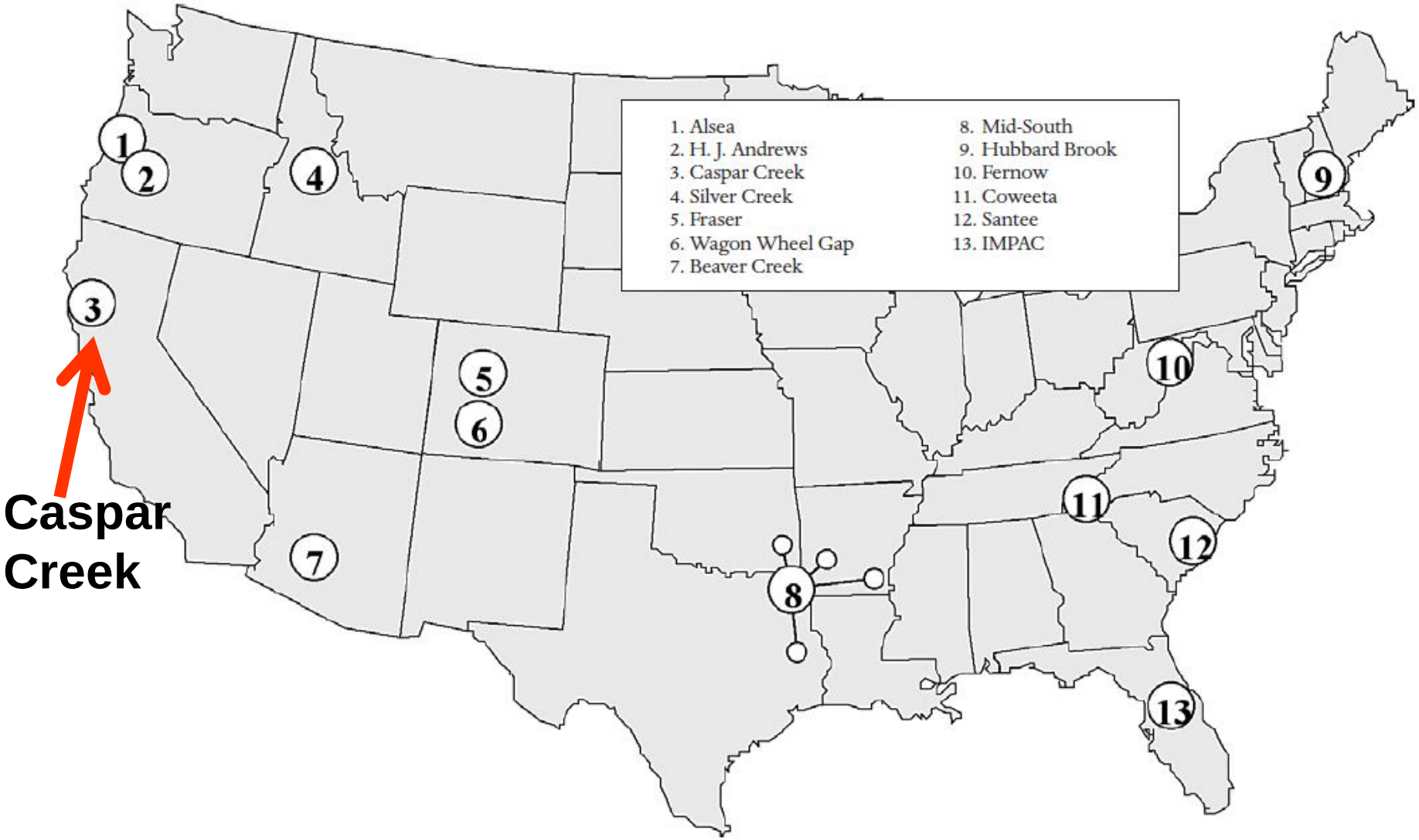
The Caspar Creek Experimental Watersheds: Background Information and Summary of Results from the First Two Experiments

22nd Annual Meeting of the California Aquatic Bioassessment Workgroup
October 20, 2015

Peter H. Cafferata
California Department of Forestry and Fire Protection

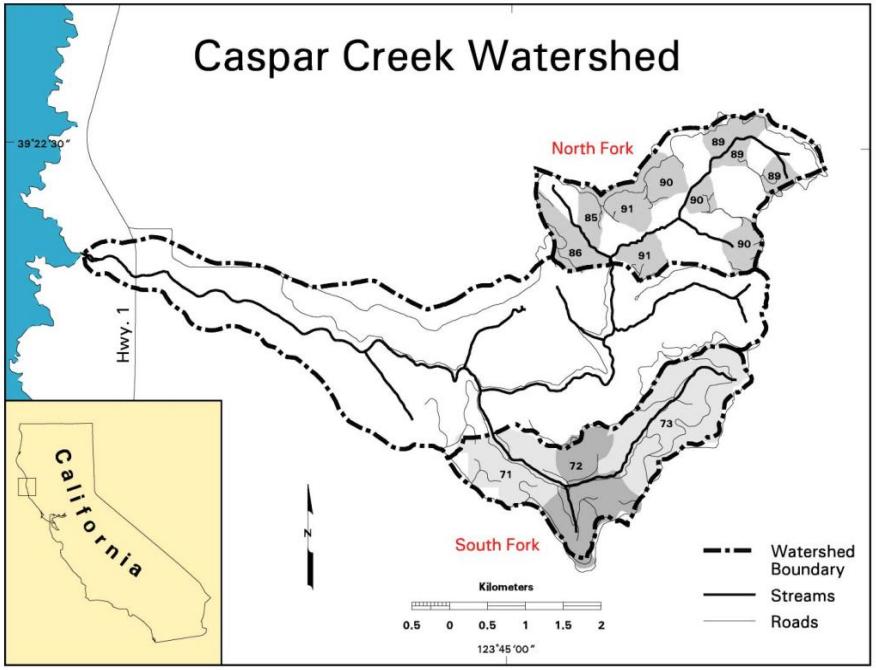
Location of Major Watershed Studies in the US (Ice and Stednick 2004)



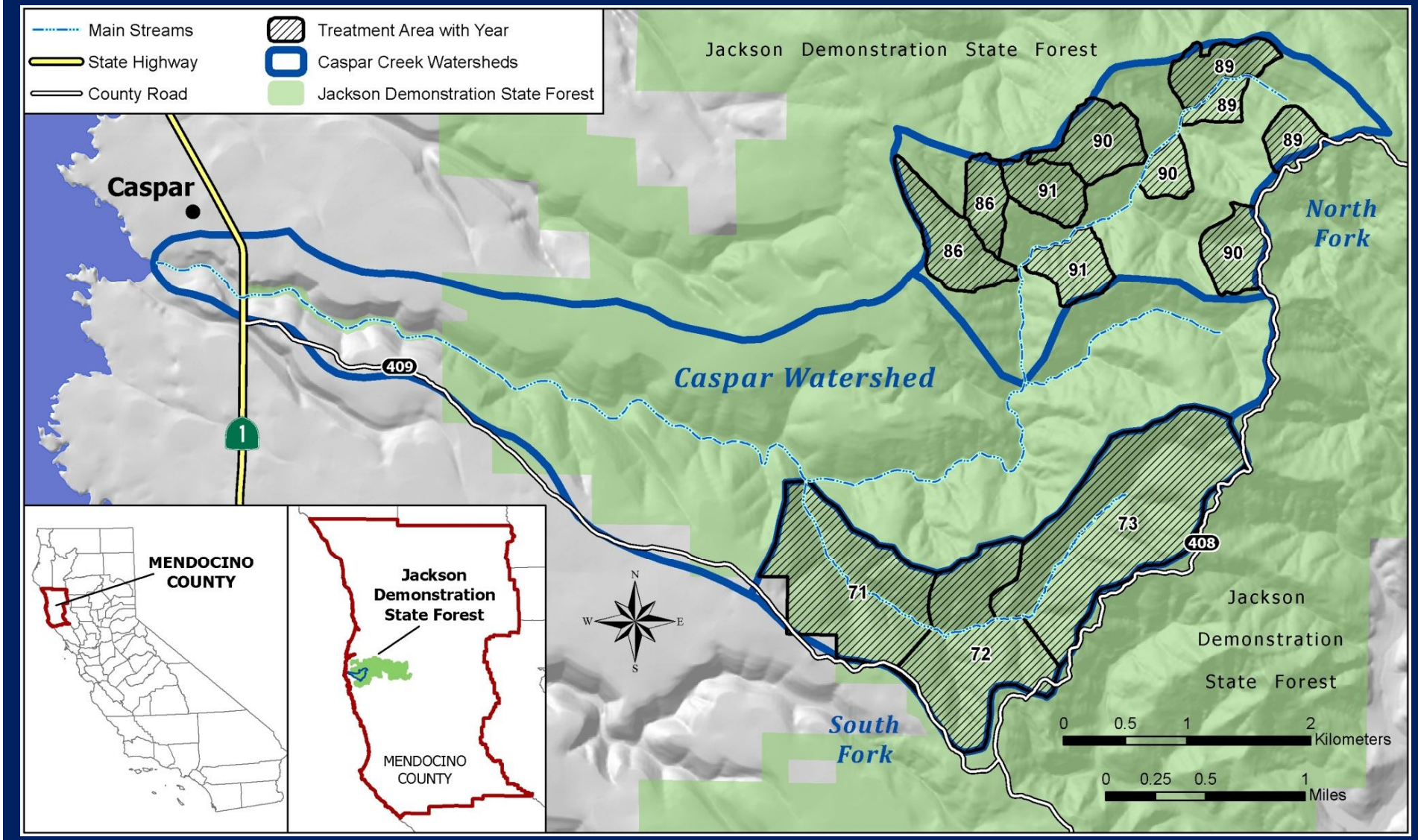
Caspar Creek: One of longest **<u>continuously</u>** running watershed studies in the U.S.—began in **1962**

Caspar Creek Watershed Study

- Cooperative study between CAL FIRE and USFS PSW that began in 1962 (53 years of data).
- 100-yr agreement to continue study to 2099 (originally signed in 1999).
- Over 150 published papers, theses available online (http://www.fs.fed.us/psw/topics/water/caspar/).
- 2 main experiments to date—South Fork (1962-1985) and North Fork (1985-present).
- 3rd experiment in planning phase (Dr. Salli Dymond to discuss).



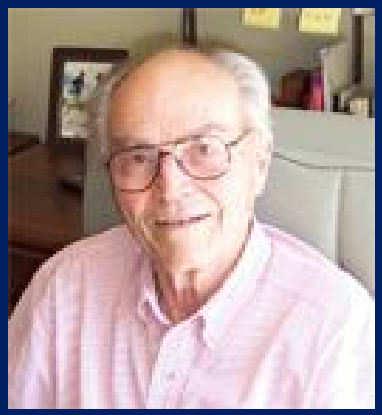
Caspar Creek Watershed—Located on Jackson Demonstration State Forest (90%)



Caspar Creek watershed: 5300 ac (2145 ha)

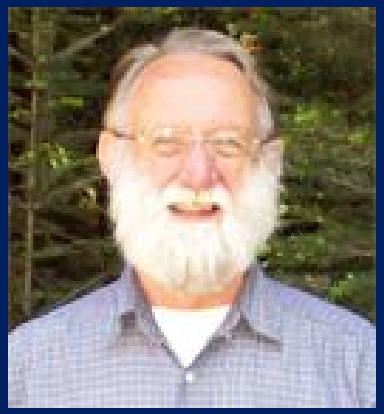
USFS-PSW Caspar Creek Watershed Leaders

(now under the Ecosystem Function and Health Program)



Dr. Ray Rice

1974-1989



Dr. Bob Ziemer

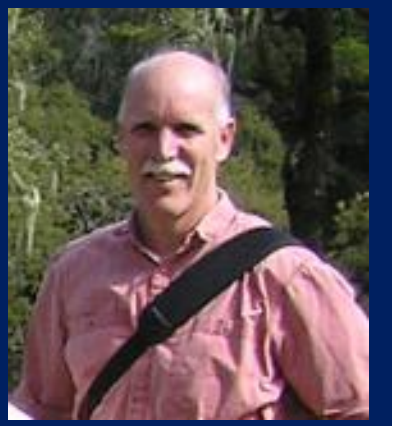
1989-2001

Dr. Tom Lisle

2001-2010

Dr. Leslie Reid

2010-2011



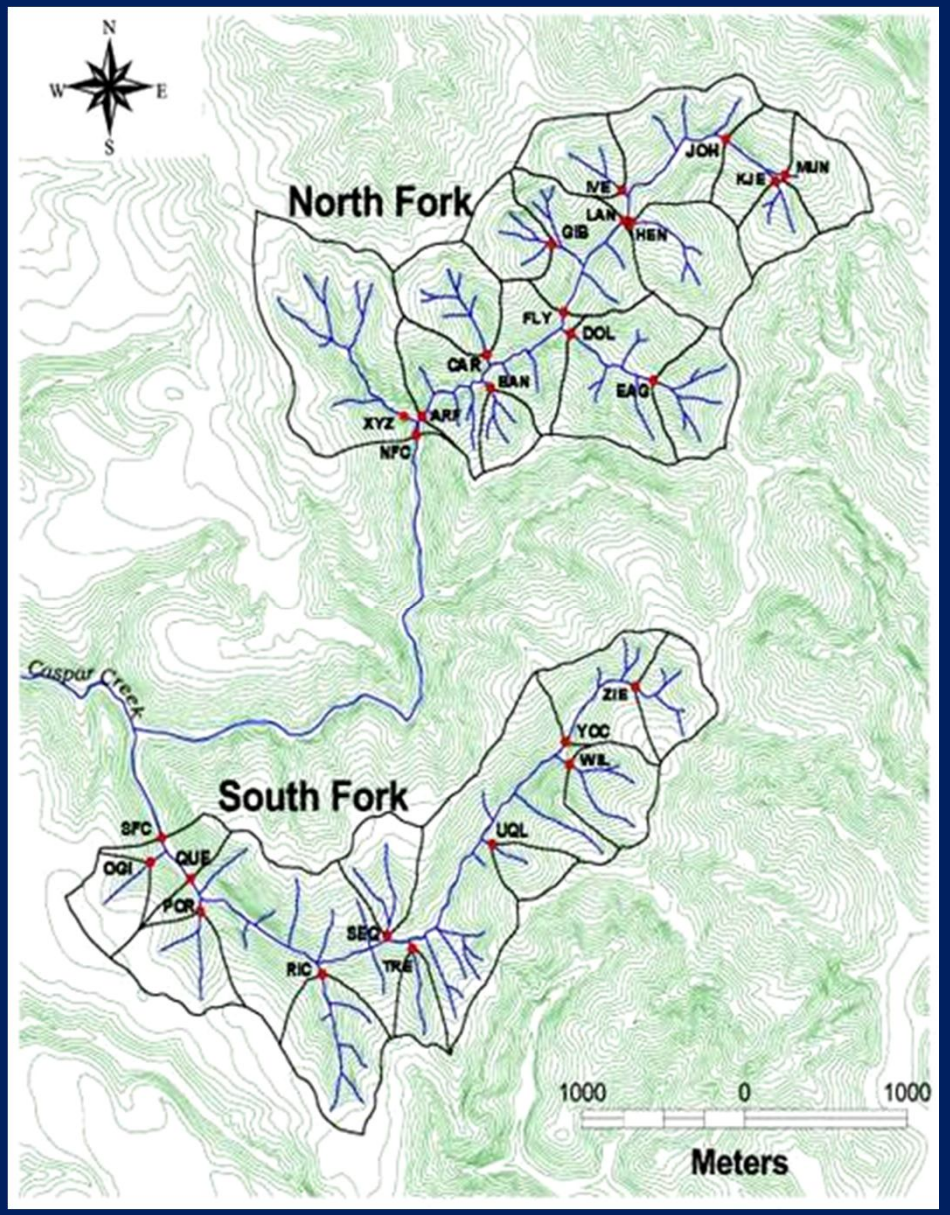
Dr. Matt Busse

2012-present

In 1960, Henry Anderson of the USDA Forest Service, Pacific Southwest Research Station (PSW) selected Caspar Creek as a site for "... a study of logging effects upon streamflow, sedimentation, fish life, and fish habitat...."

Monitored Variables

- **Streamflow**: peak flows, low flows, storm volumes, annual yield
- **Sediment**: suspended load and bedload
- **Erosion**: landslides, gully erosion, bank failures, channel cross sections
- **Aquatic and Riparian Ecosystems**: LWD, water temperature, shading, fish, macroinvertebrates, nutrients



Caspar Creek Experimental Watersheds

- 46 in (1170 mm) annual precipitation
- Sedimentary bedrock
- Steep, erodible terrain
- Well-drained loam soils
- 2nd-growth redwood and Douglas-fir forest
- Anadromous fish—coho salmon and steelhead trout

1169 acres

(473 ha)

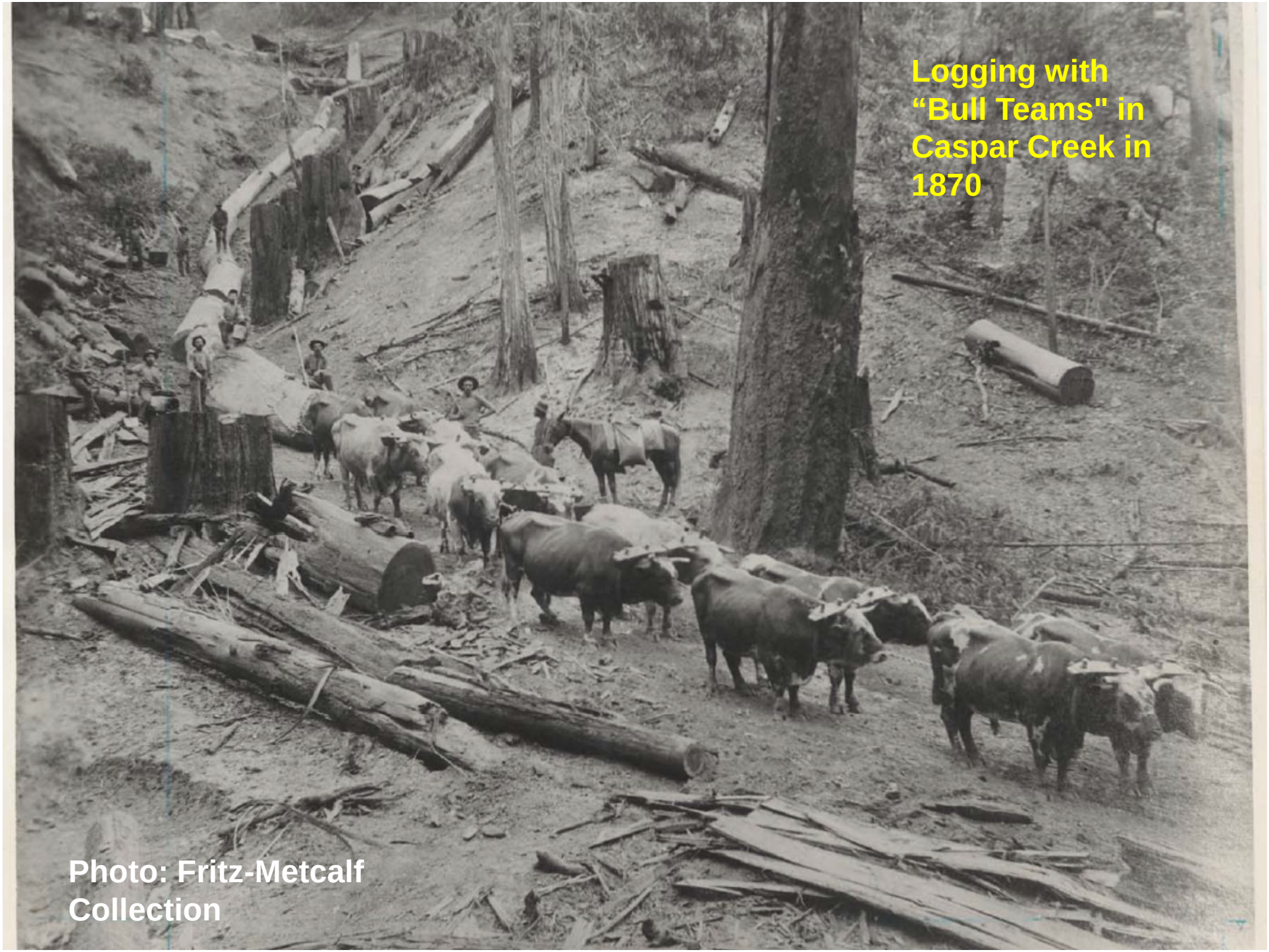
1048 acres

(424 ha)


Second Growth
Forest in the
North Fork
Caspar Creek
Watershed

Old-Growth Logging

- Logged from 1860's to 1904.
- Oxen and splash dam logged initially, to ~1890. 3 splash dams.
- Railroad logged and yarded with stream donkeys in part of the North Fork from the 1890's to 1904.


Logging with
“Bull Teams" in
Caspar Creek in
1870
Photo: Fritz-Metcalf
Collection

Seth Buck Collection

Logs stacked in Elk River in 1892, waiting for a winter freshet to carry them down to the booms.

Splash Dam
South Fork of
Caspar Creek

1868

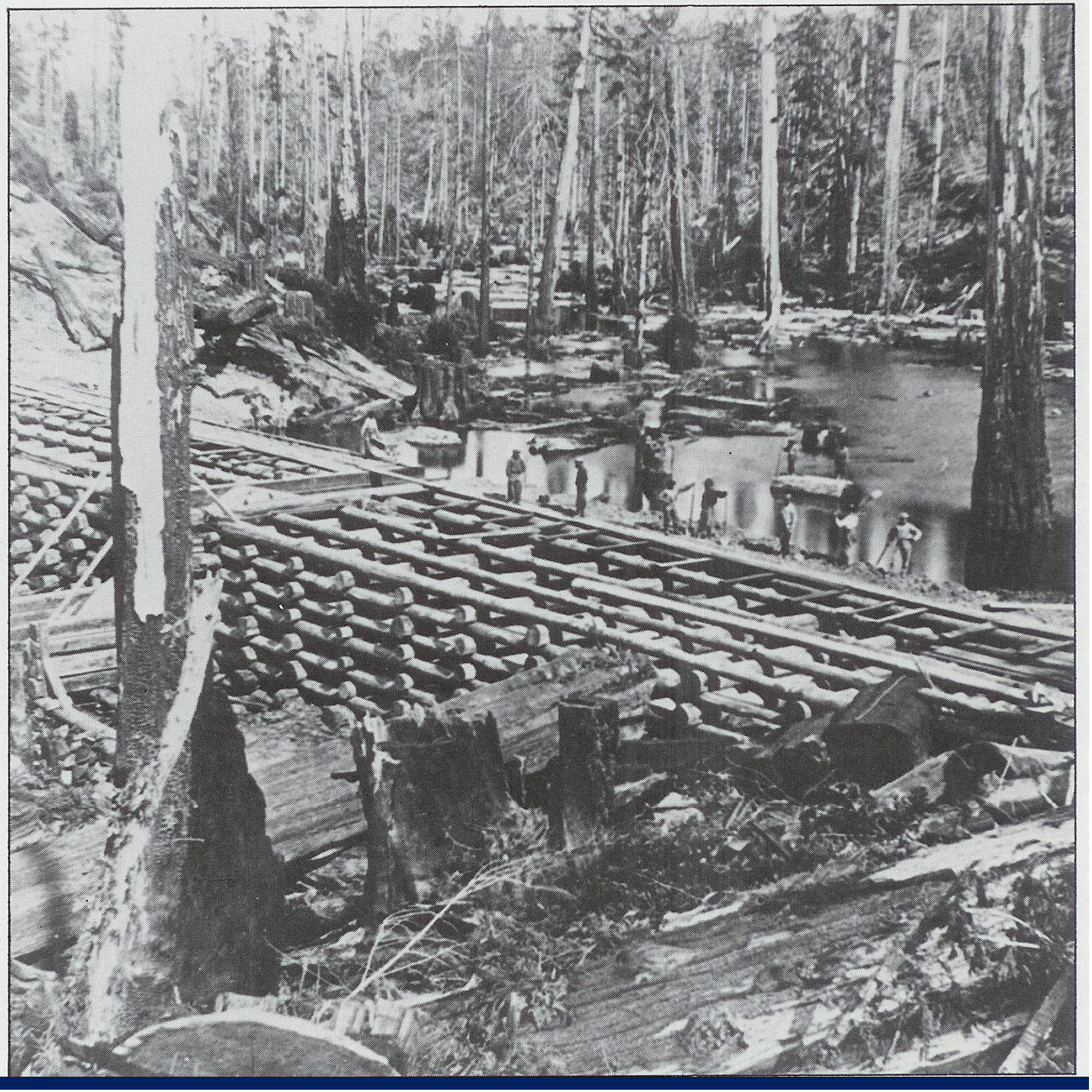


Photo: Wurm
1986

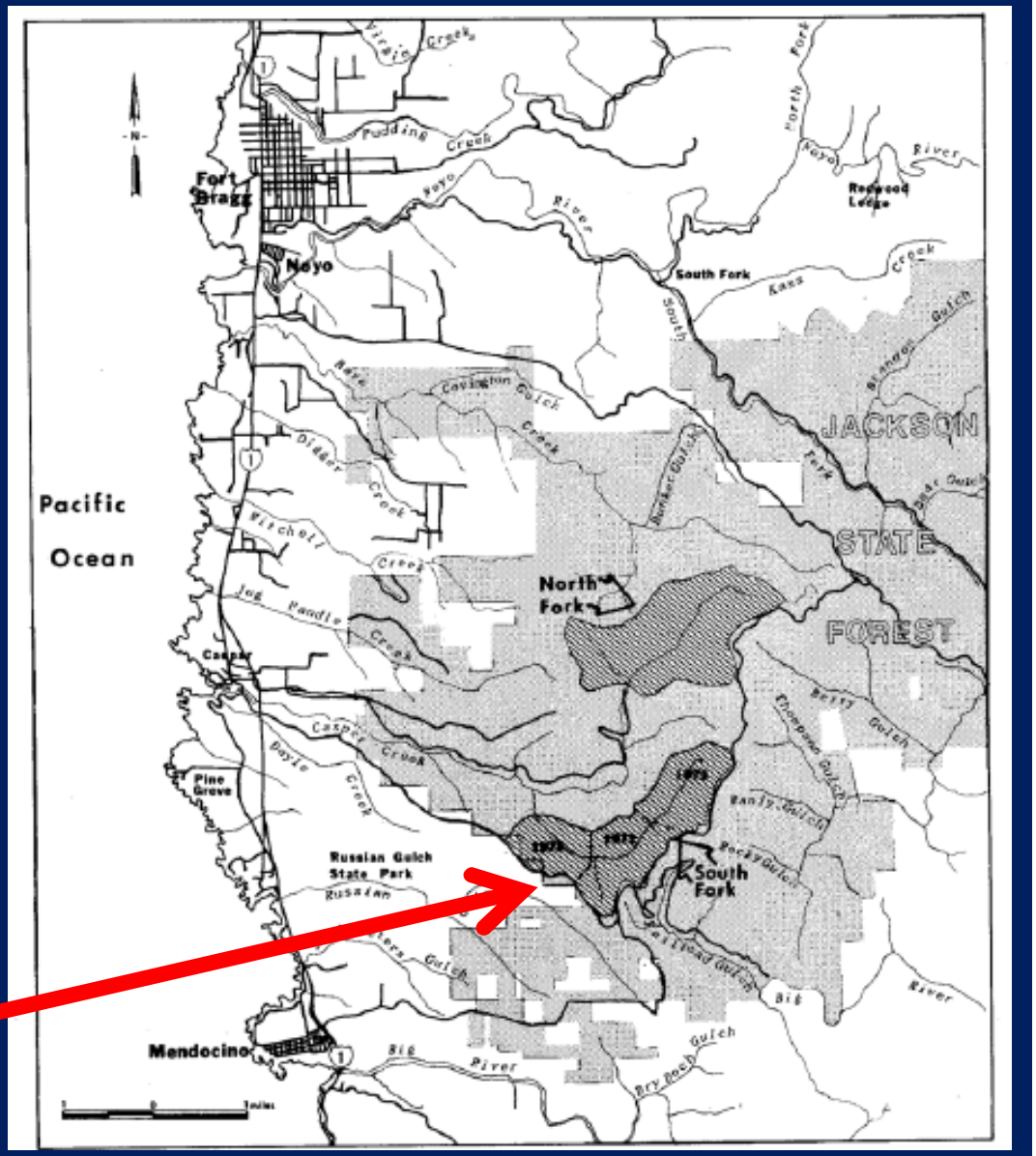
This crib dam on Caspar Creek impounded water for the purpose of floating logs to the mill in springtime. Note spillway in center. M.M. Hazeltine took this photo in 1868.

Georgia Pacific Museum

Big River Splash Dam in Operation

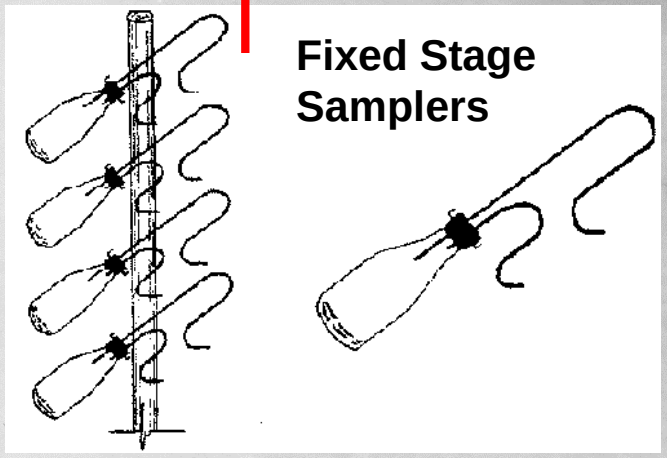
South Fork Caspar Creek Experiment

- Paired watershed study.
- Mainstem weirs built in 1962.
- Calibration: 1962-1966 (develop pre-treatment relationships between basins).
- Main South Fork haul road and spur road construction in 1967 (4.2 mi or 6.8 km).
- Selection harvest and tractor yarding 1971-1973.



Concrete Weirs Built in 1962 at both the North Fork and South Fork

Calibration Period between NF and SF: 1962-1966



Fixed Stage Samplers

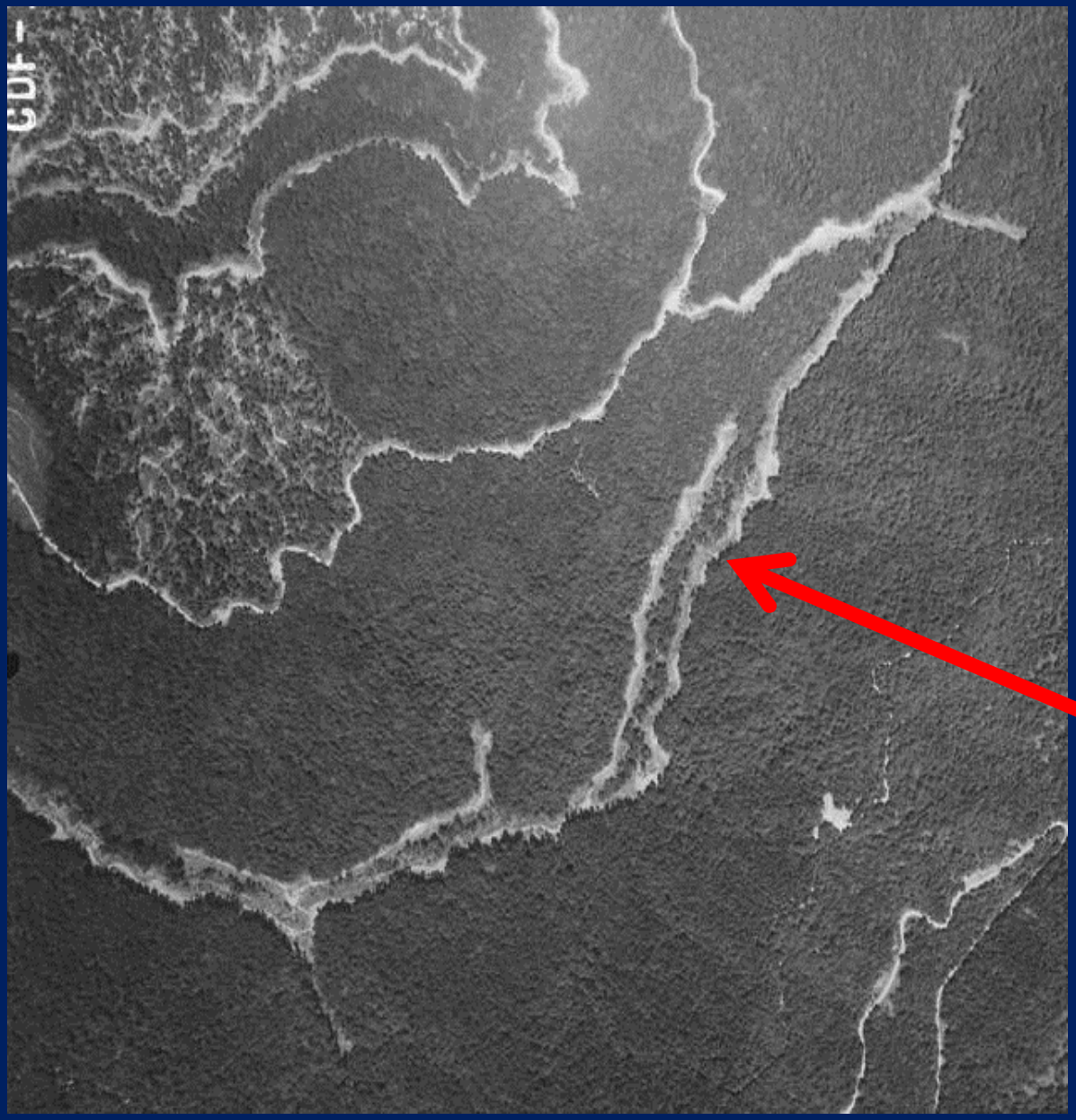
Early Depth Integrated Sampling at Caspar Weir: circa 1963

NFC Weir Pond Survey June 65

Annual Survey of Sediment Accumulation in Weir Ponds made since 1963


4.2 mi (6.8 km) of road built in 1967
September 1, 1967

About 360 ft (98 m) of streambed was disturbed by tractors directly in the channel (Krammes and Burns 1973)



South Fork Caspar Creek Watershed

1968

75% of the road constructed was within 200 ft (61 m) of the channel

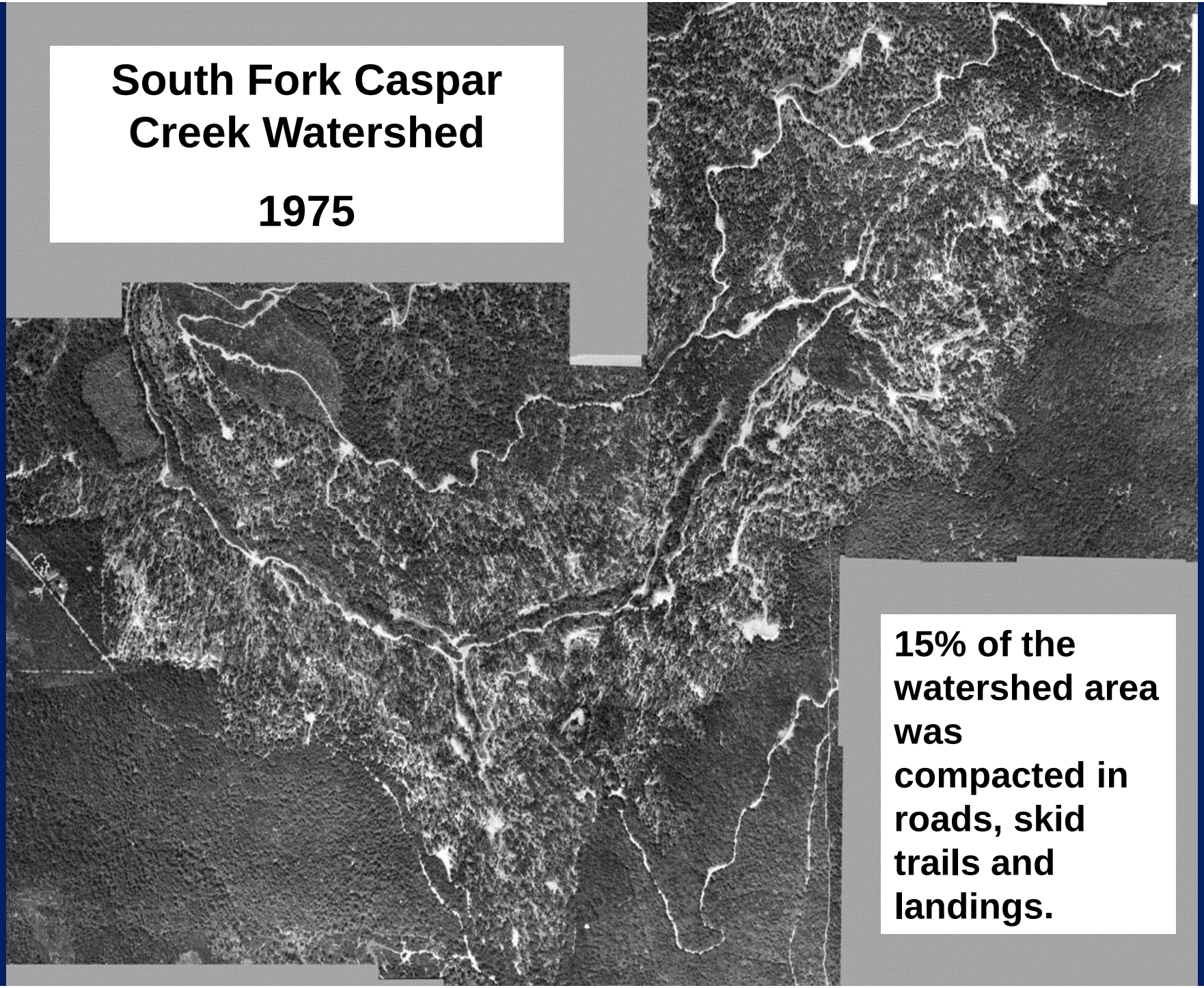
South Fork Caspar Creek Tractor Logging -- Residual Stand Watershed Sale No. 1 -- 1971

South Fork Caspar Creek Tractor Logging -- Watershed Sale No. 2 -- 1972

Practices used were typical of the period before the modern FPRs

South Fork Caspar Creek Watershed

1975



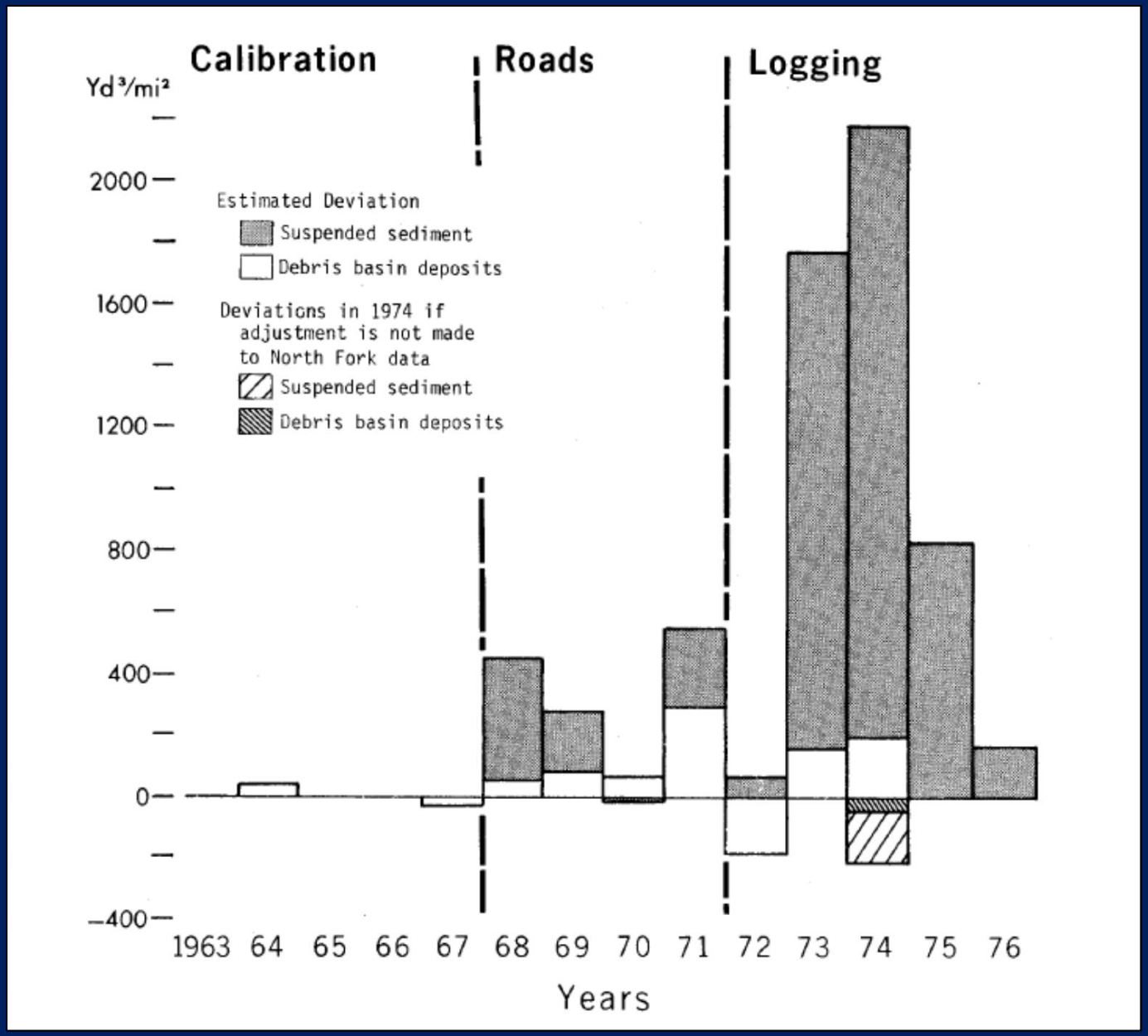
15% of the watershed area was compacted in roads, skid trails and landings.

South Fork Sediment Results to 1990

- Suspended sediment yields after road construction (1968-1971) were about **twice** those expected for pre-treatment conditions.

- Suspended sediment yields increased **4 to 5 times** those expected for the first 6 years after tractor logging, then returned to pre-treatment levels by about **1980**.

- Landslides related to roads, landings, and skid trails were responsible for most of the sediment.



Rice et al. 1979

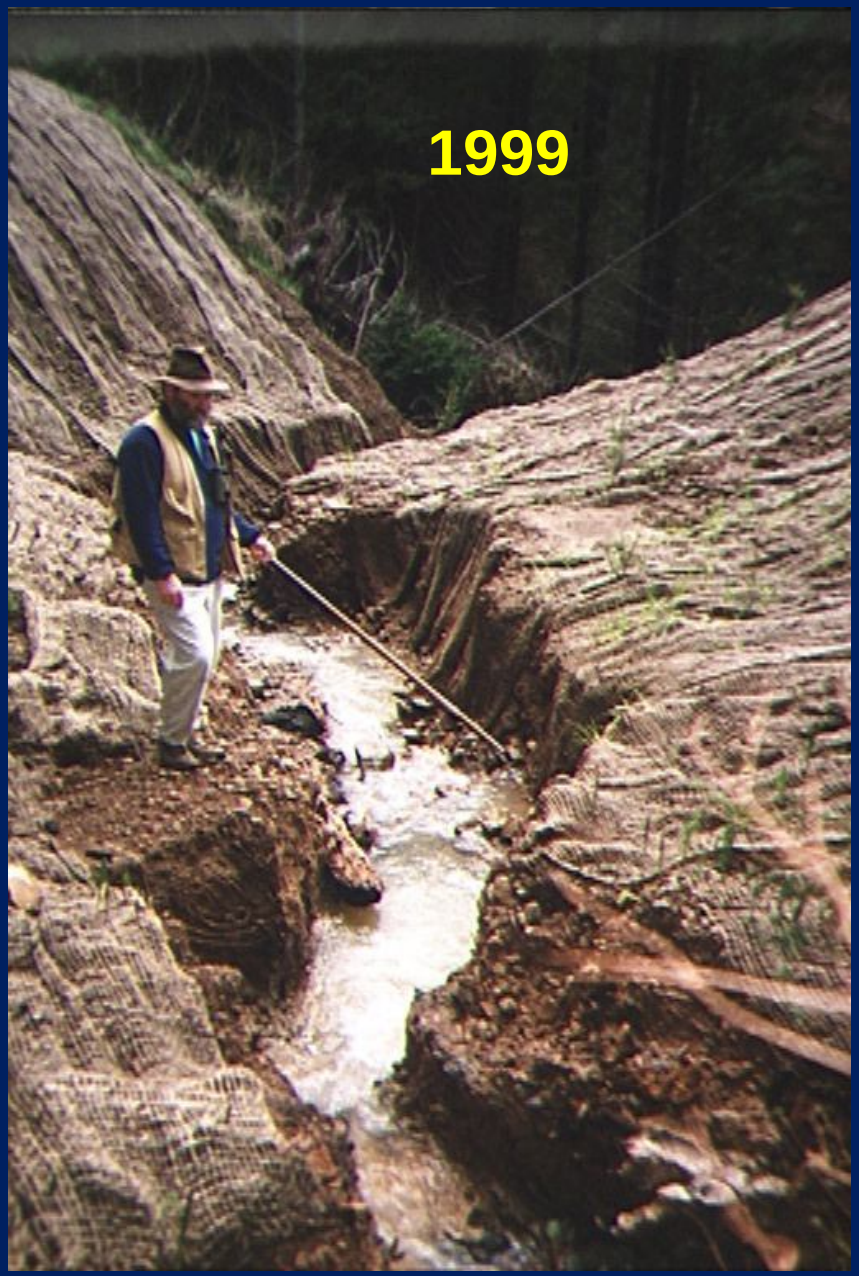
Deviations of sediment yield in the South Fork from amounts predicted

South Fork Caspar Creek Rd 600 Slide—February 1998

Deterioration of the Road System Started New Period of Excess Sediment by 1993

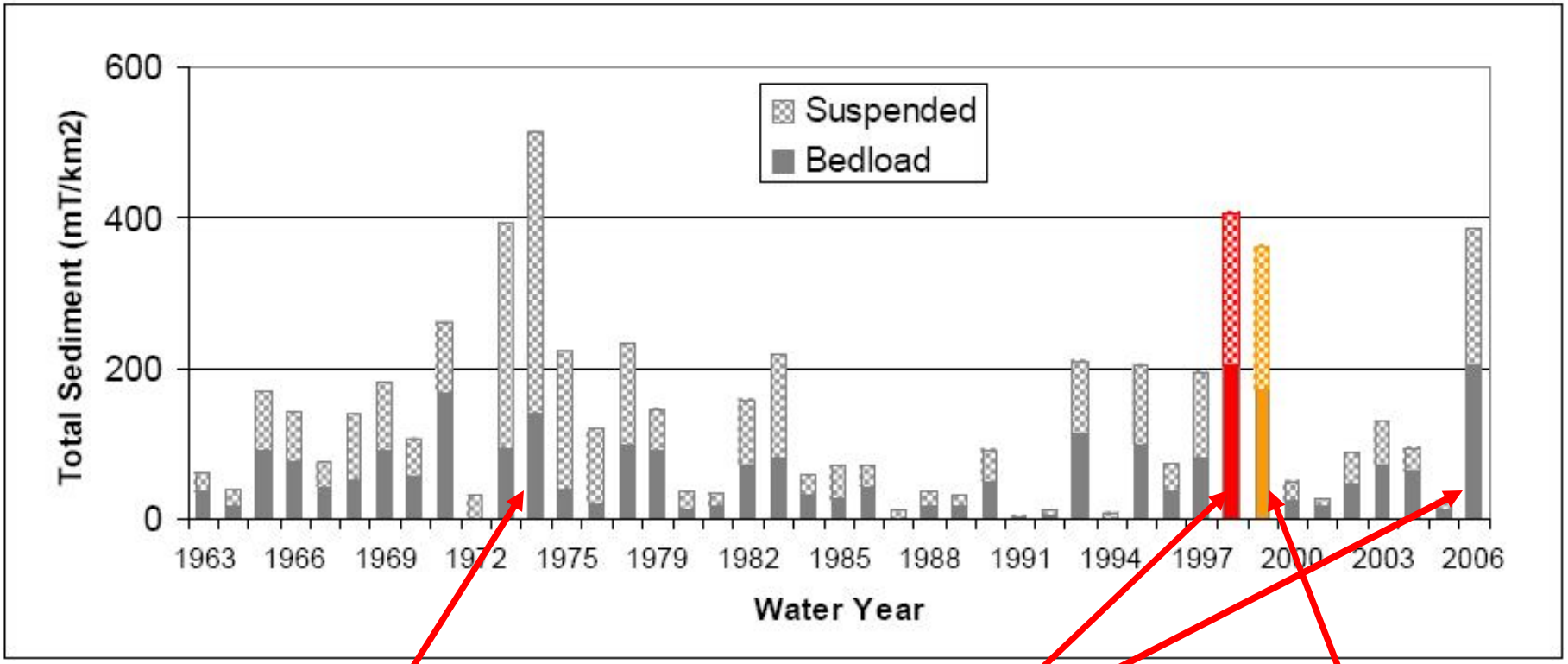
South Fork Road 600 Decommissioning
Approximately 3 mi (5 km) Decommissioned during 1998

Crossing CX-7: Example of Severely Eroded Decommissioned Rd 600 Crossing



Total Annual Sediment Yield for South Fork Caspar Creek, 1963-2006

(Keppeler et al. 2007)



South Fork Logging

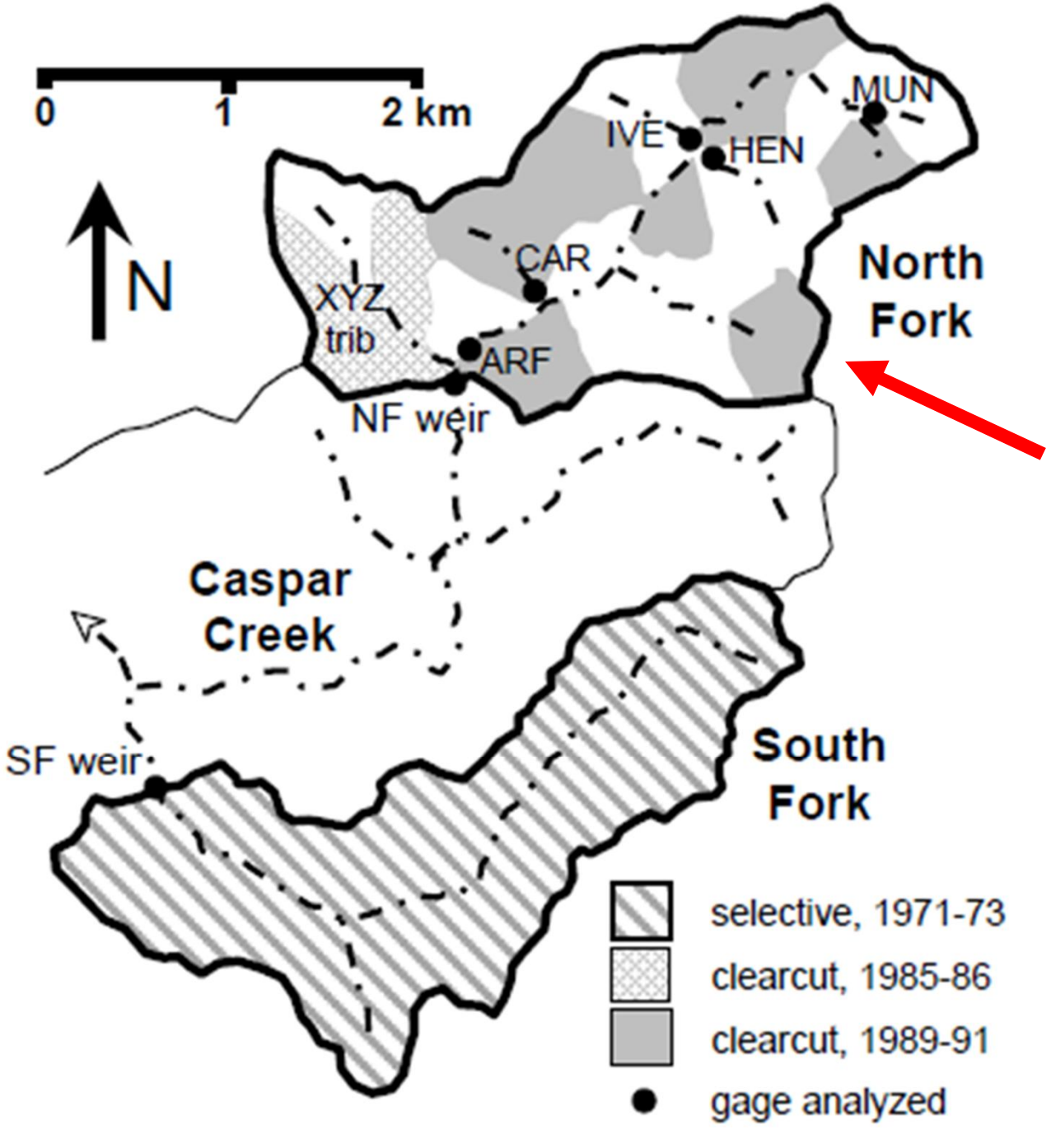
SF Road 600 Landslides

Road Decommissioning Impacts

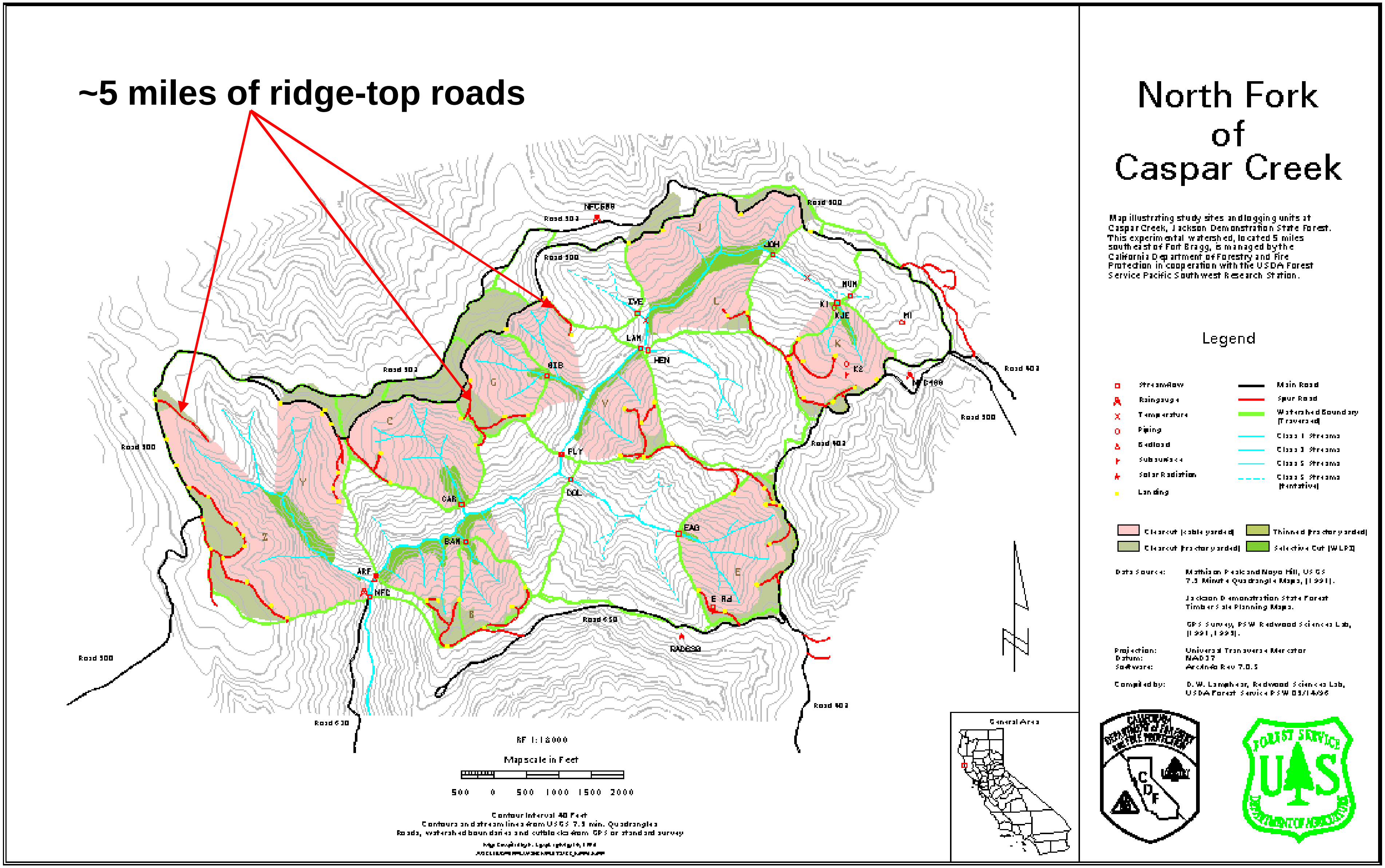
Benefits of a long-term study seen

North Fork Caspar Creek Experiment

- Designed to evaluate CWEs.
- 13 nested watersheds
- 3 control subwatersheds
- Harvested from 1985-1992 with 4 timber sales.
- Modern FPRs.
- Cable yarded, roads on ridges.
- Clearcuts; ~50% of NF basin cut.



North Fork Caspar Creek Logging Units

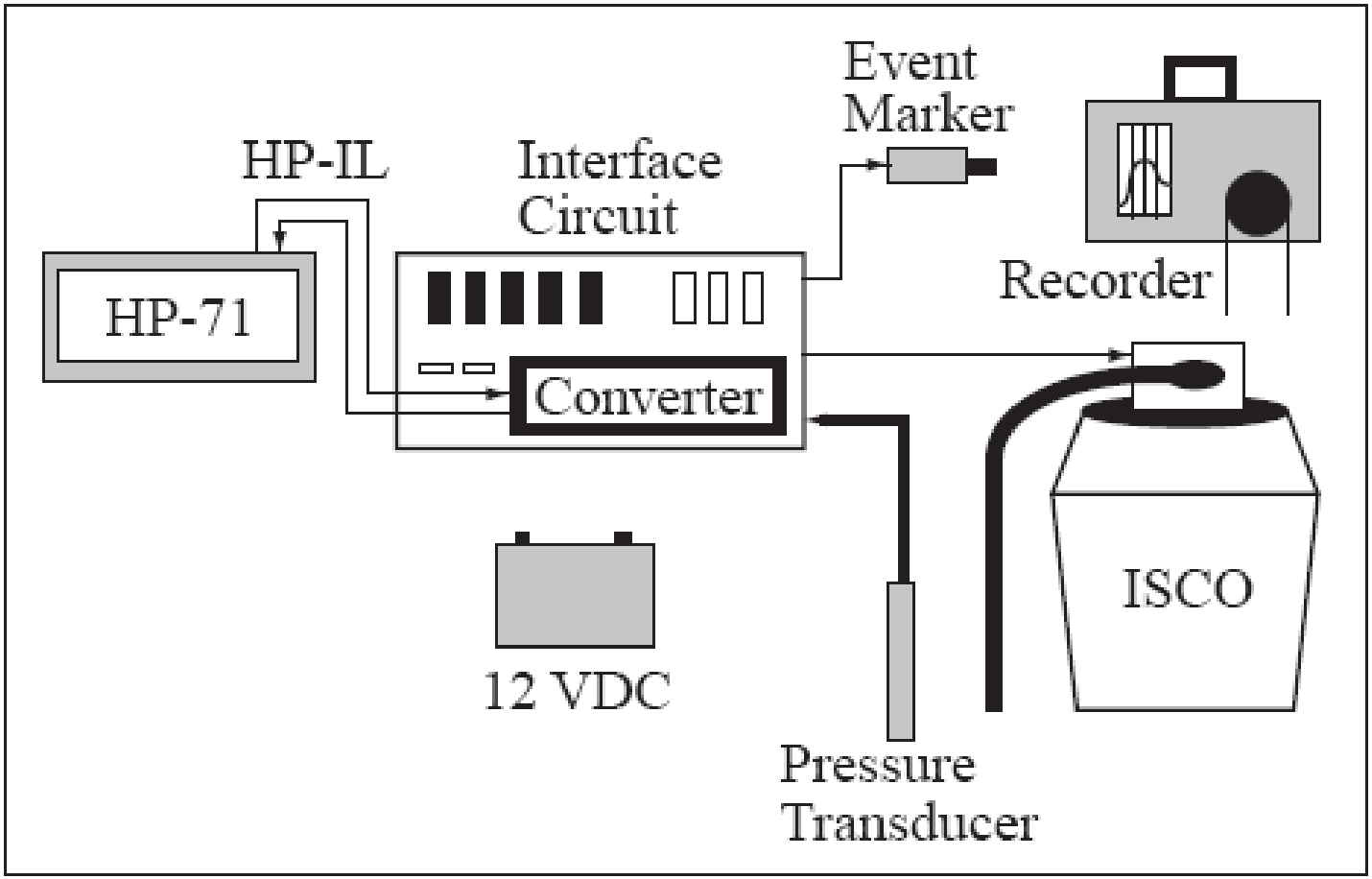


10 Parshall Flumes Built during the Summer of 1984

North Fork Calibration Period: 1985-1989

North Fork Instrumentation Used in 1985

Automated Pumping Samplers Triggered by Statistically-Based Sampling Algorithms

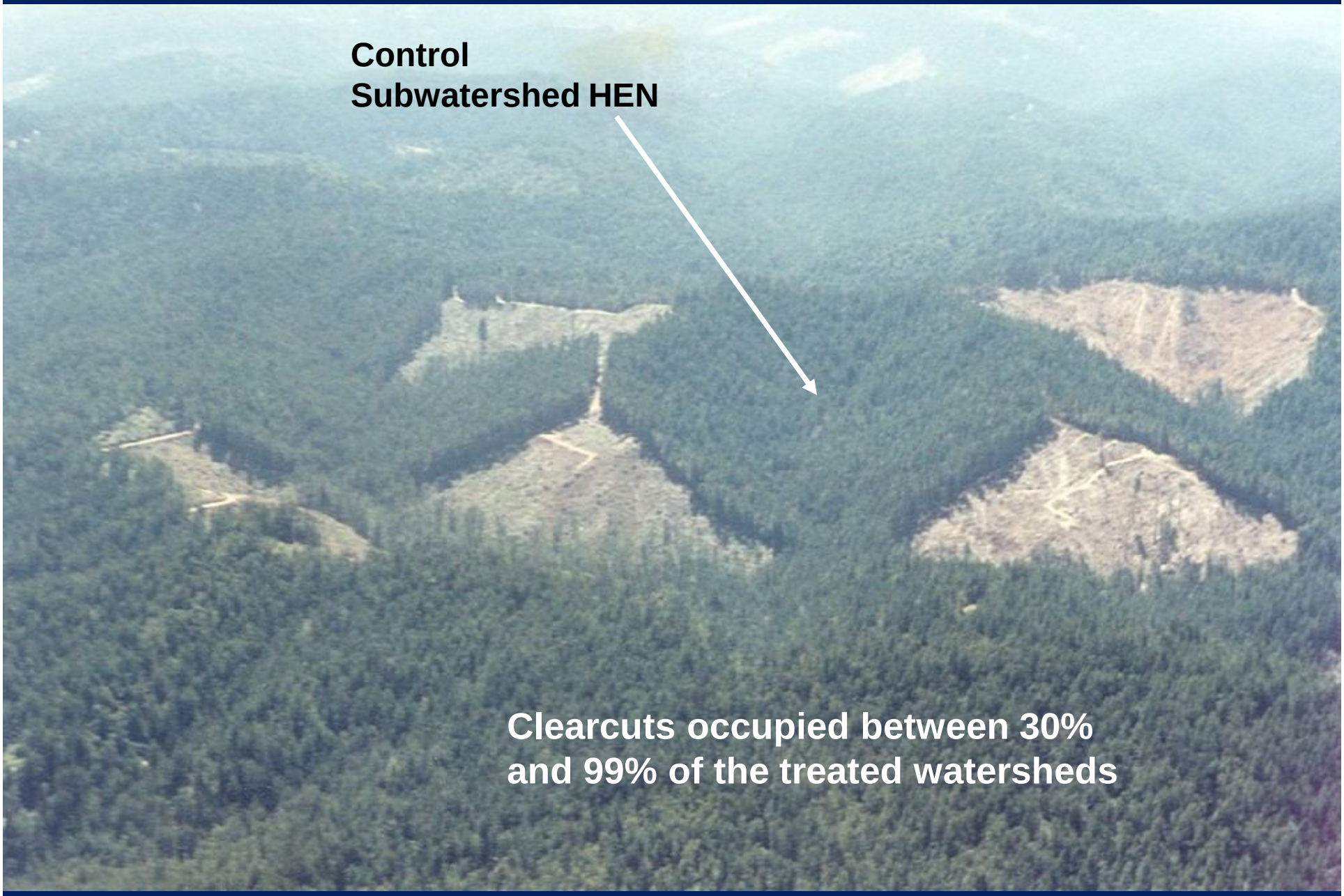


Henry 1998

Logging Units J and L, with Buffer Strip (WLPZ) along the Watercourse

March 1990

North Fork Caspar Creek Watershed: Clearcut Units K, L, J, E, and V; 1991



Oct. 1990,
Pre-Burn

Nov 1990,
Post-Burn

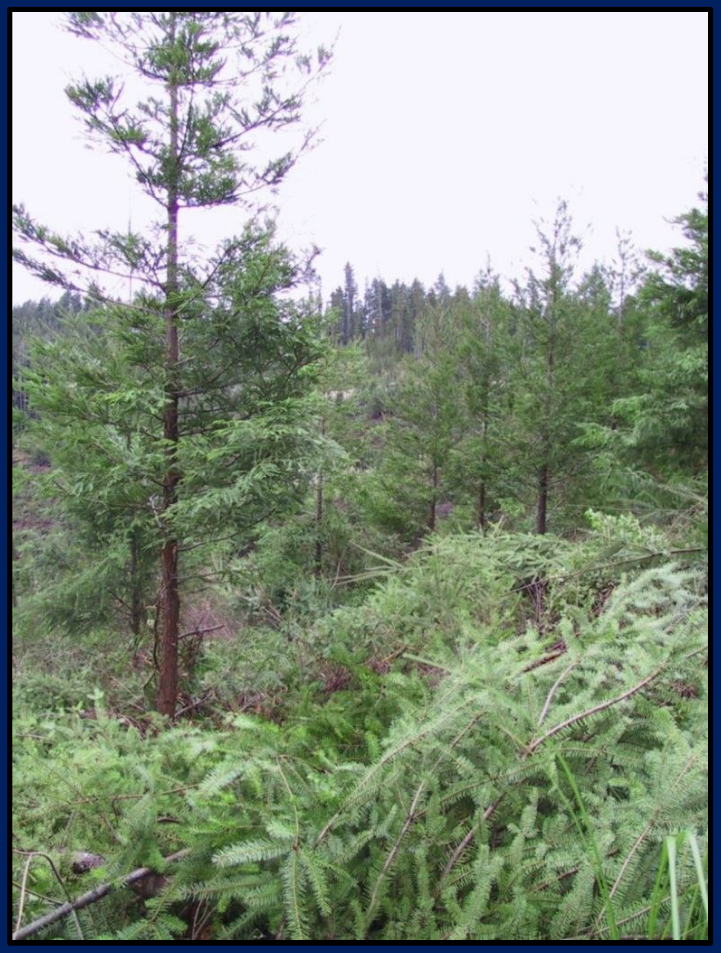
1994

Clearcut and Burned Logging Unit J, and Photo Point 4 Years Later

4 Harvest Units, totaling ~230 acres (93 ha), were broadcast burned and later treated with herbicides to control competition

Pre-Commercial Thinning in NF Units Occurred from 1998 to 2002

Third Growth Stand in the North Fork

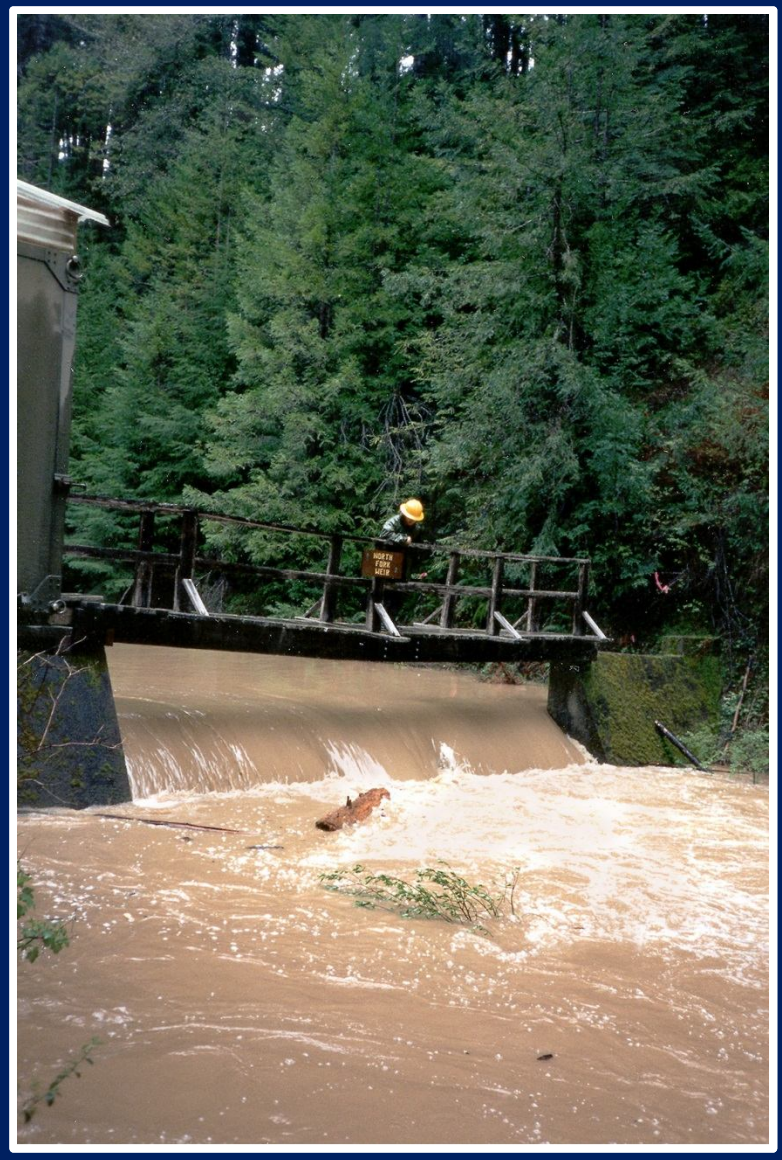


Inventory Plot in Logging Unit J, July 2003

North Fork Peak Flow Results

Peak flows: 100% clearcut tributaries—mid-winter storm peak flows increased an average of 27% ↑ (2-yr RI storm).

Peak flow increases related to soil wetness, proportion of watershed logged, storm size, and time after logging.



North Fork Sediment Results

- **Suspended sediment increased 89% the first 4 years after logging -- mainly from a January 1995 large landslide in a tributary very near the weir.**
- Even with the North Fork landslide, South Fork Caspar produced **2.4 to 3.7** times more suspended sediment compared to NF Caspar.
- Cumulative 20 year post-harvest sediment excess measured at station ARF (located 100 m upstream of the NF weir) was only **5%** above that predicted.

Unit Z 1995 Landslide--4700 yds^3 (3600 m^3)

North Fork Erosion Results

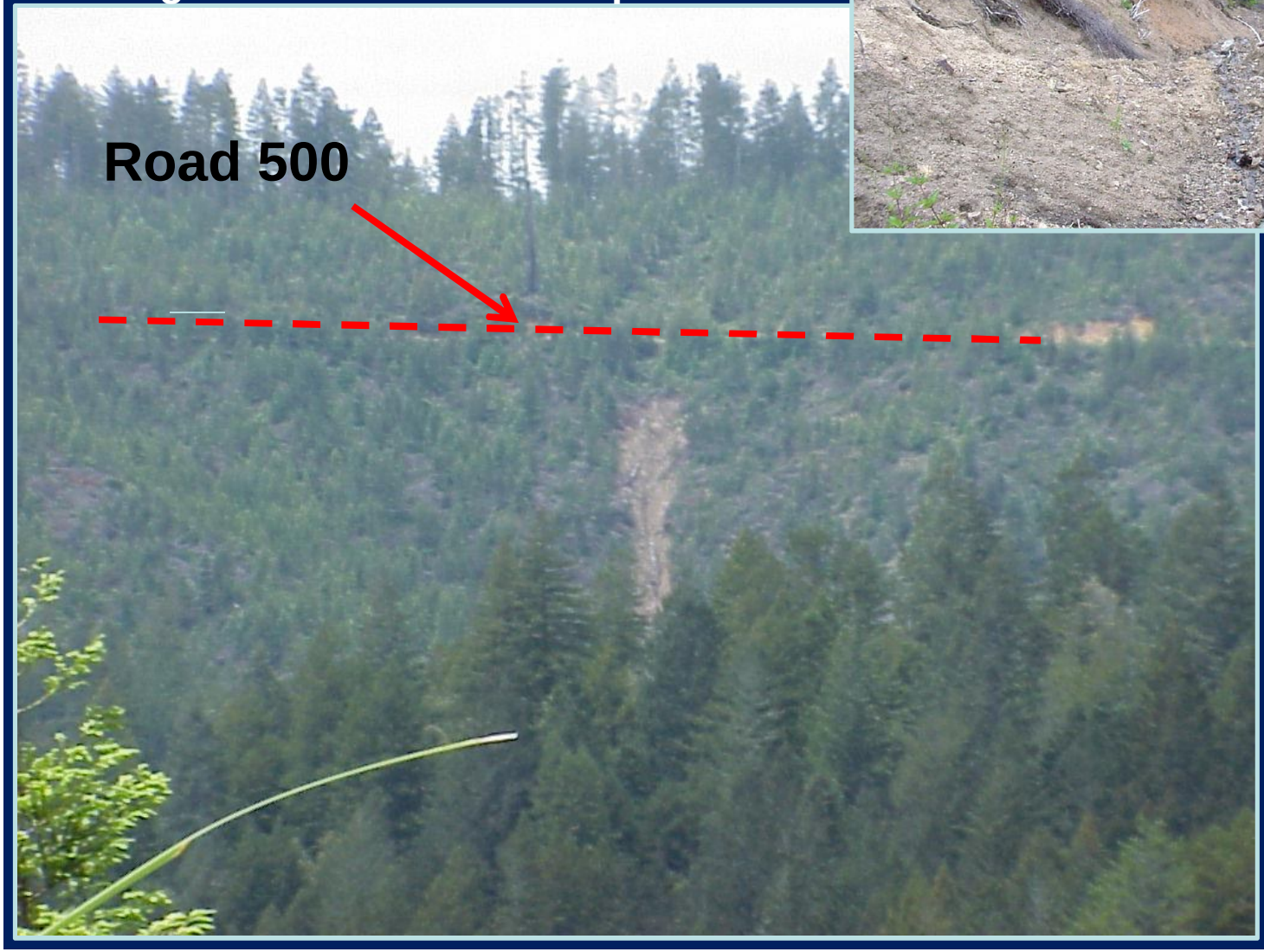
- The main sediment inputs were from **landslides** and **in-channel erosion**, not road surface erosion.

- **In-channel erosion** (gullying, channel incision, bank erosion) was the major source of sediment during periods without major landslides.

Caspar Creek Gully Headcut

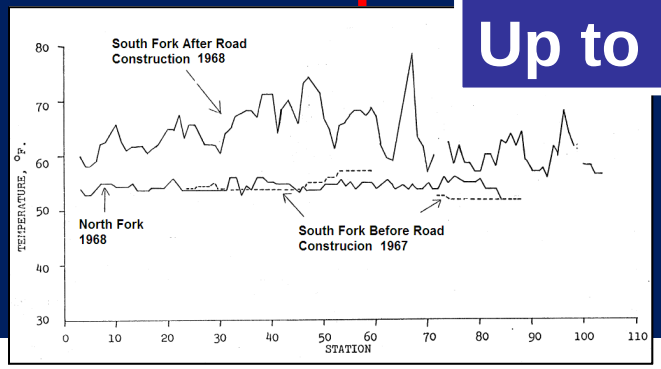
North Fork Unit G Landslide, December 2002

Partly triggered by concentrated road drainage into the clearcut slope

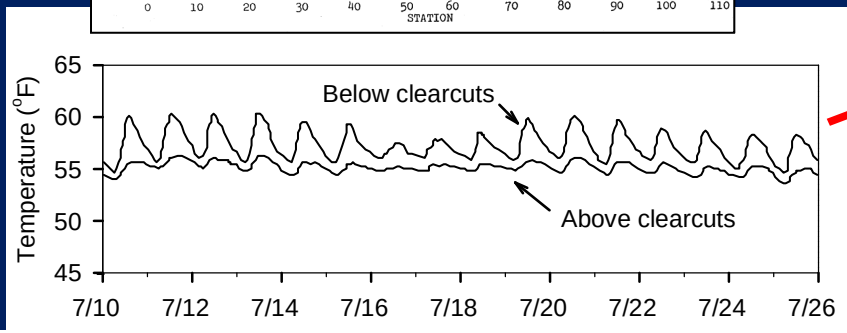


Clearcutting appears to have increased the number of large landslides and destabilized slopes adjacent to roads.

South Fork Caspar Creek after Road 600 Construction in 1967



Up to 11 ºC ↑

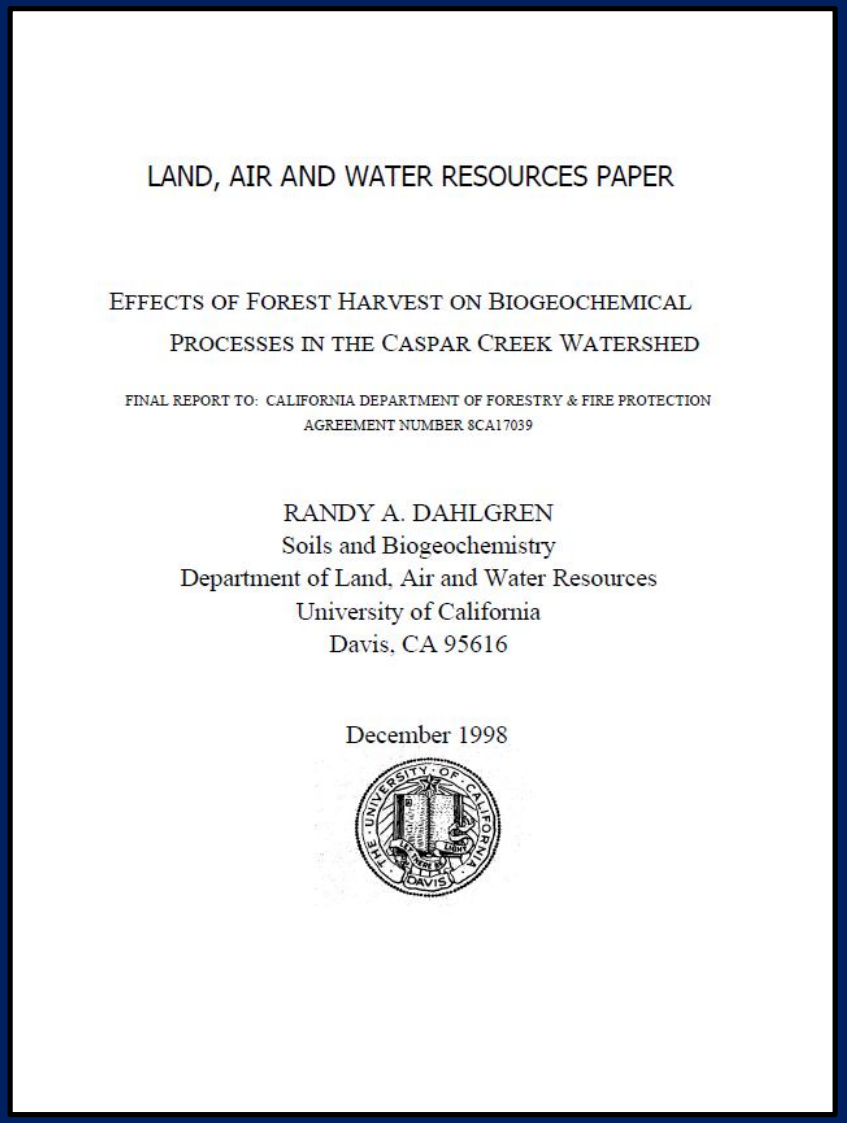


2 ºC ↑

North Fork Caspar Creek, 1990

North Fork Nutrient Cycling Results

- Nitrate nitrogen concentrations **increased** in streams after clearcutting in the North Fork, but fluxes were **relatively low** compared to results from other studies.
- **Rapid regrowth** in coast redwood forests appear to make these forests relatively resistant to nutrient losses from leaching after harvest.



LAND, AIR AND WATER RESOURCES PAPER

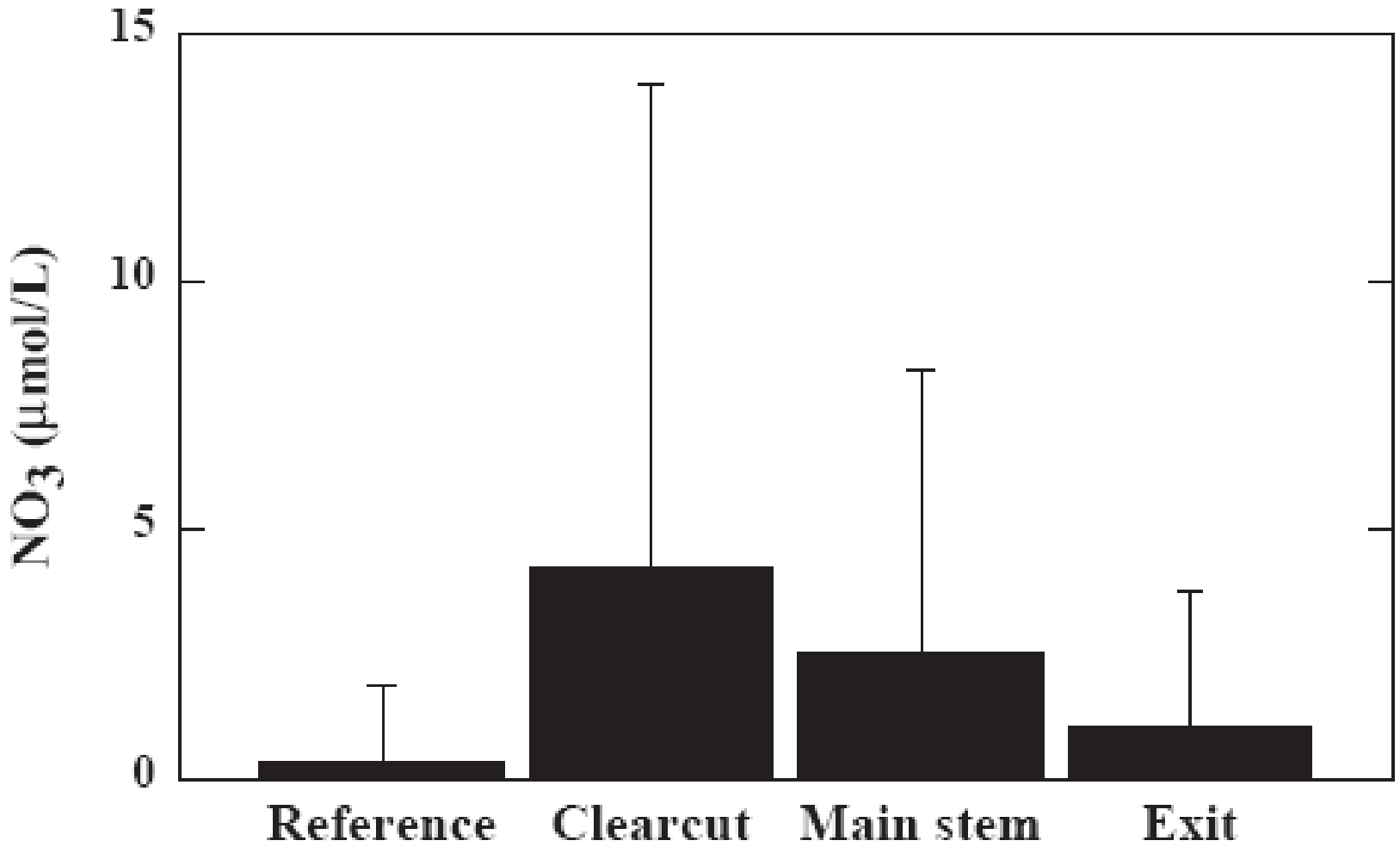
EFFECTS OF FOREST HARVEST ON BIOGEOCHEMICAL PROCESSES IN THE CASPAR CREEK WATERSHED

FINAL REPORT TO: CALIFORNIA DEPARTMENT OF FORESTRY & FIRE PROTECTION
AGREEMENT NUMBER 8CA17039

RANDY A. DAHLGREN
Soils and Biogeochemistry
Department of Land, Air and Water Resources
University of California
Davis, CA 95616

December 1998

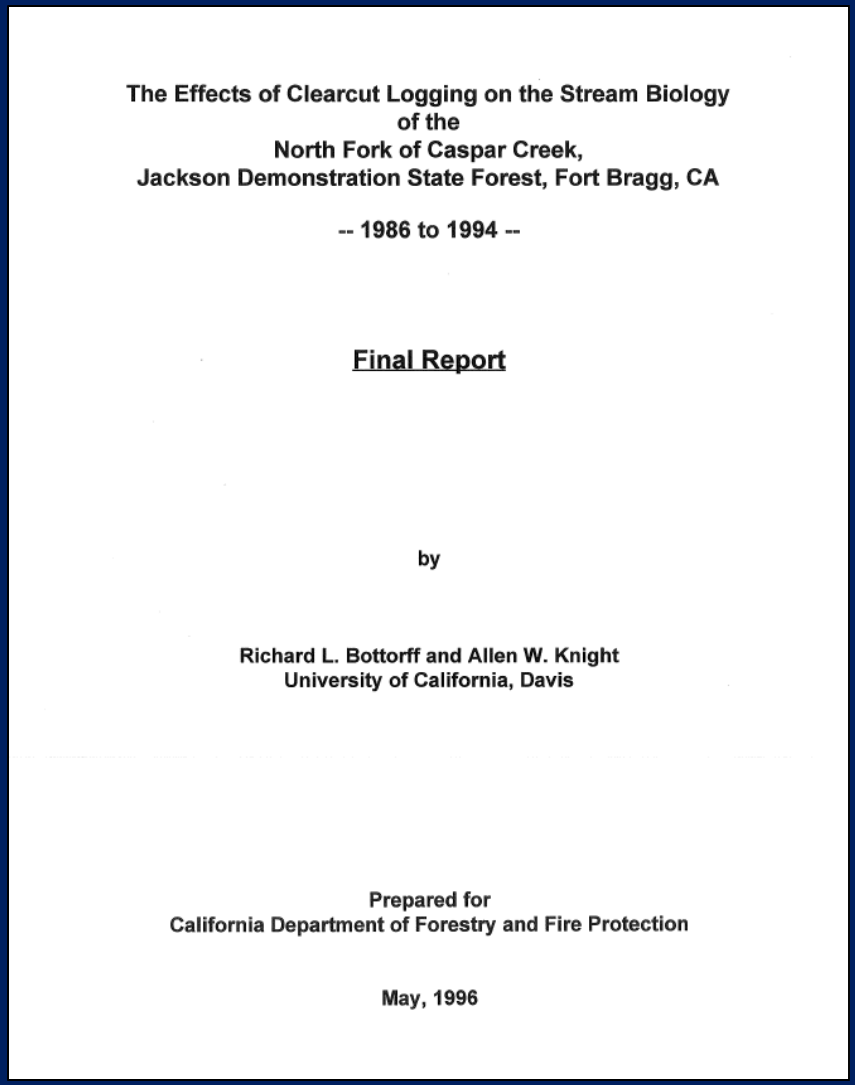
Nitrate Concentrations at Various Locations in the North Fork Caspar Creek Watershed



Dahlgren 1998

North Fork Stream Biology Results

- PI: Dr. Allan Knight, UC Davis (retired).
- Study conducted from 1986 to 1994, including years before, during, and after logging in the NF.
- **Three basic stream components studied**:
  - Macroinvertebrates
  - Algae
  - Leaf decay rates
- Final Report finished in 1996: http://www.fs.fed.us/psw/publications/4351/Bottorff.pdf



The Effects of Clearcut Logging on the Stream Biology
of the
North Fork of Caspar Creek,
Jackson Demonstration State Forest, Fort Bragg, CA

-- 1986 to 1994 --

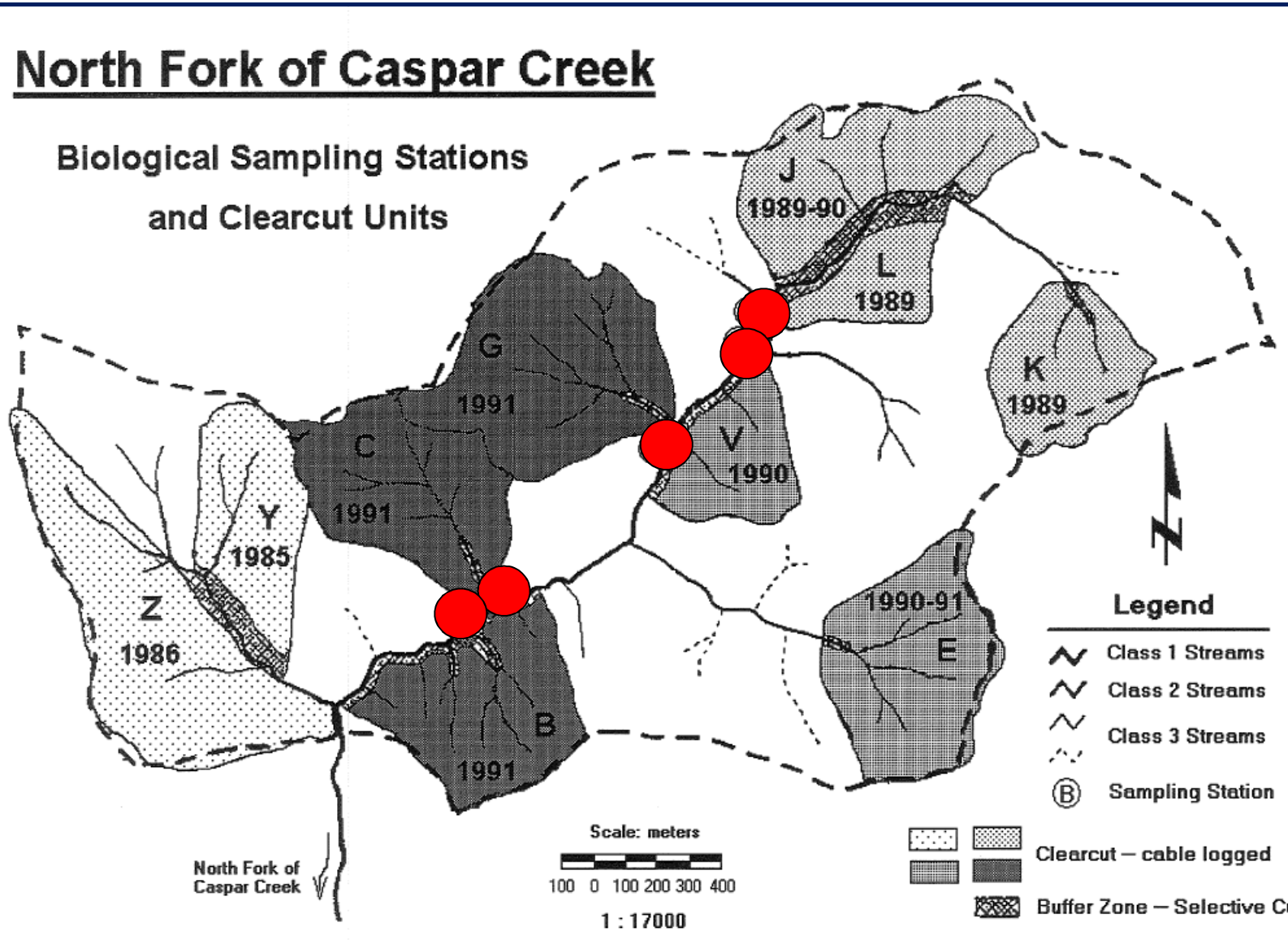
Final Report

by

Richard L. Bottorff and Allen W. Knight
University of California, Davis

Prepared for
California Department of Forestry and Fire Protection

May, 1996



5 main sites used for data collection; samples collected immediately above and below each of the 5 trib confluences (3 sub-basins logged; 2 unlogged)

North Fork Stream Biology Results

- **Stream algae significantly increased in chlorophyll-a and biomass during and after logging.**
- **Even with a buffer strip, increase probably due to increased light levels (also some effects may have been related to nutrient increases or water temperature increases).**

Unglazed Clay Quarry Tile

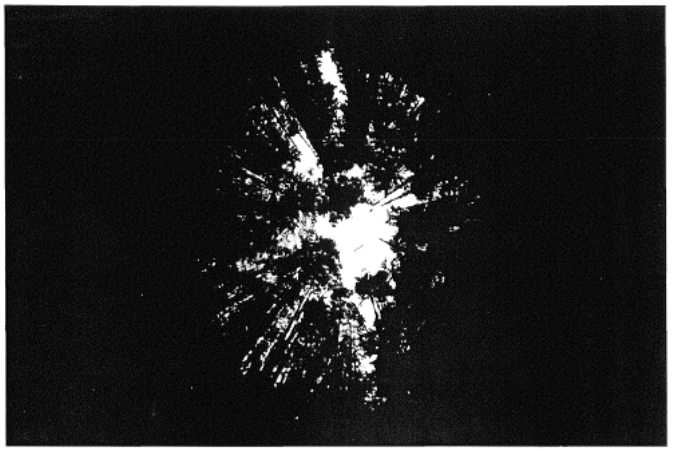
North Fork Stream Biology Results

- **Significant increases in macroinvertebrate density and diversity reported, as well as EPT density and diversity.**
- **Functional feeding groups: significant increases after logging were found for scrapers, shredders, and collector-filterers.**

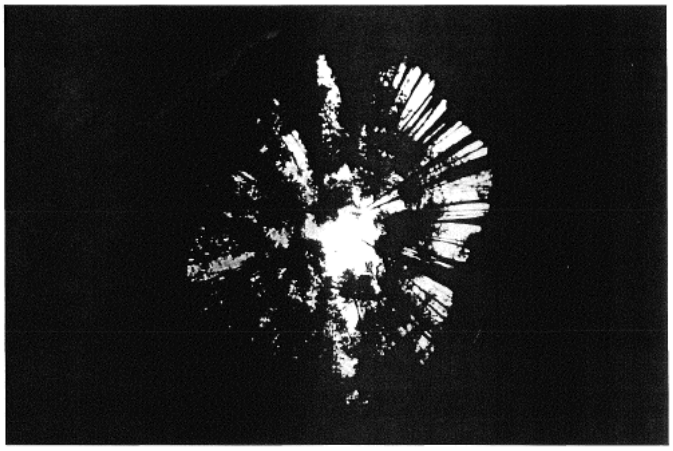
Artificial Substrate Samplers

North Fork Stream Biology Results

- **Leaf decay rates doubled for 2 years during and after logging, then returned to pre-logging levels.**
- **The effects documented in the biology study likely reflect increased light, nutrient, and water temperature levels.**



Forest canopy at Station G on 29 October 1989 -- PRE-LOGGING



Forest canopy at Station G on 29 June 1991 -- POST-LOGGING V

Shading reduced ~13%

North Fork Fisheries Results

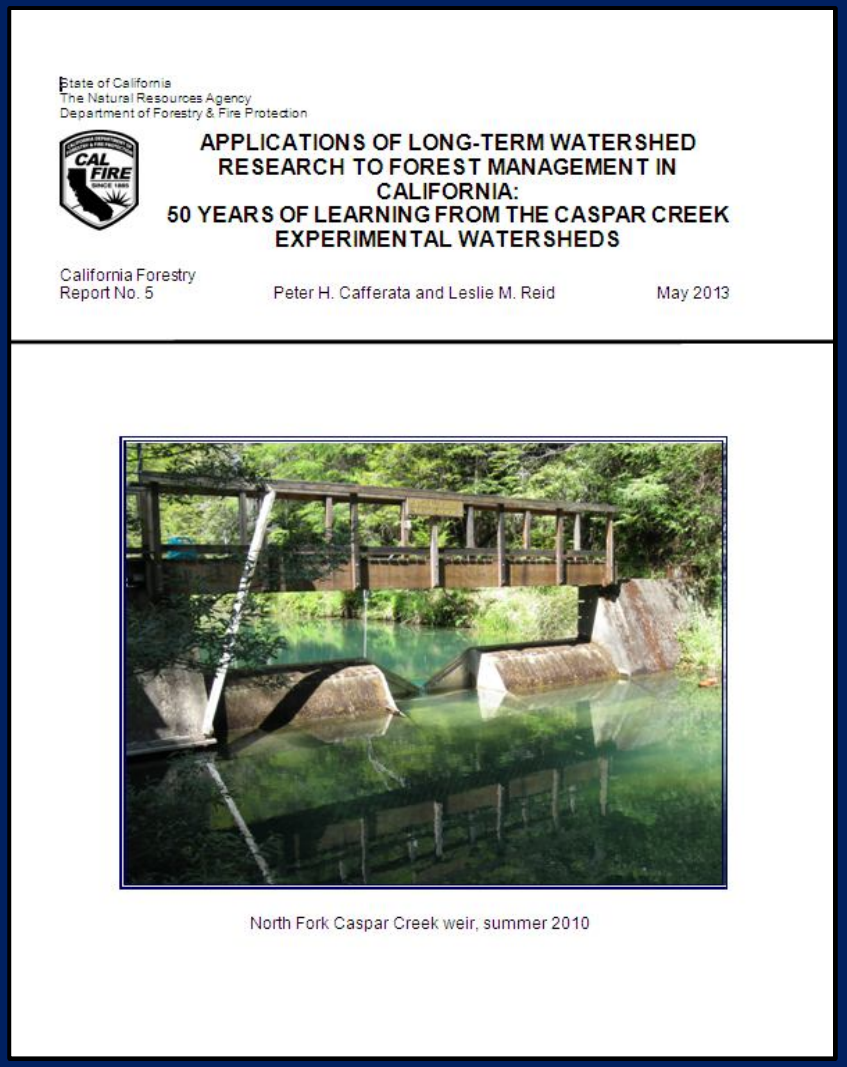
- **Variability was high, but no dramatic changes in the abundance of coho salmon or steelhead trout were recorded after the North Fork logging.**

Nakamoto 1998

Juvenile Steelhead Trout Trapped in the Lower Caspar Creek

Summary Points

- **Implementation of the modern CA FPRs (post-1975) have substantially reduced water quality impacts related to sediment.**
- **Results from the first two experiments suggest management strategies for reducing potentially significant impacts.**
- **The results have been applied broadly by foresters and other resource professionals over the past two decades to address numerous forestry-related issues.**
- **The third experiment at Caspar Creek will build on what we have learned so far and improve our understanding of the impacts of contemporary logging practices.**



State of California
The Natural Resources Agency
Department of Forestry & Fire Protection

APPLICATIONS OF LONG-TERM WATERSHED RESEARCH TO FOREST MANAGEMENT IN CALIFORNIA:
50 YEARS OF LEARNING FROM THE CASPAR CREEK EXPERIMENTAL WATERSHEDS

California Forestry Report No. 5 | Peter H. Cafferata and Leslie M. Reid | May 2013

North Fork Caspar Creek weir, summer 2010

http://calfire.ca.gov/resource_mgt/downloads/reports/California_Forestry_Report_5.pdf