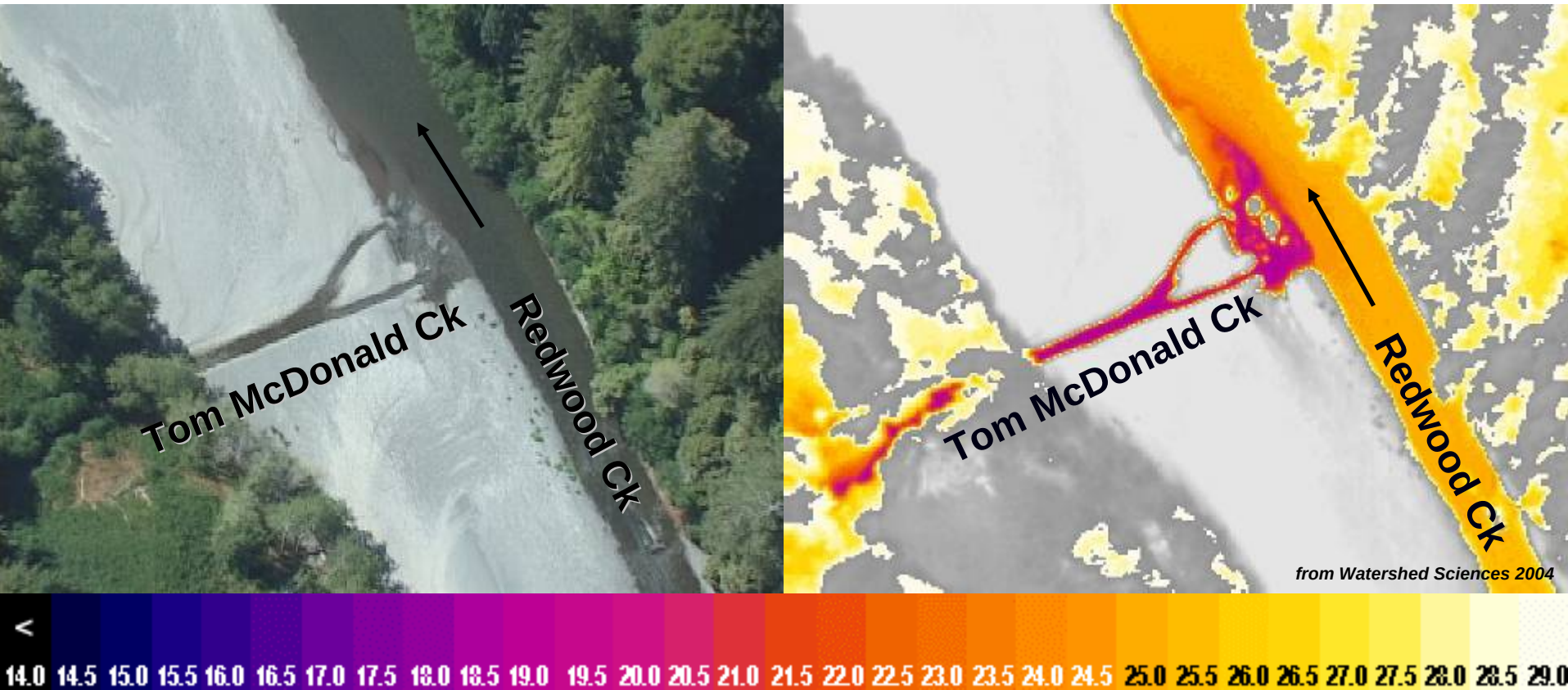
*Project Funded by:
NPS Water Resources
Division*



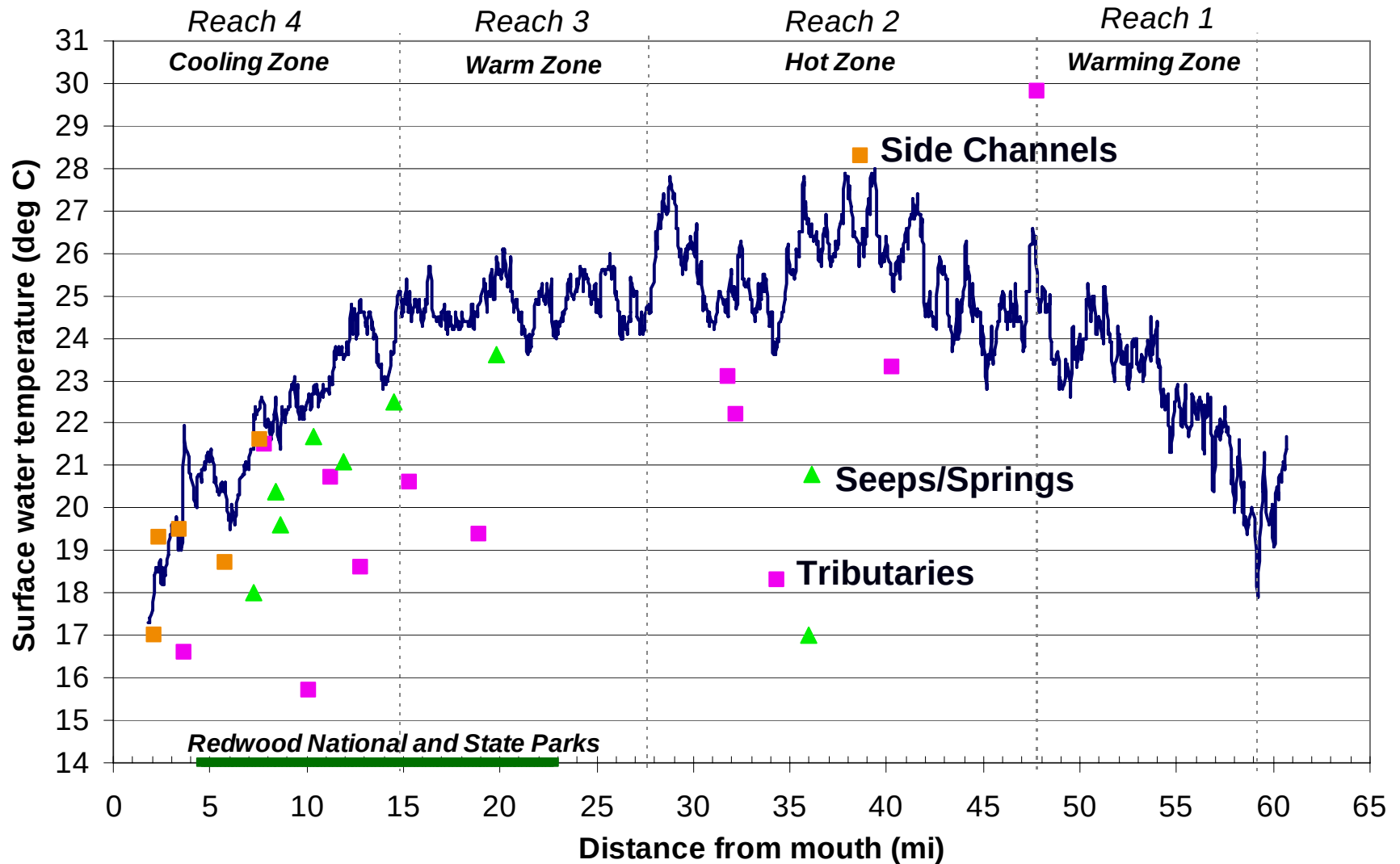
For each Image:

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

Example: Cool Tributary Inflow



Redwood Creek TIR Temperature Data



— Redwood Creek (7/29/03)

■ Tributary

■ Side Channel

▲ Spring/Seep

The Search for Juvenile Coho

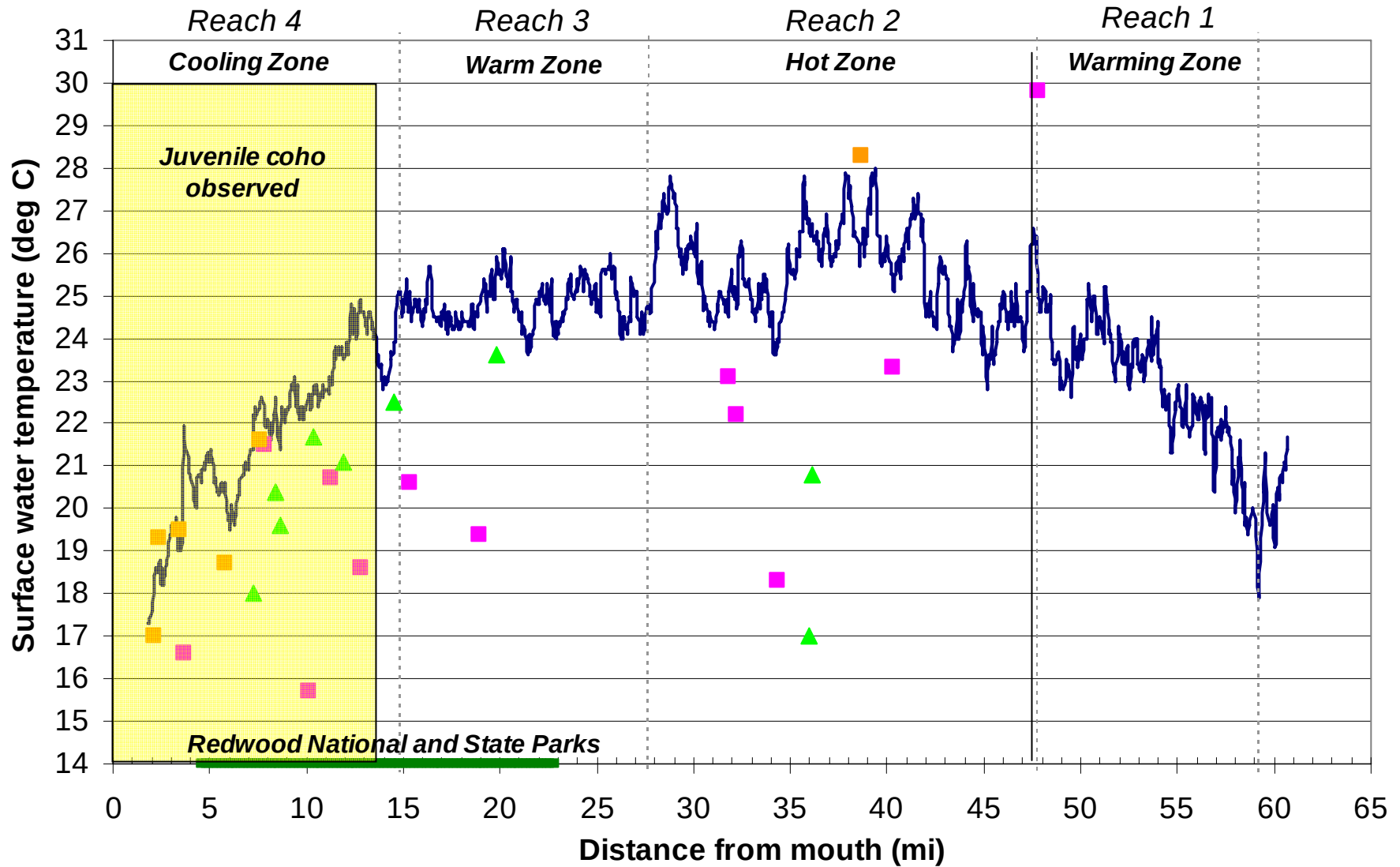
- Juvenile Coho Presence/Absence
- Direct Observation
- Survey 40% lower channel
- Determine juvenile coho use of the mainstem





- 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

Redwood Creek



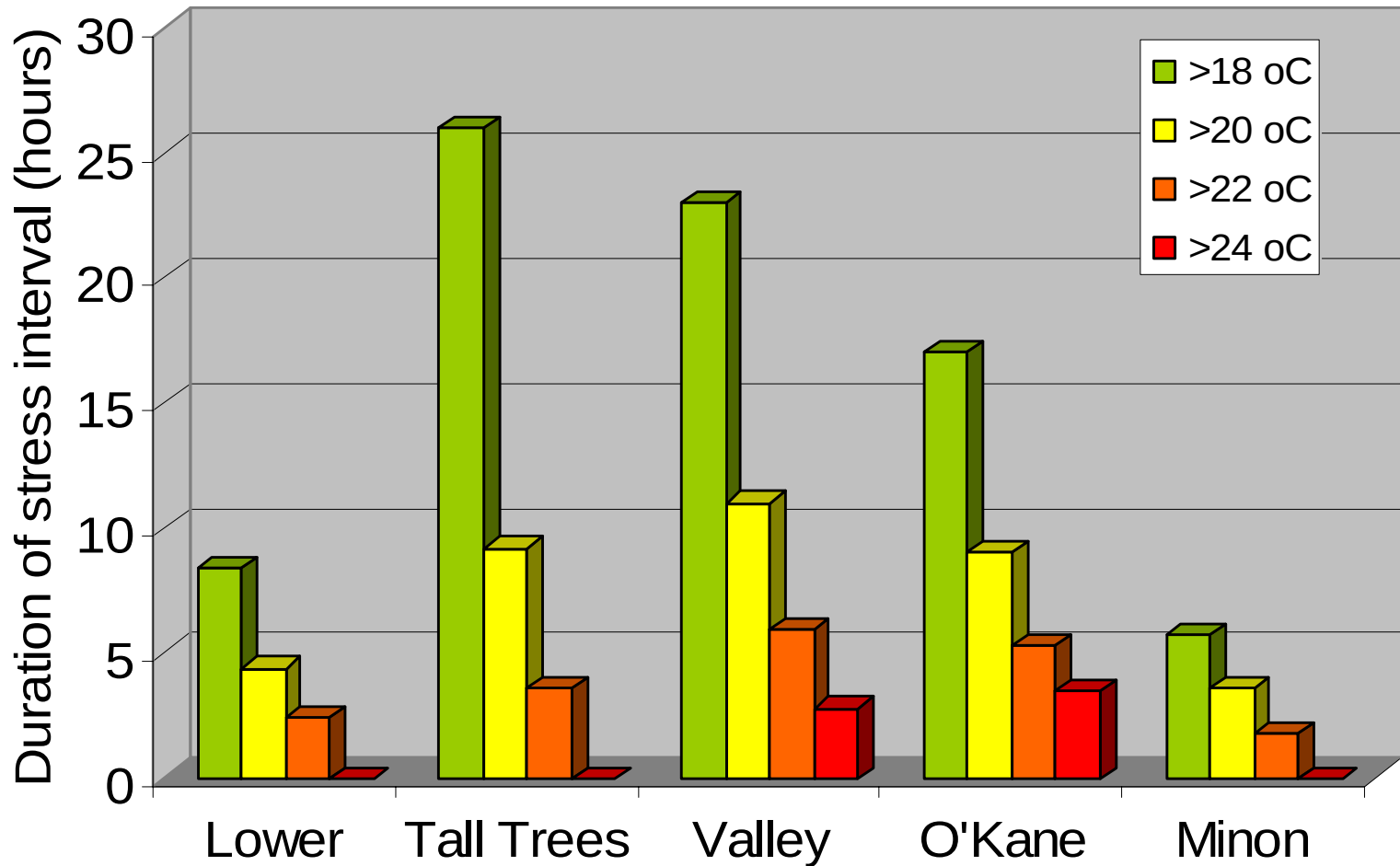
— Redwood Creek (7/29/03)

■ Tributary

■ Side Channel

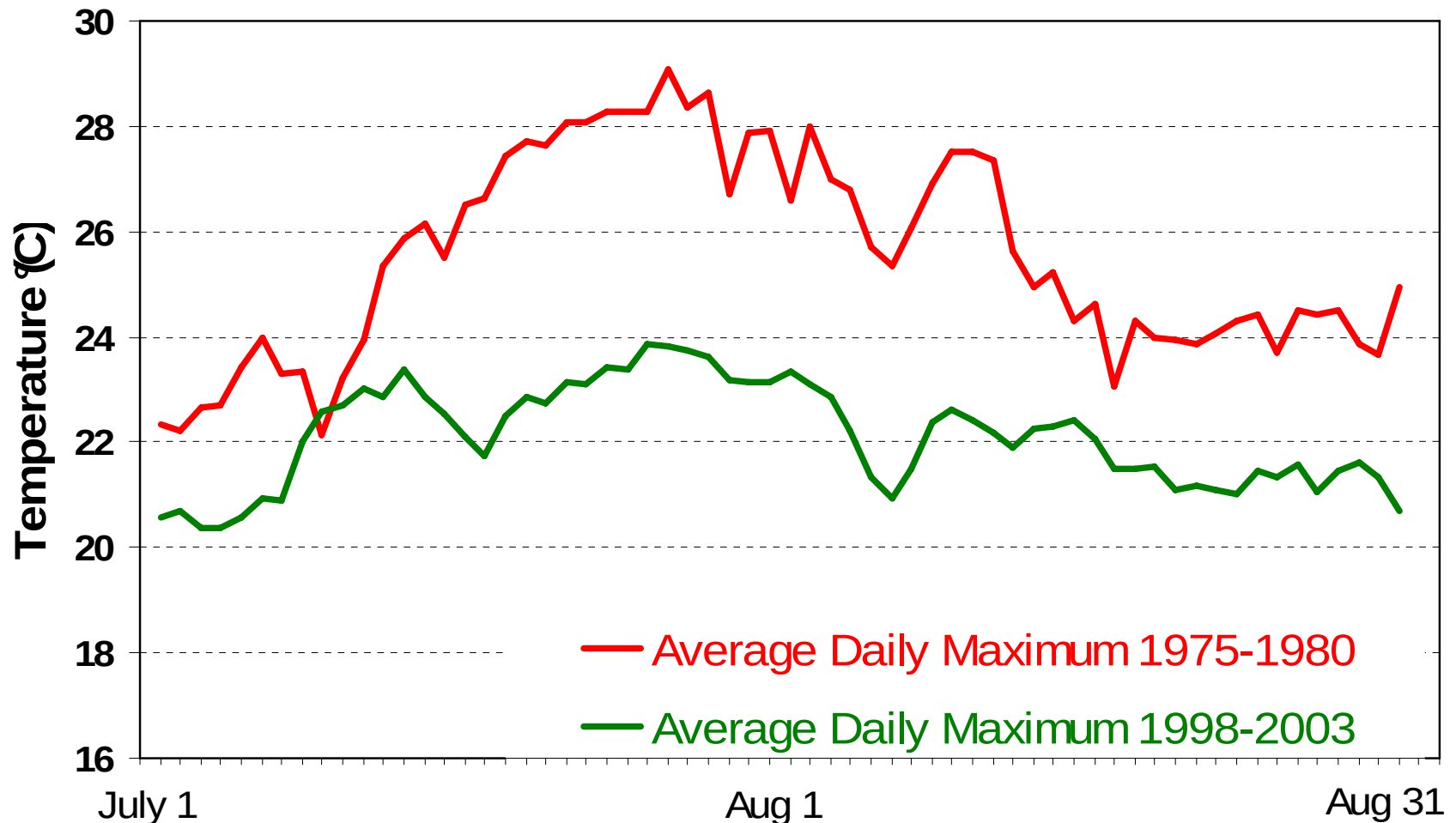
▲ Spring/Seep

Thermal Stress Interval (mean)



How have water temperatures changed over time?

Summer Water Temperatures, Redwood Creek at O'Kane





2004-2005:
Repeated USGS
1970's
sampling of
aquatic biota

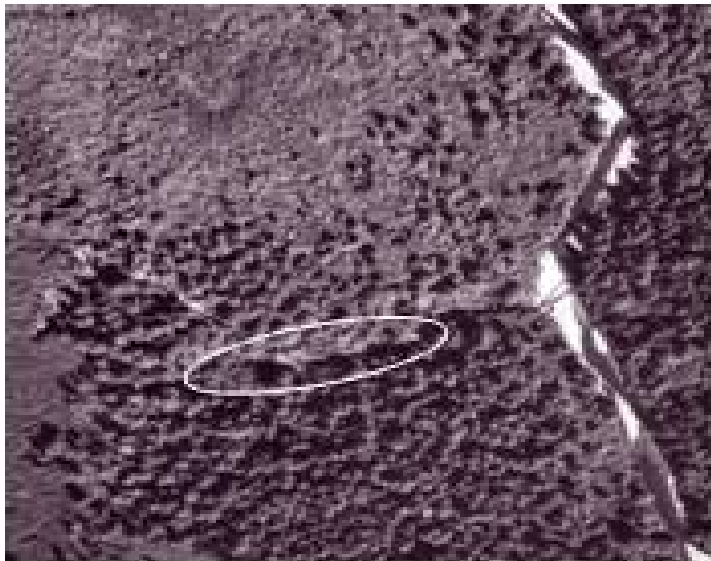
Bridge Creek



1978

1978

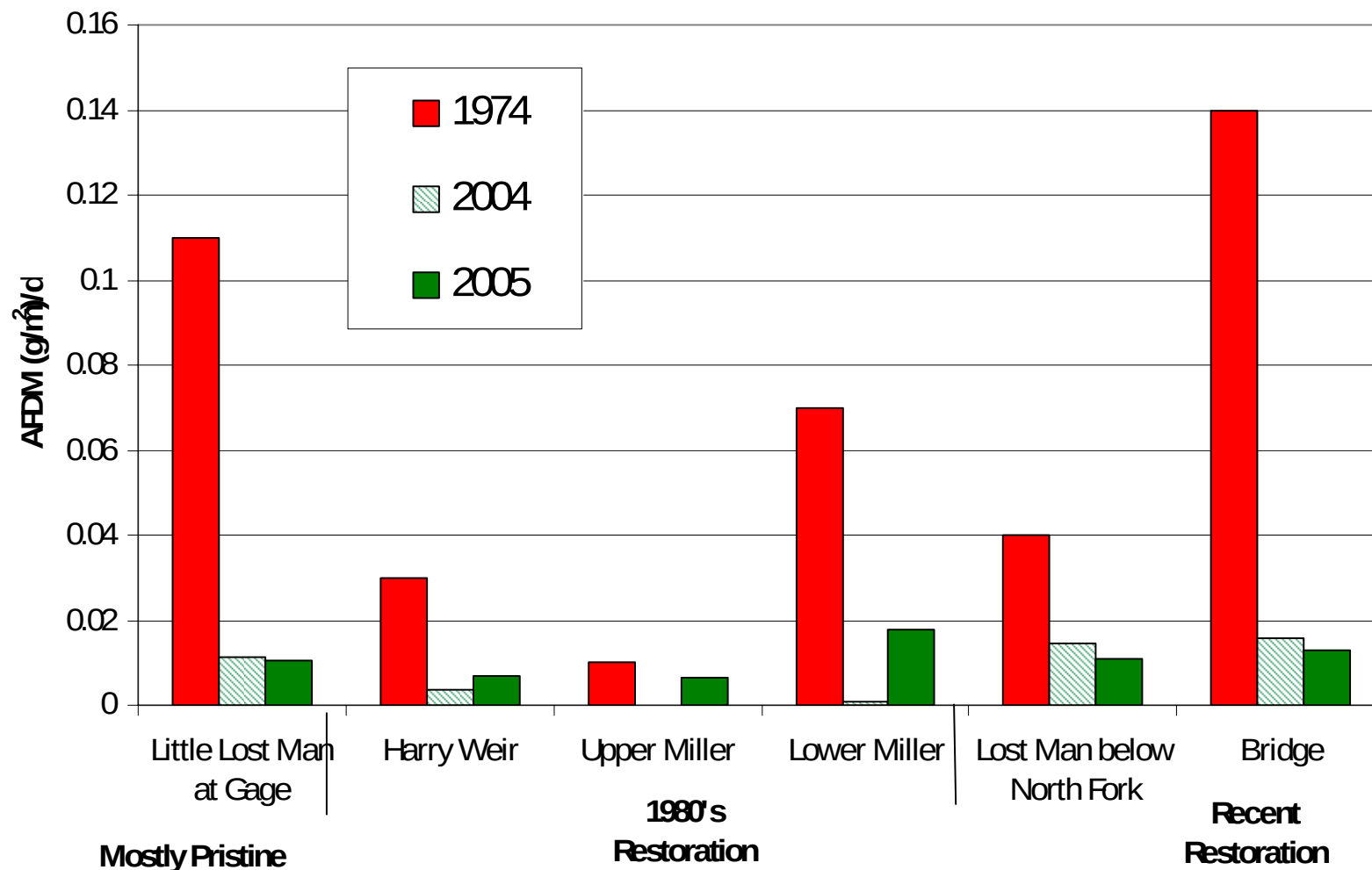
**Canopy closure
over streams has
increased**



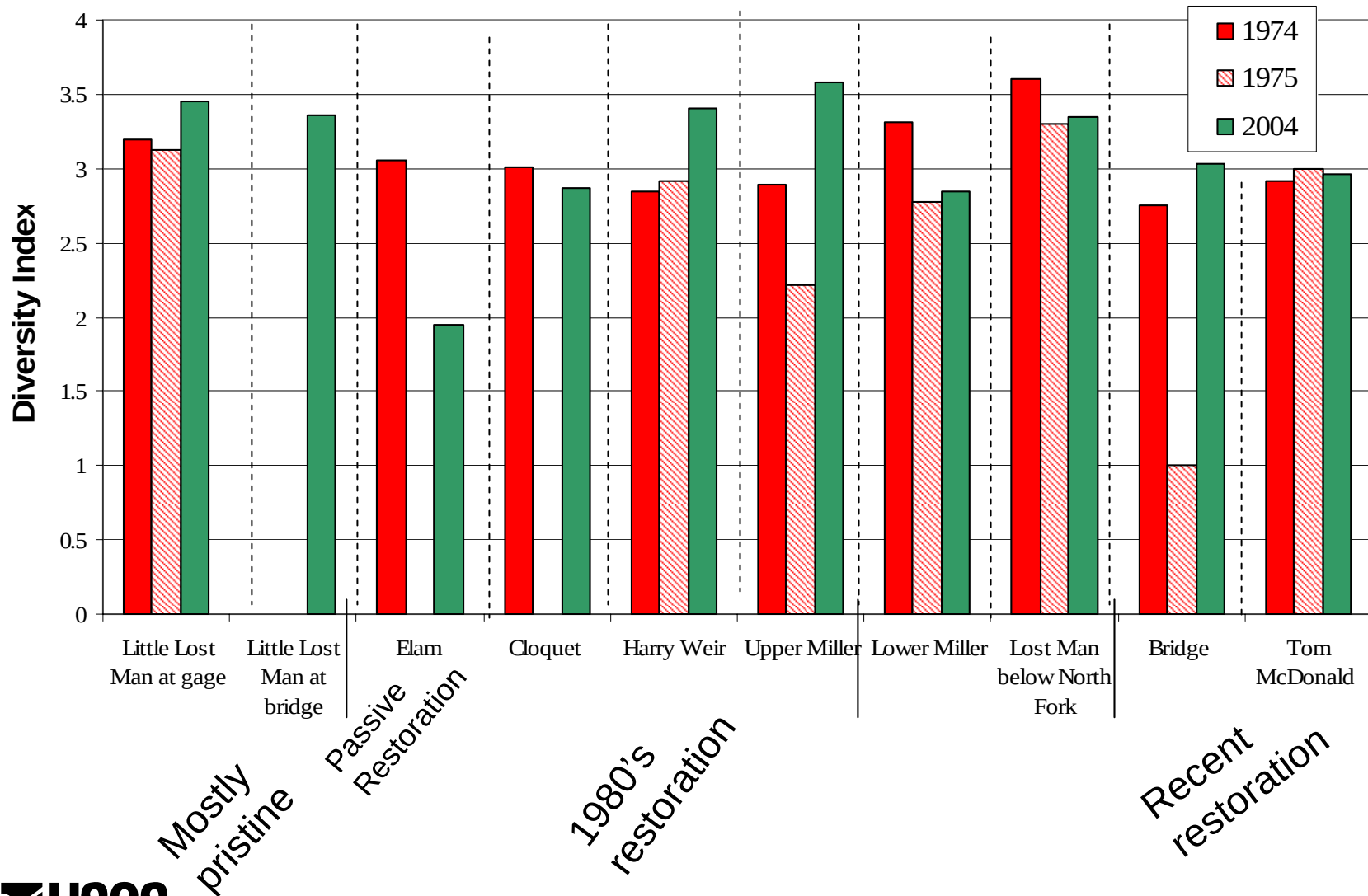
1997

1997

Summer Periphyton Accrual Rates

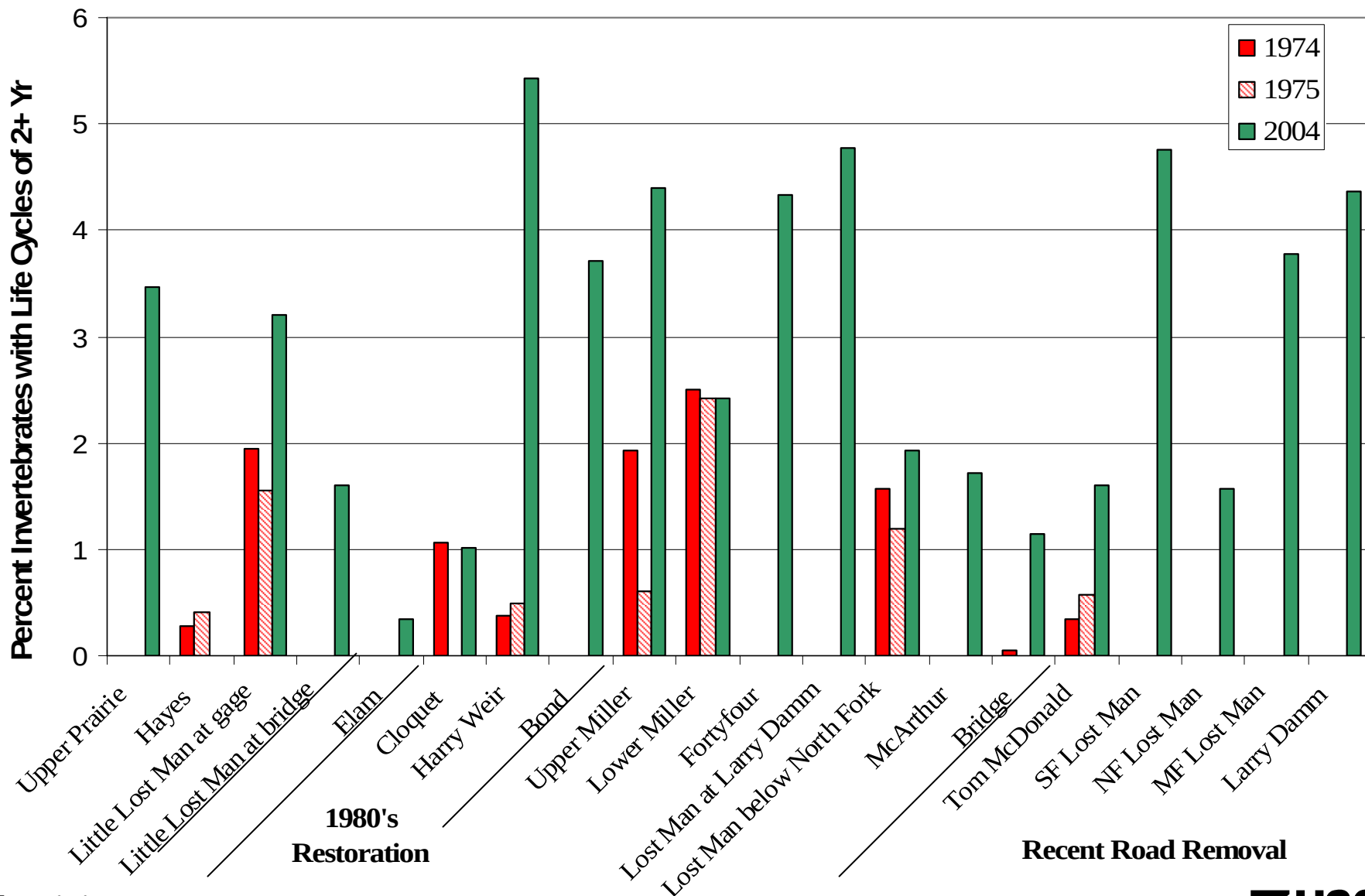


Macroinvertebrate Diversity Index



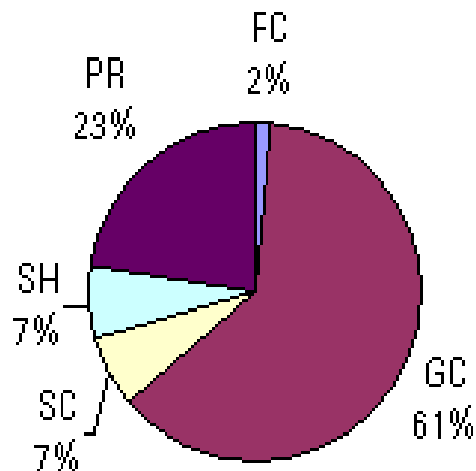
Invertebrates with long life cycles (2+ years)

(Odonates, Megaloptera, Perlids and Larva)



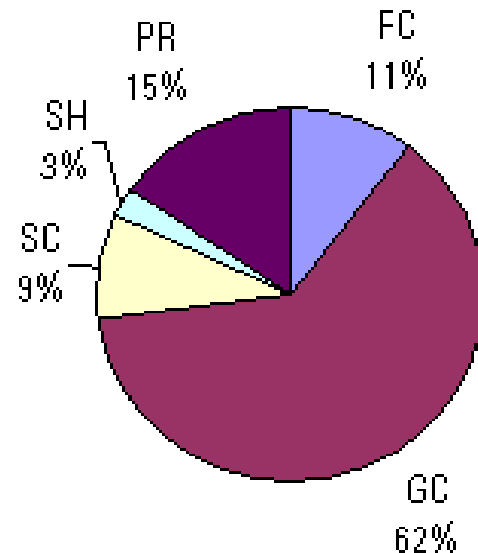
Comparison of Functional Feeding Groups

**Pre-restoration
Summer 1974**



GC=Gathering collector
FC=Filtering collector
SC = scraper
SH= Shredder
PR=Predator

**Post-restoration
Summer 2004**



Tom McDonald Creek

(See full USGS report for details)

Electrofishing



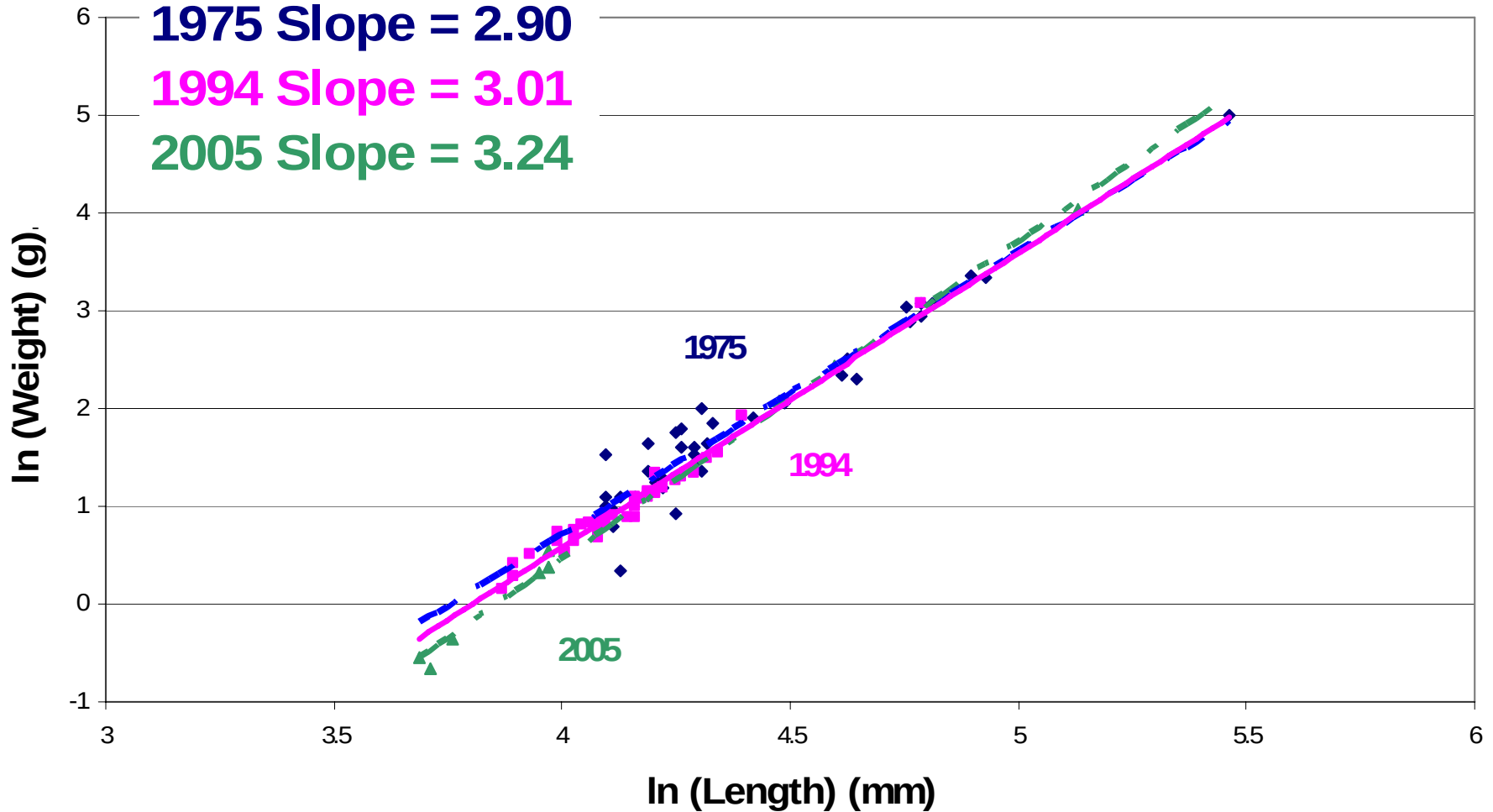
Condition of Steelhead Trout, Emerald Creek

(Weight = $a \text{ Length}^b$)

1975 Slope = 2.90

1994 Slope = 3.01

2005 Slope = 3.24



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.
- Prevention of erosion and delivery to channels more effective 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.