Forest Management and Restoration Practices: Effects on Stream Health and Function

Ken Roby (retired)
Fisheries Biologist
Lassen National Forest

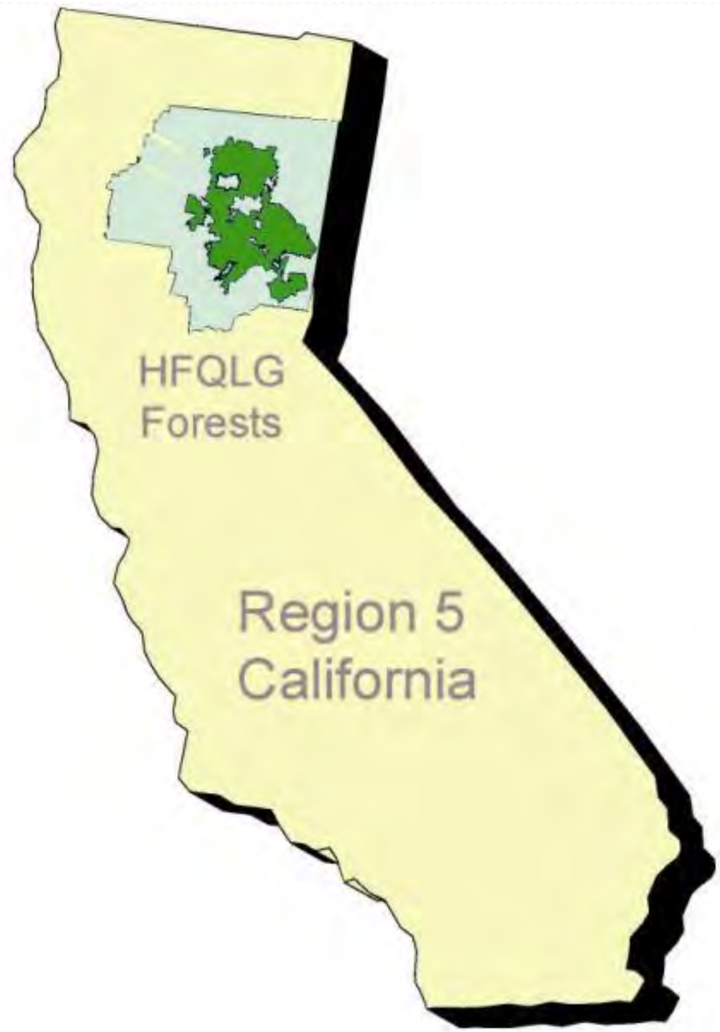
Chris Mayes
Fisheries Biologist
Lassen National Forest

Objectives

- Share Results of Herger-Feinstein Quincy Library Group (HFQLG) Monitoring
  - Vegetation Management
  - Aspen Enhancement
  - Road/Culvert Decommissioning
  - Stream/Meadow Improvement
- Wildfire Effects on Stream Attributes
- Discuss Management Implications

Herger-Feinstein Quincy Library Group Pilot Project

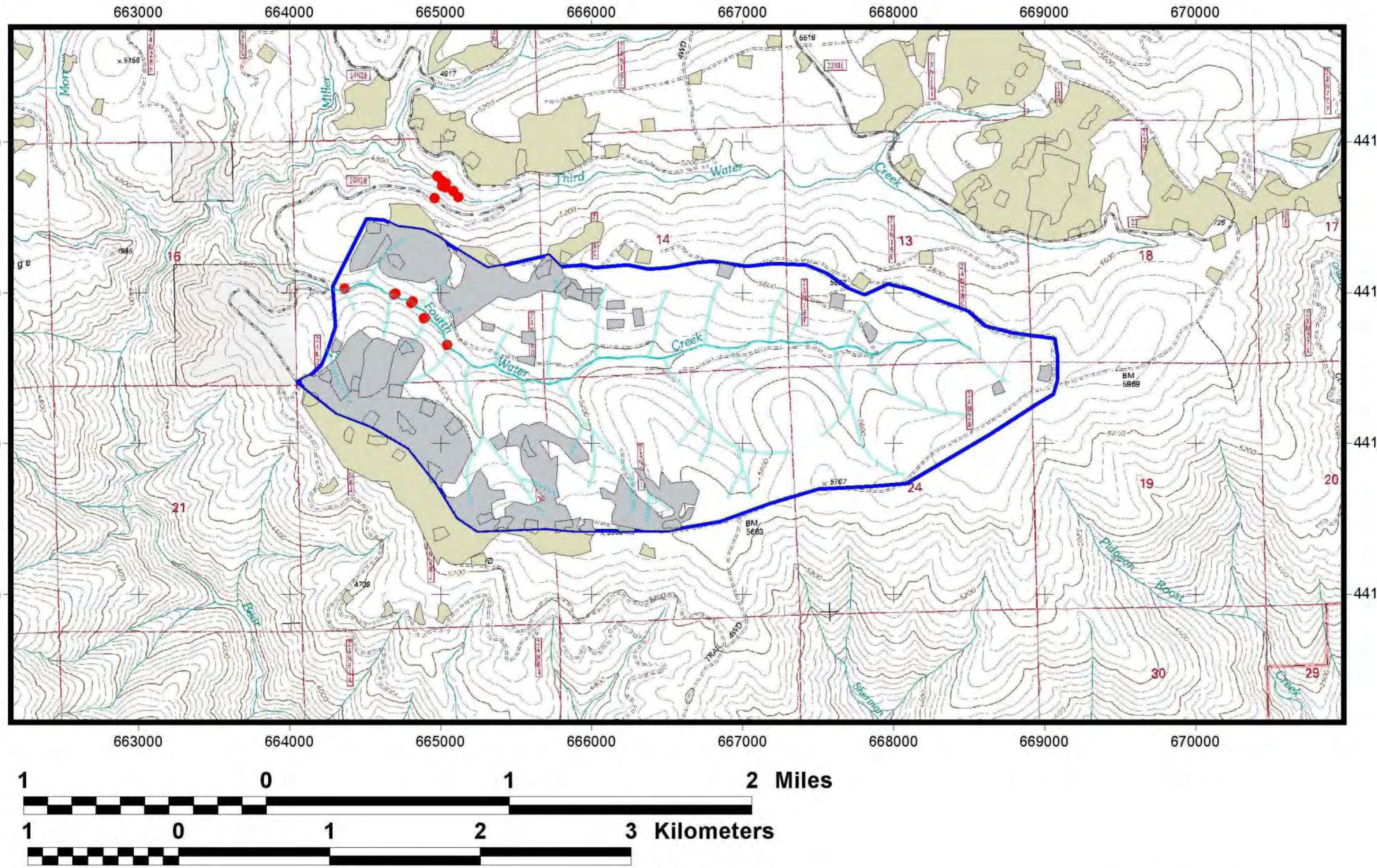
- Implemented 1998-2012 over 1.5 million acres of the Plumas, Lassen National Forests and Sierraville RD of Tahoe NF.
- Designed to test and demonstrate the effectiveness of fuels and vegetation management activities to meet ecological, economic, and fuel reduction objectives.



Herger-Feinstein Quincy Library Group Monitoring Plan

- How do attributes (channel, riparian, and macroinvertebrate assemblages) of streams in the pilot project area change over time?
- What is the trend in channel and riparian attributes and macroinvertebrate assemblages **in watersheds with the highest concentration of activities?**

4th Water Creek SCI Site



Scale 1:36,000

NAD 1927 CONUS

Streams
4th Water SCI DFPZ
4th Water Creek Watershed Area
SCI Site Points
Meadow Vly QLG Project

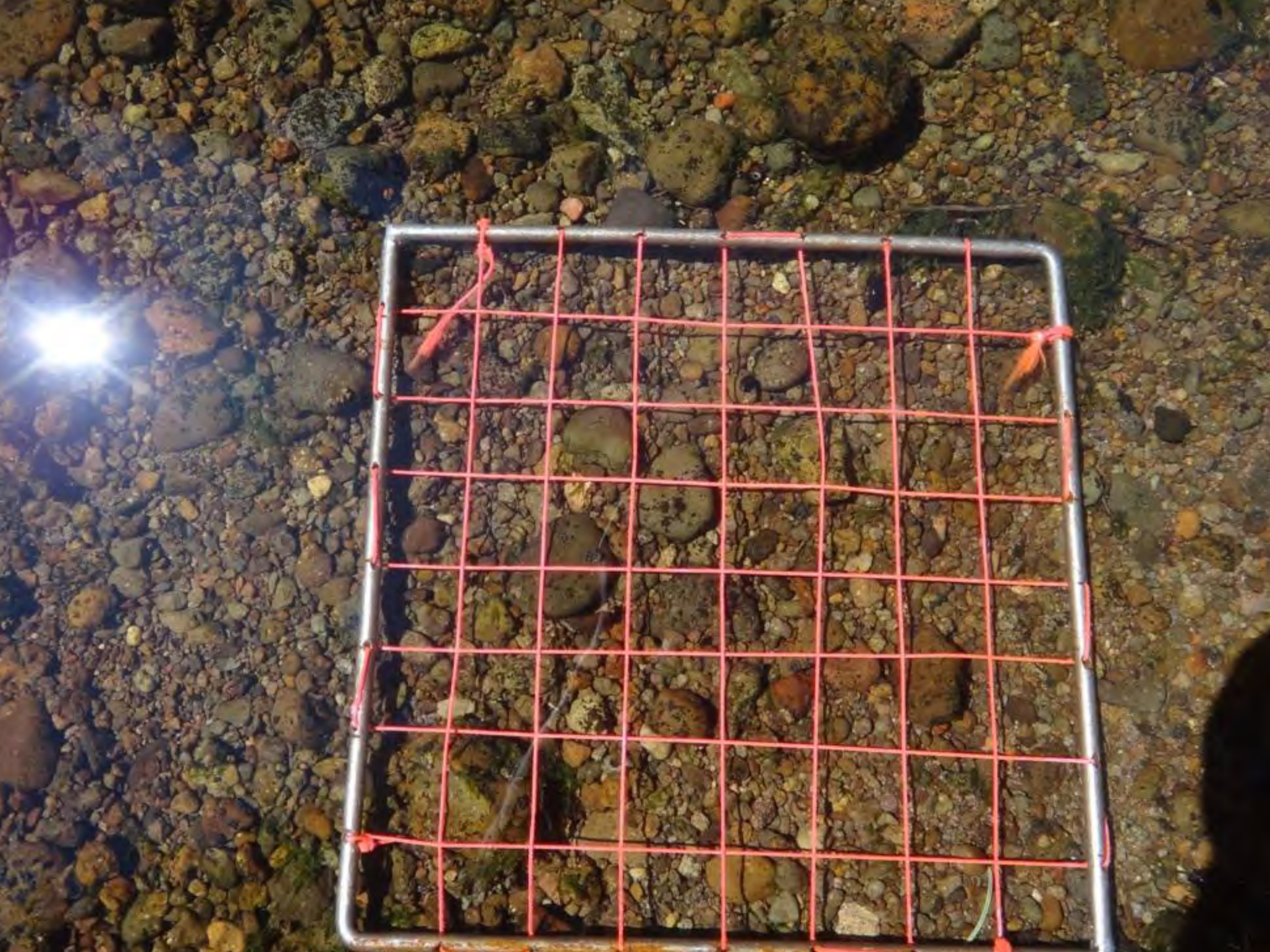
USGS Quad : Dogwood Peak, CA

HFQLG Stream Monitoring: Focus and Methods

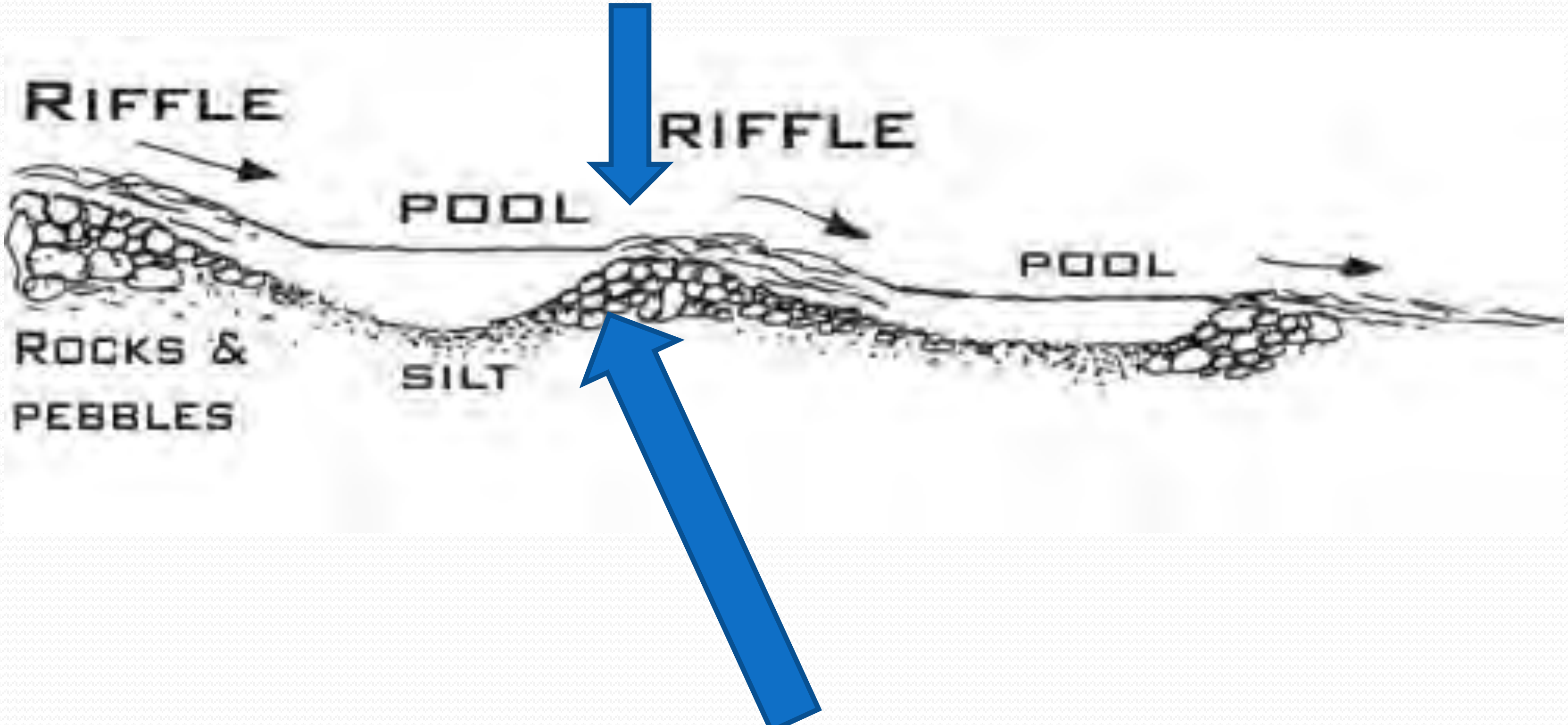
- Primary Activities: Thinning, Fuels Reduction, Group Selection

- Concern- Increased Ground Disturbance, Erosion → Increased Sediment Delivery
  - Attributes Measured: Residual pool depths, particle counts, **pool tail surface fines**, macroinvertebrates
- Concern- Reduced Stream channel shade →Increased Water Temperature
  - Attributes Measured: shade, water temperature, macroinvertebrates

USFS R5 Stream Condition Inventory Conducted at all sites, includes many attributes



Pool Tail Crest



Measurements made upstream of crest, at distance 10% of pool length from crest

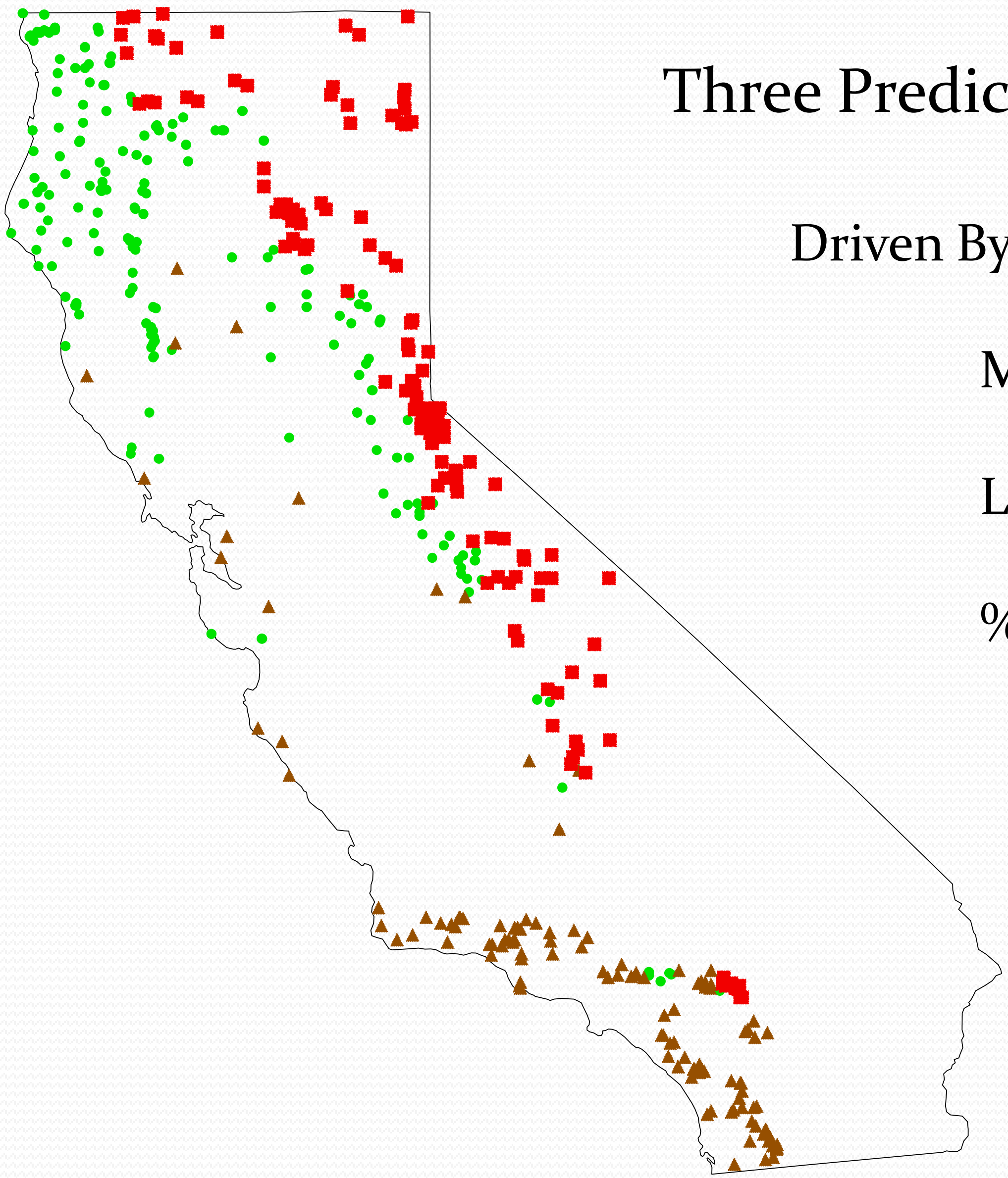

UNSHADED GRID NUMBERS GIVE % OF DAILY TOTAL RADIATION FOR ALL HORIZONTAL SURFACES DURING EACH HALF HOUR PERIOD (AVERAGED FOR EACH MONTH)
AVERAGE SUN PATHS FOR EACH MONTH
FOR 37°–43° N.LAT.
MAGNETIC DECLINATION WEST OF NORTH
MAGNETIC DECLINATION EAST OF NORTH
DEC
JAN
NOV
FEB
OCT
MAR
SEP
APR
AUG
MAY
JUL
JUN
SOLAR TIME
SOLAR PATHFINDER
"THE ENERGY EVALUATOR"
TO USE: (1) LEVEL INSTRUMENT (2) ORIENT TO TRUE SOUTH (3) VIEW FROM 12-18 INCHES (30-45 cm) DIRECTLY ABOVE


©Wayne Wurtsbaugh

SCI Biological Stream Attributes

- Sampled with D-Net or Surber Sampler
- 8 1ft x 1ft samples (2 from 4 riffles) composited
- Two metrics used to express data from community
  - Biologic Index (BI)
    - (EPT, Shannon Diversity, % scrapers, % dominant taxa)
    - Range: 4 (poor) to 20 (good)
  - Observed/Expected (O/E) ratio
    - Value closer to 1 = “good” condition

RIVPACS Reference Sites



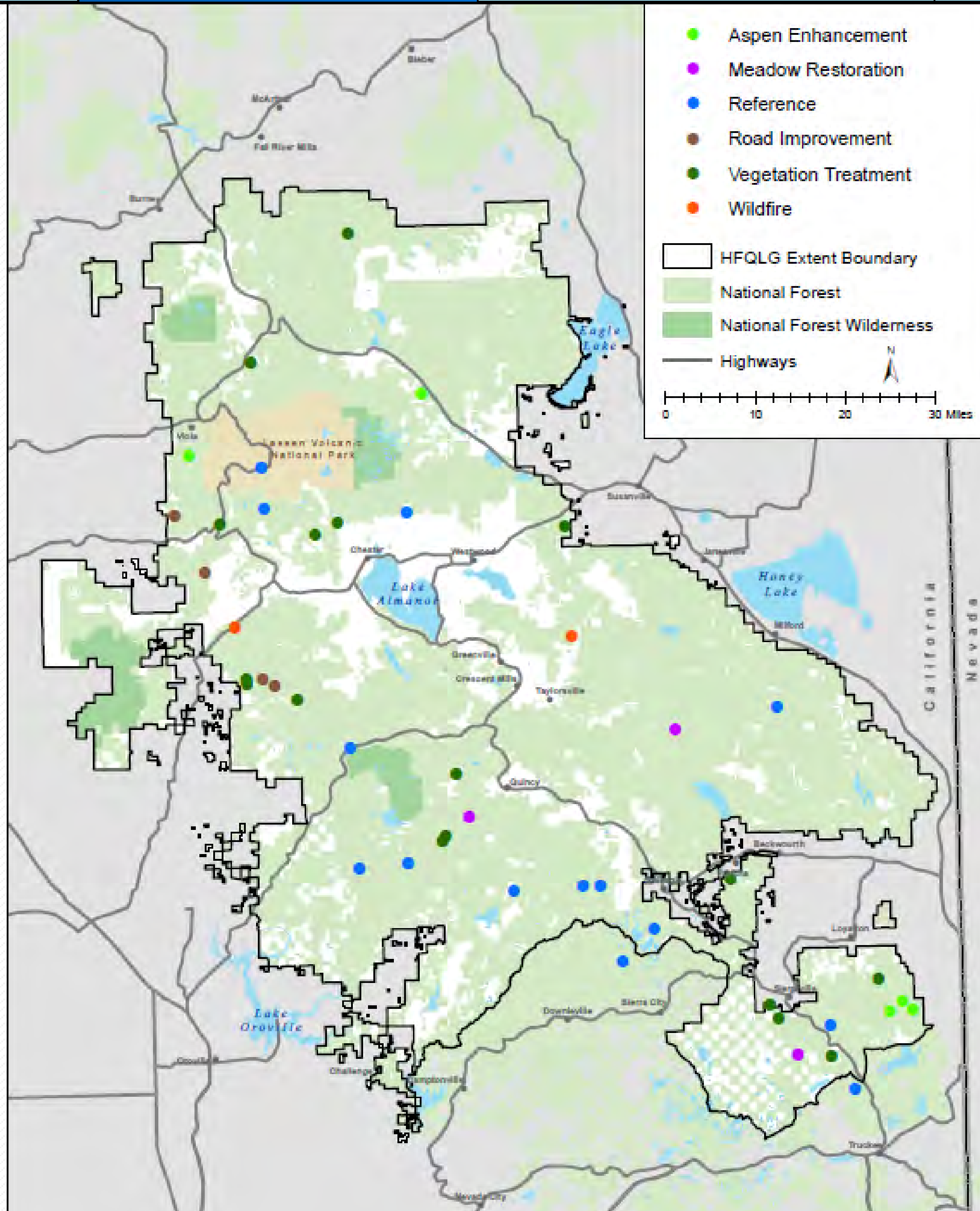
Three Predictive Models Developed

Driven By:

- Mean Annual Precipitation
- Longitude
- % Sedimentary Geology

Management Activities

- Vegetation Management
  - DFPZ treatments, area thinning, mastication, etc.
- Aspen Enhancement
- Near-Stream Road/Culvert Decommissioning
- Stream/Meadow Improvement


Aspen Enhancement
Meadow Restoration
Reference
Road Improvement
Vegetation Treatment
Wildfire
HFQLG Extent Boundary
National Forest
National Forest Wilderness
Highways
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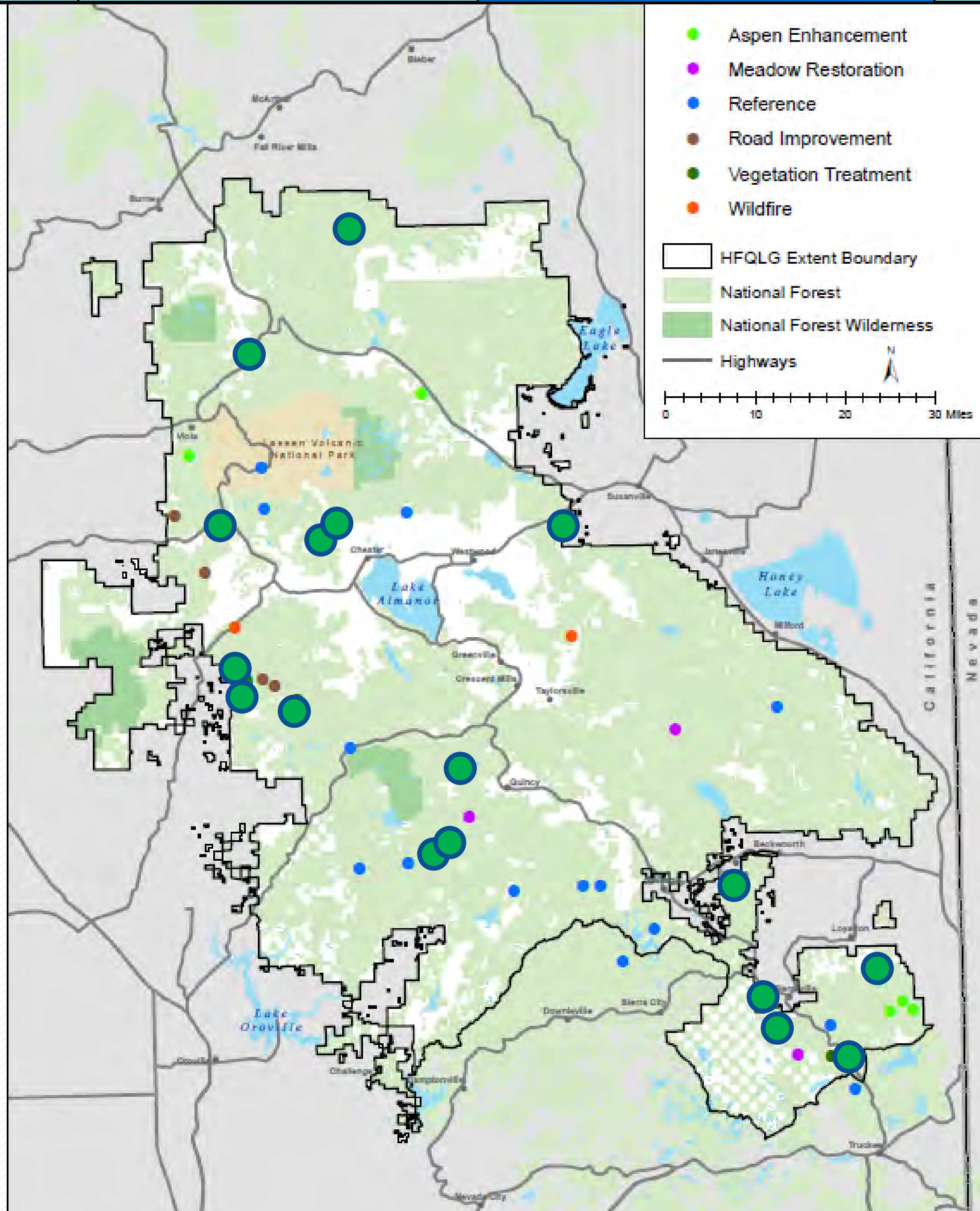
20
30 Miles
Eagle Lake
Lassen Volcanic National Park
Lake Almanor
Honey Lake
Lake Oroville
California
Nevada

Vegetation Management

- Defensible Fuel Profile Zones (DFPZ), area thinning, mastication, group selections.
- 16 streams monitored before and after treatment
- Most treatments >100 feet away from stream channels
- Primary concerns: sediment, stream channel shade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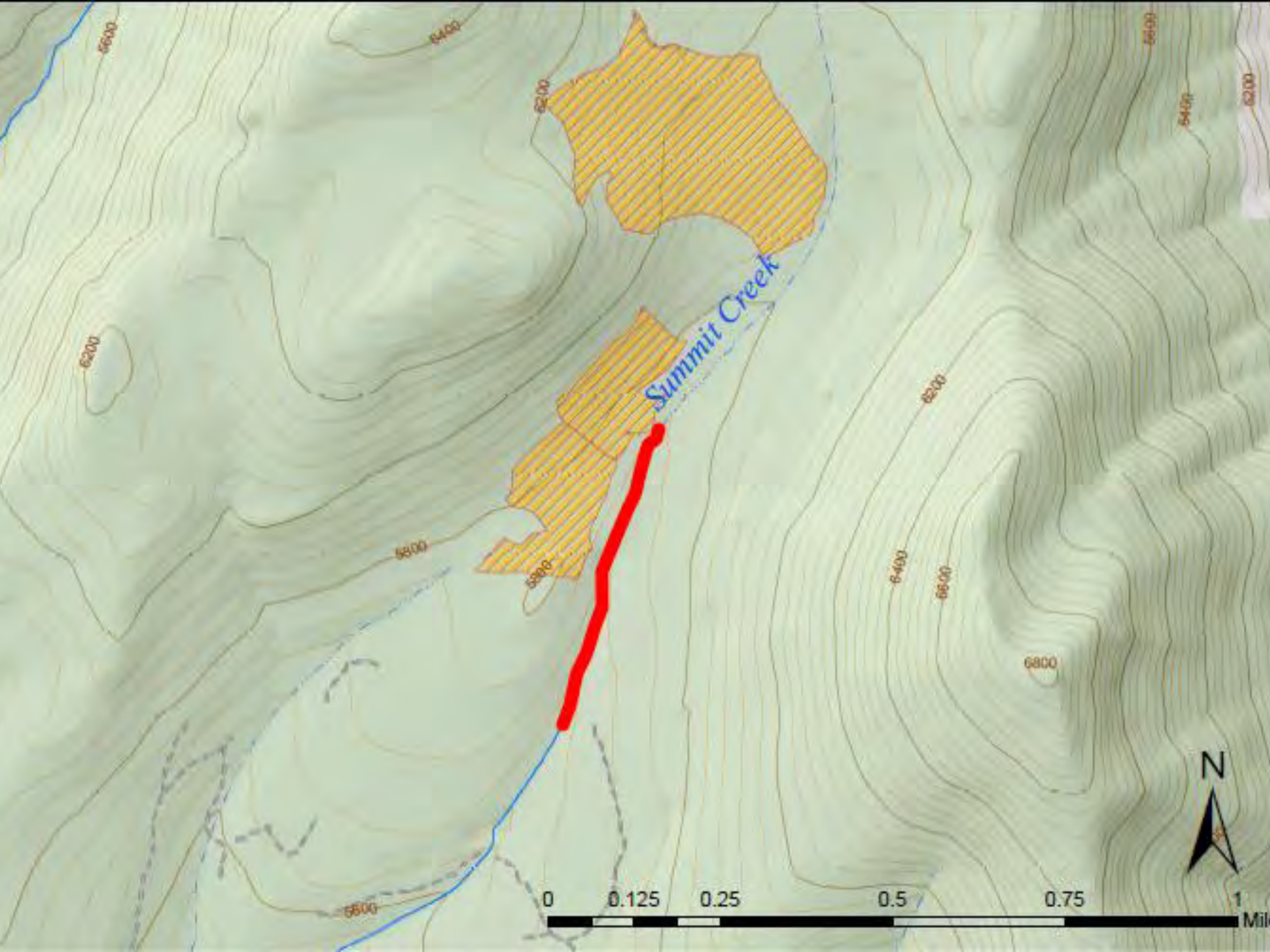
Case Study: Summit Creek

- Low-gradient stream flowing through gently sloping, forested terrain.
- 2005: 61 acres of DFPZ treatment conducted upstream of the SCI monitoring reach.
- 200 foot no-treatment buffer maintained between the treatment area and Summit Creek.
- SCI surveys conducted 2003, 2006-2010


Summit Creek
6400
5600
6200
6200
6200
5800
5800
6200
6400
6600
6800
5600
6400
6200
N
0
0.125
0.25
0.5
0.75
1
Mile

Summit Creek, lower portion of SCI monitoring reach. 2009.

Culvert over Summit Creek, 0.3 miles upstream of the SCI monitoring reach. 2003.

Case Study: Summit Creek

- 2006: significant increase in sediment
  - 2003 pool tail fines: 4%
  - 2006 pool tail fines: 10%
  - Likely due to culvert failure upstream.
- Small increases in stream channel shade from 2003 to 2010.
  - Not attributed to project activities.
- No change/positive change in macroinvertebrate indices.

Case Study: Summit Creek

Table 1. Pre- and post-project mean values for pool tail fines and percent shade for the Summit Creek monitoring reach.

Year		Pool Tail Fines (%)	Shade (%)
Pre-Project	2003	4	64
Post-Project	2006	10	64
	2007	2	65
	2008	3	74
	2009	8	74
	2010	2	72

Case Study: Summit Creek

Table 2. Biotic Index (BI) and Observed/Expected (O/E) scores for the Summit Creek SCI monitoring reach. BI scores range from a minimum of 4 to a maximum of 20, with 4 considered "very degraded" and 20 considered "very healthy." O/E scores closer to 1 are considered "healthy."

Year		Biotic Index score	O/E score
Pre-Project	2003	7	1.04
Post-Project	2006	18	1.13
	2007	16	1.04
	2008	9	0.95
	2009	11	1.13
	2010	14	1.04

General Findings: Vegetation Management

- 16 sites monitored
  - Ran pre-post project statistical comparisons
- Minimal/no change in sediment metrics
- No changes in stream channel shade observed.

Channel Results Consistent with Upslope BMP Monitoring

Table 3. Best Management Practice (BMP) Effectiveness monitoring results *.

BMP	# Evaluations	% Implemented	% Effective
Stream Courses	108	97.2	98.1
Skid Trails	147	91.8	99.3
Landings	147	97.3	100

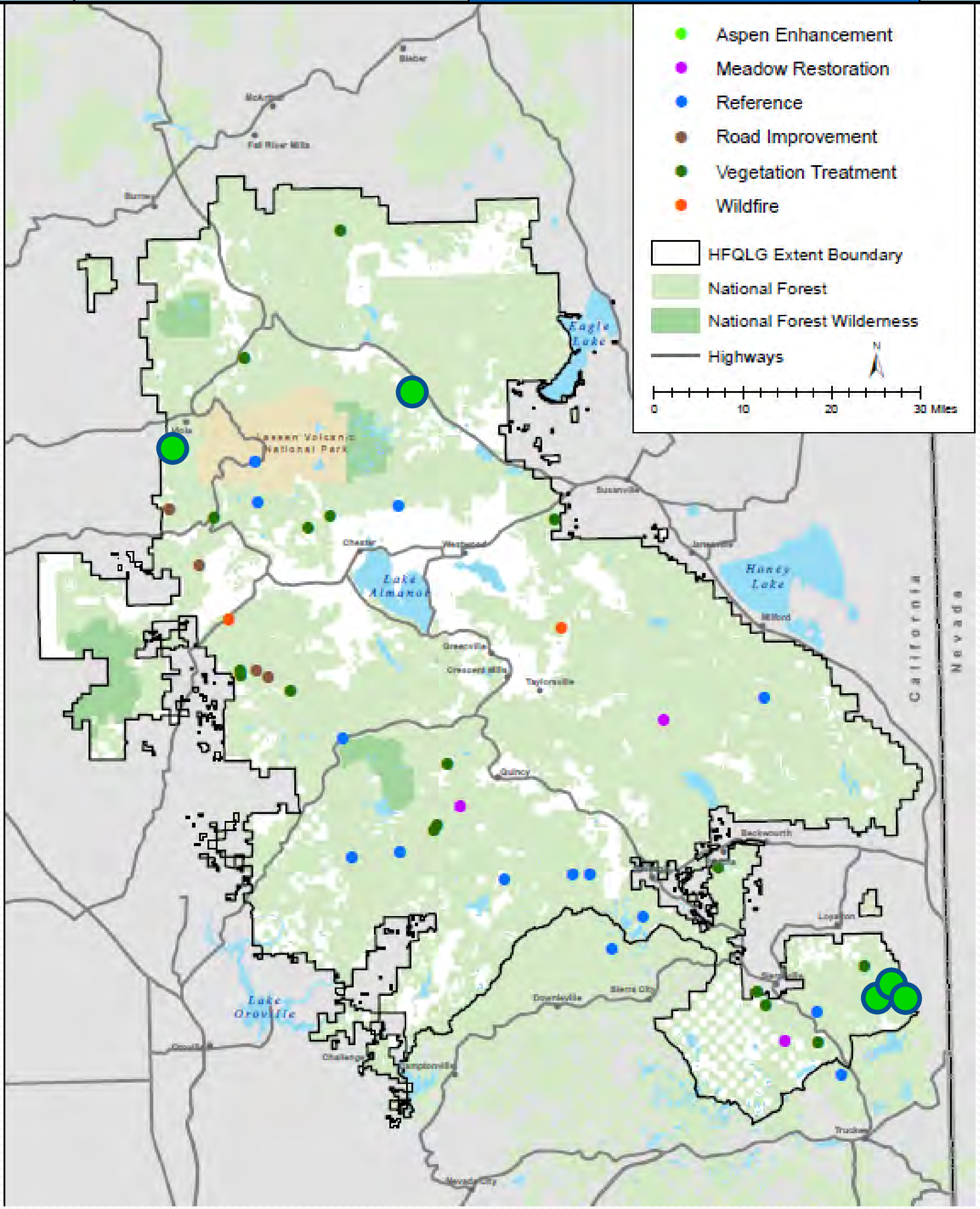
* Source: HFQLG BMP monitoring, 2006-2011

Aspen Enhancement

- Often involves removal of most conifers within 150-200 foot radius around aspen stand.
- Aspens often found close to streams.
- 5 sites monitored before and after treatment
- Primary concerns: sediment and stream channel shade → water temperature.

Aspen enhancement unit, pre-treatment.

Aspen enhancement unit, eight years after treatment.


Aspen Enhancement
Meadow Restoration
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Road Improvement
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Wildfire
HFQLG Extent Boundary
National Forest
National Forest Wilderness
Highways
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20
30 Miles
Eagle Lake
Lassen Volcanic National Park
Lake Almanor
Honey Lake
Lake Oroville
California
Nevada
Susanville
Chester
Westwood
Greenville
Crescent Mills
Taylorsville
Quincy
Milford
Beckwourth
Loyalton
Downieville
Sierra City
Truckee
Nevada City
Challenge
Oroville
Mineral
Bieber
McArthur
Fall River Mills
Burney

Case Study: Pine Creek

- Low-gradient stream flowing through flat, forested terrain.
- Aspen stands near stream competing with dense conifers.
- Work conducted from 2004 to 2007 over 3 distinct phases, including over-the-snow operations.
- 292 acre aspen enhancement project; 75 acres within 300 feet of Pine Creek.
- Mechanical equipment allowed to operate up to 15 feet from Pine Creek.

Pine Creek
6400
6000
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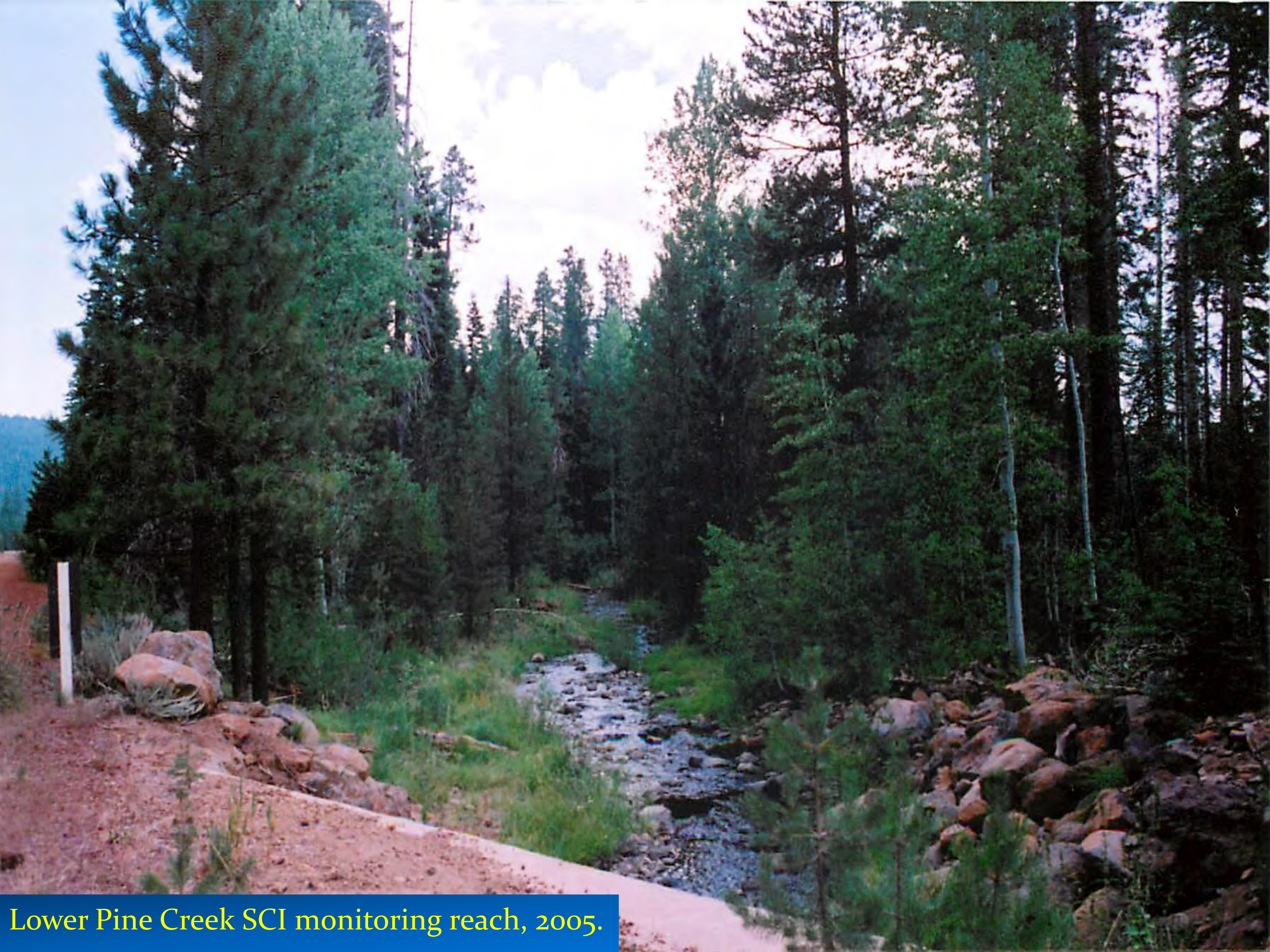


Lower Pine Creek SCI monitoring reach, 2005.

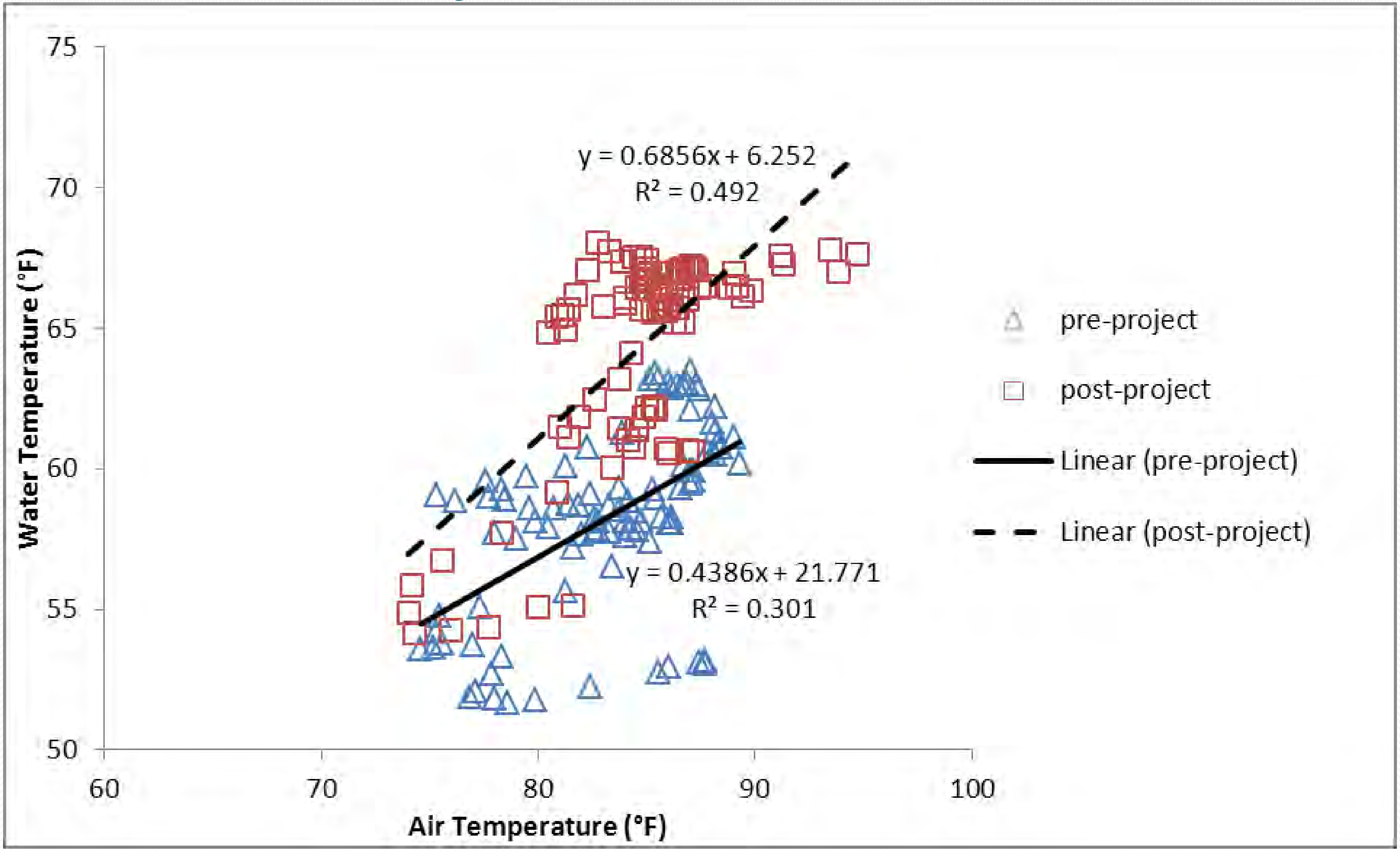
Case Study: Pine Creek

Table 4. Pre- and post-project mean values for pool tail fines and percent shade for the Summit Creek monitoring reach.

Year		Pool Tail Fines (%)	Shade (%)
Pre-Project	2003	8	70
Mid-Project	2004	7	61
	2005	1	63
Post-Project	2008	2	56

- Significant decline in stream channel shade.
  - Was water temperature affected?

Case Study: Pine Creek

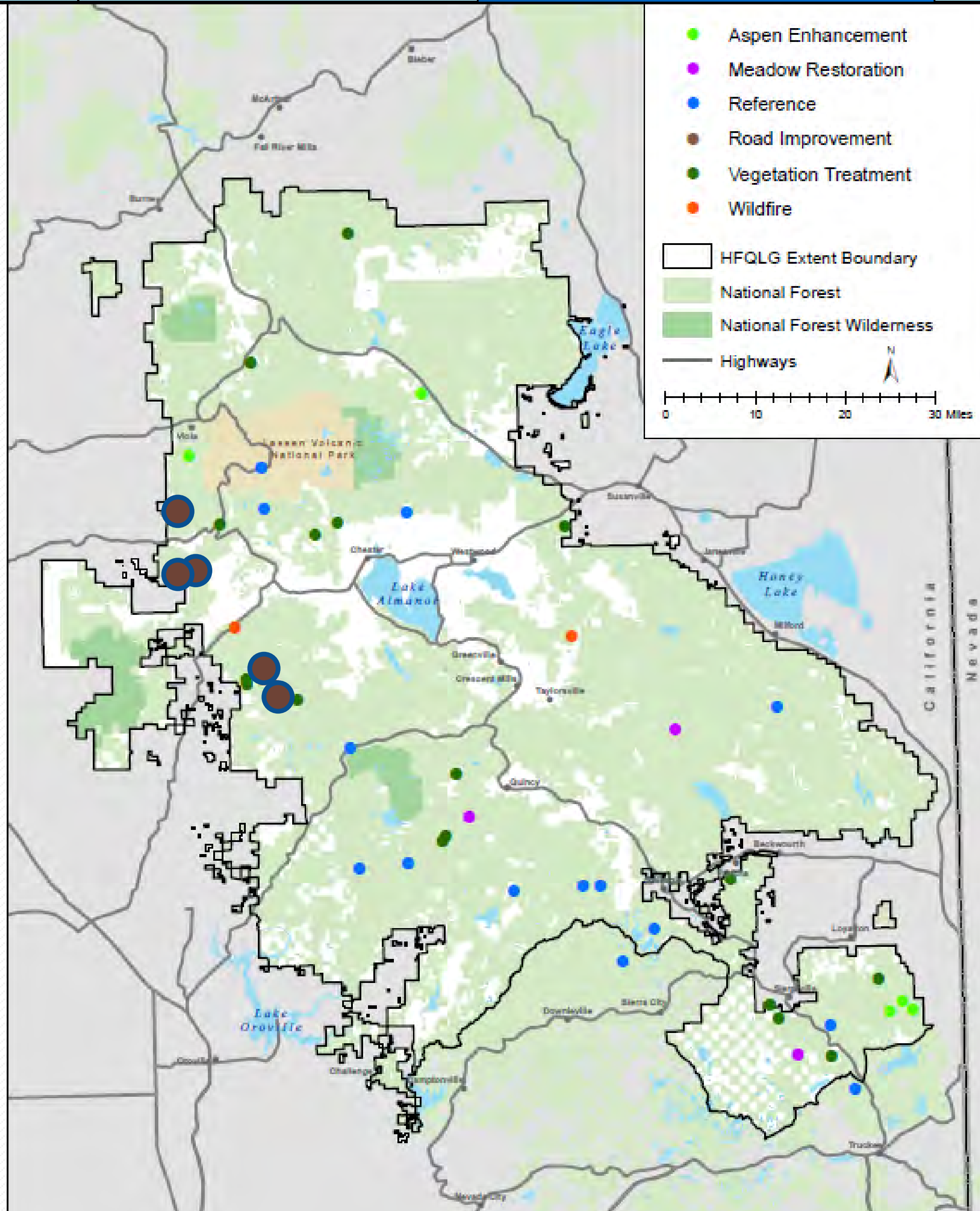


General Findings: Aspen Enhancement

- 5 sites monitored
- No changes in sediment metrics
- Changes in shade often observed, and expected.
    - No significant changes in water temperature at other sites.
- No changes in macroinvertebrate indices

Near-stream Road/Culvert Decommissioning

- Roads and stream crossings are chronic sediment sources.
- Decommissioning is expected to result in a short-term increase in fine sediment in streams.
- 5 sites monitored
- Primary concern: sediment


Aspen Enhancement
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HFQLG Extent Boundary
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Lake Almanor
Honey Lake
Lake Oroville
National Park
California
Nevada
Chester
Westwood
Susanville
Greenville
Taylorsville
Quincy
Downieville
Truckee

Case Study: Rocky Gulch

- High-gradient stream with a boulder/cobble substrate.
- Tributary to an anadromous fishery (Mill Creek).
- 2004: large culvert removed from Rocky Gulch, 1.5 miles of road decommissioned.
- Primary concern: sediment

Looking upstream towards the Rocky Gulch culvert, 2004.

Site of Rocky Gulch culvert removal, with erosion control measures in place. Fall 2004.

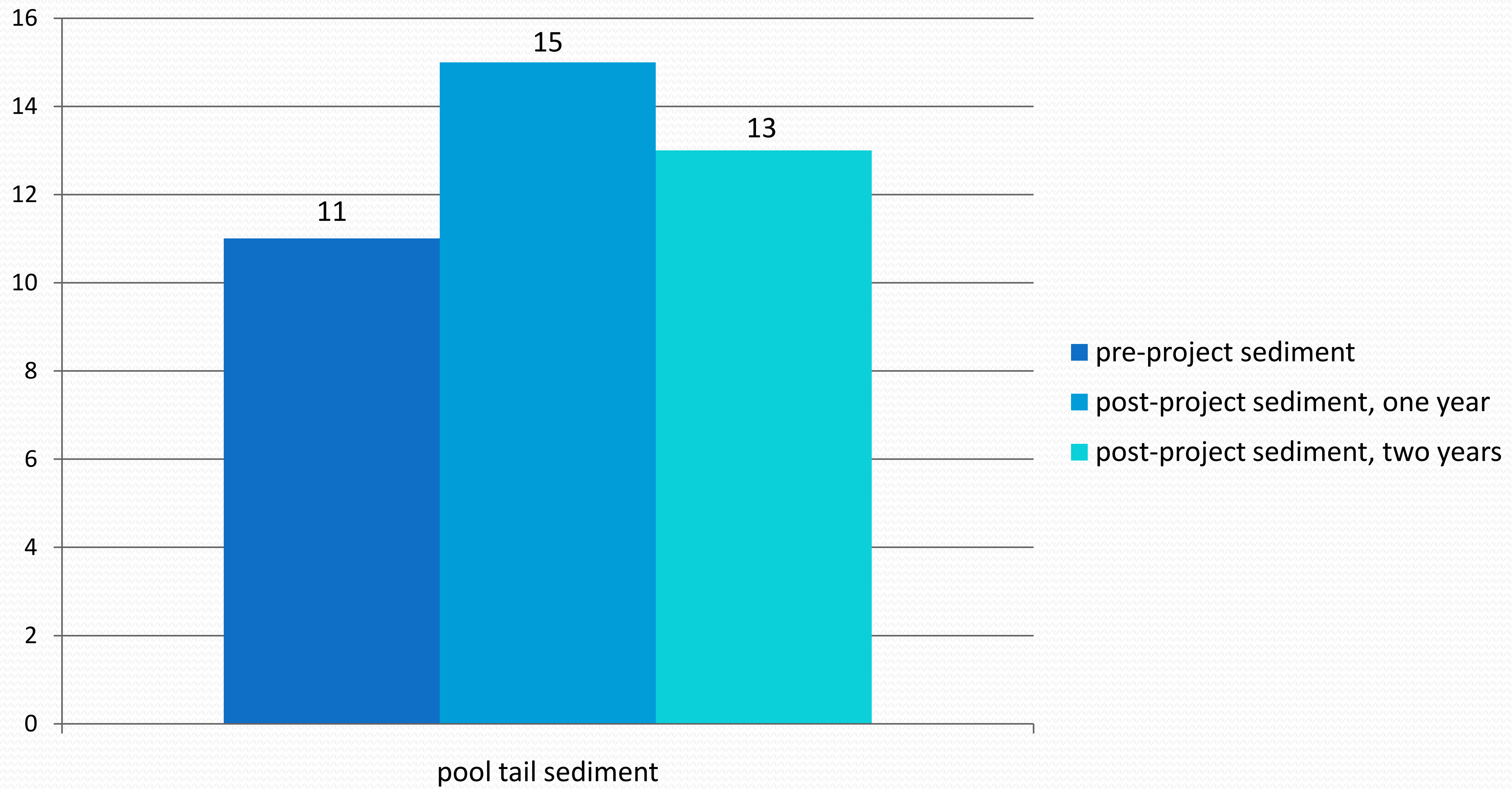
Case Study: Rocky Gulch

- Post-project surveys completed immediately after culvert removal (2004) and one year later (2005).
- Pool tail fines showed slight changes:
  - 2002: 1%
  - 2004: 4%
  - 2005: 2%
- No significant changes in pool depths.

General Findings: Road/Culvert Decommissioning

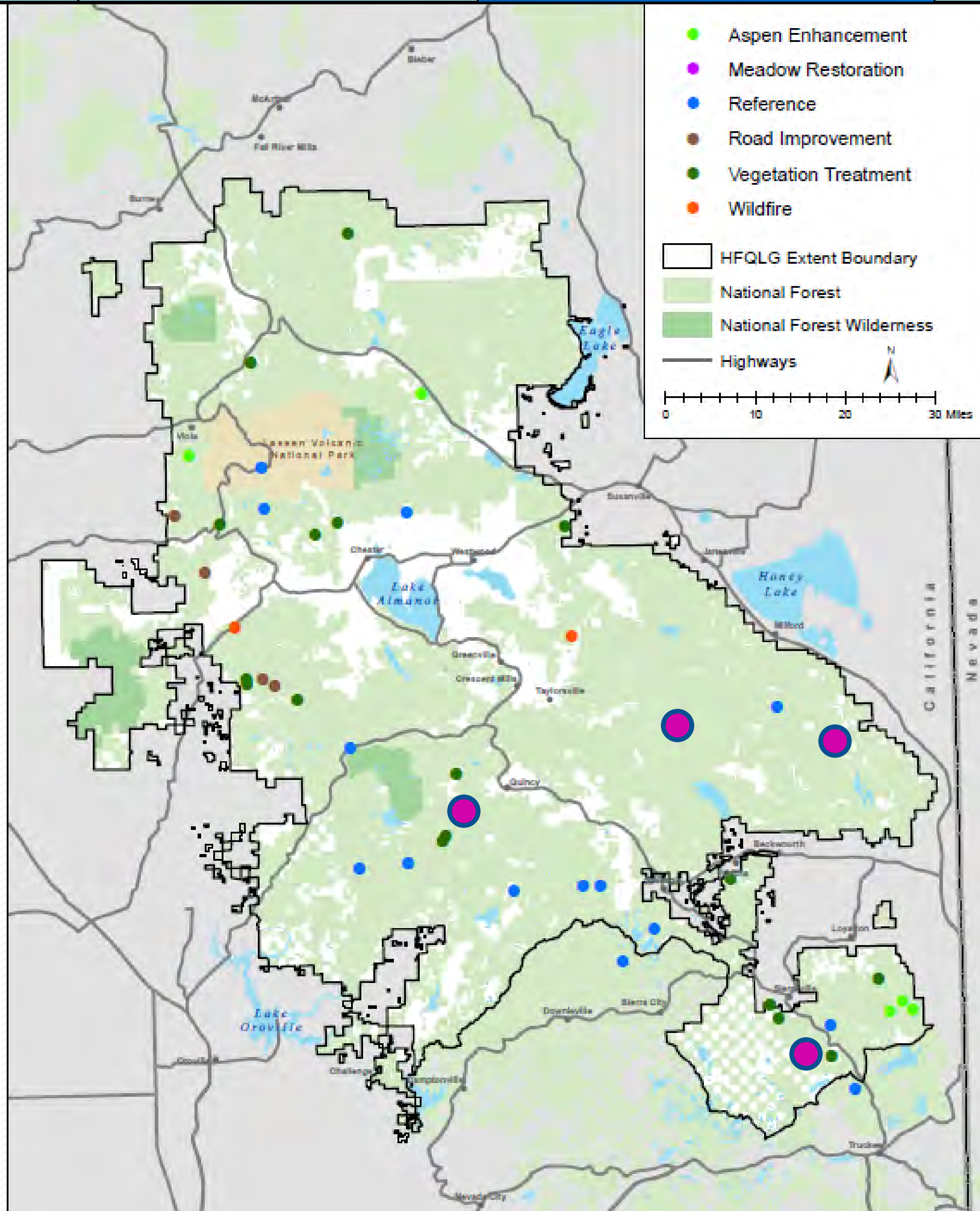
- We often observed increases in fine sediment immediately following near-stream road and/or culvert decommissioning.
  - Likely to be short-term
- Macroinvertebrates appeared to be resilient to short-term increases in sediment.

General Findings: Sediment



Stream/Meadow Improvement

- Variety of activities
  - Stream bank restoration, “pond & plug”
- 4 streams monitored
- Activities took place within stream channels
- Primary concerns: sediment, water temperature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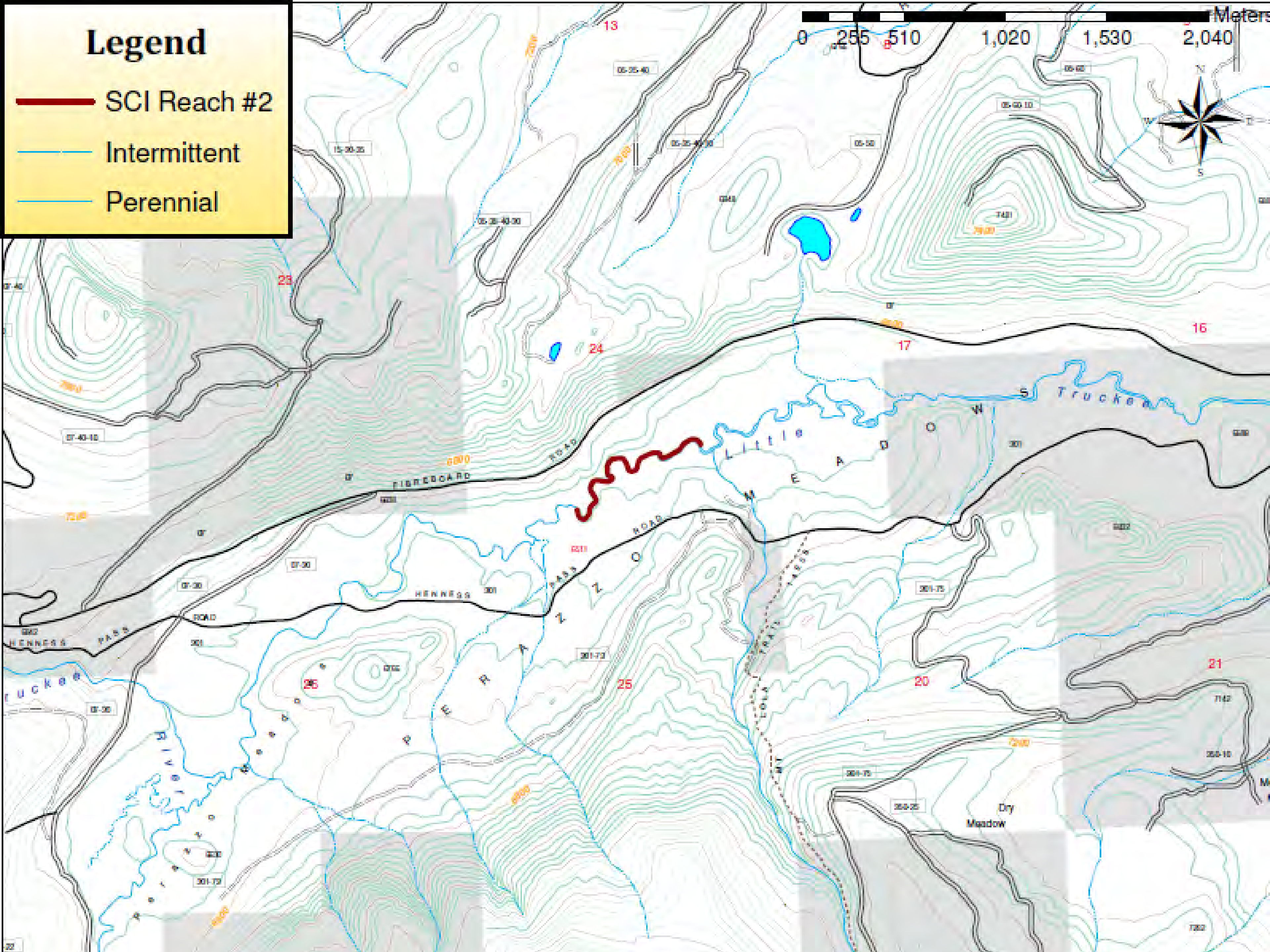
Taylorsville
Downieville
Truckee

Case Study: Little Truckee River

- Low-gradient stream with a wide floodplain (Perazzo Meadows).
- 2009: 152 acres of "pond and plug," rock riffle construction, and restoration of flow to a historic channel within the meadow.
- Rain-on-snow event in May 2010 resulted in breaching of 3 earthen plugs.
  - Plugs repaired September 2010.


Legend
SCI Reach #2
Intermittent
Perennial
Meters
0 255 510 1,020 1,530 2,040
Little Truckee
MEADOWS
PERAZZO
Meadows
Truckee
River
FIBREBOARD ROAD
HENNESS PASS ROAD
HENNESS PASS
Dry
Meadow
13
23
24
17
16
26
25
20
21

Little Truckee River SCI monitoring reach, 2006.

Perazzo Meadows pond-and-plug restoration site. 2010.

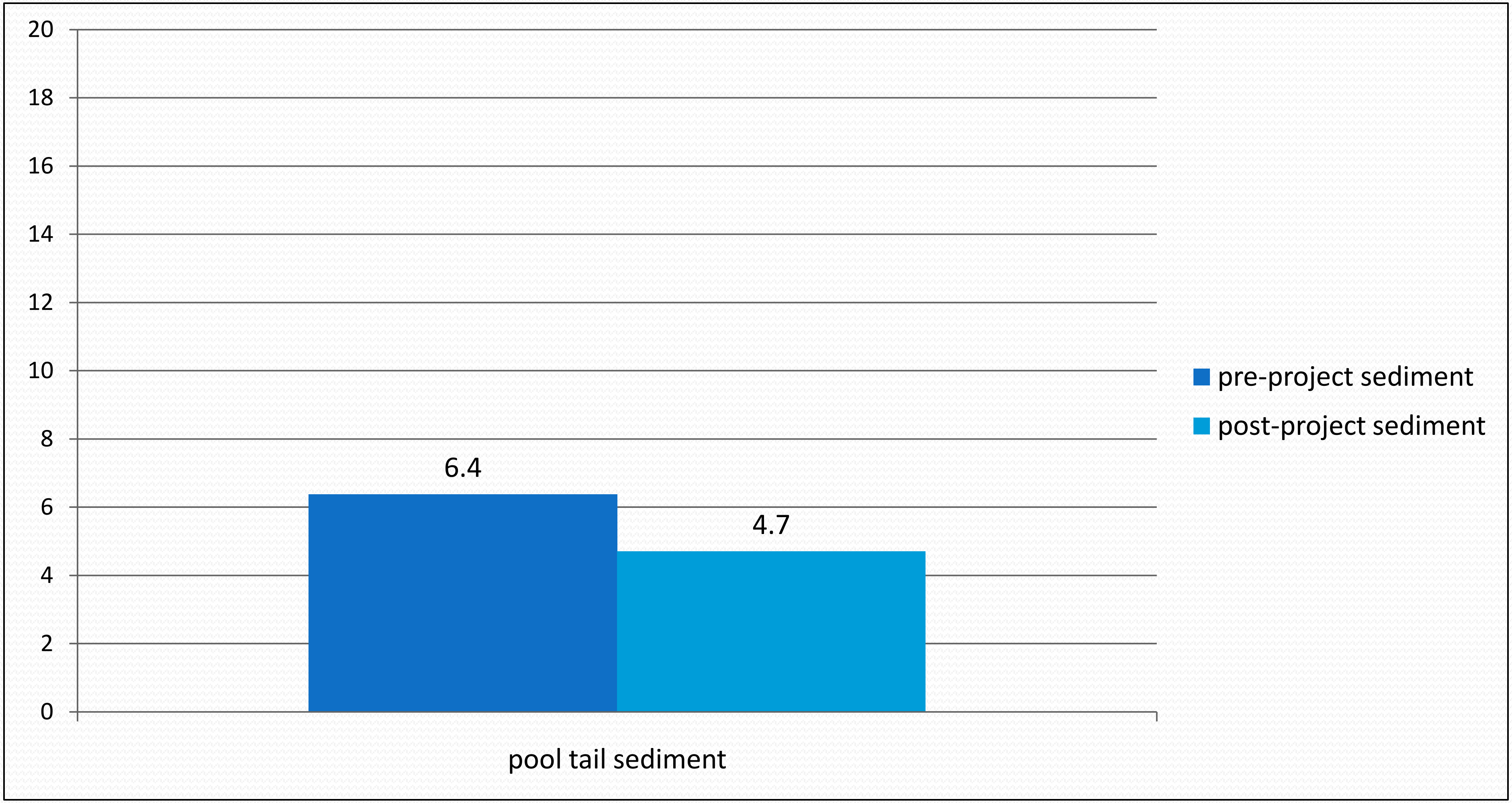
Case Study: Little Truckee River

- Significant increase in fine sediment downstream of the project area.
  - 2006: 3% pool tail fines
  - 2010: 34% pool tail fines
  - Duration of increased sediment…?
- No change in stream channel shade.
- Macroinvertebrate indices showed no effect.

General Findings

- 4 sites monitored
- No significant changes in sedimentation following in-channel work such as "pond and plug."
  - …unless the plugs are breached by high flows
- Minimal changes in downstream water temperatures.

General Findings: Sediment



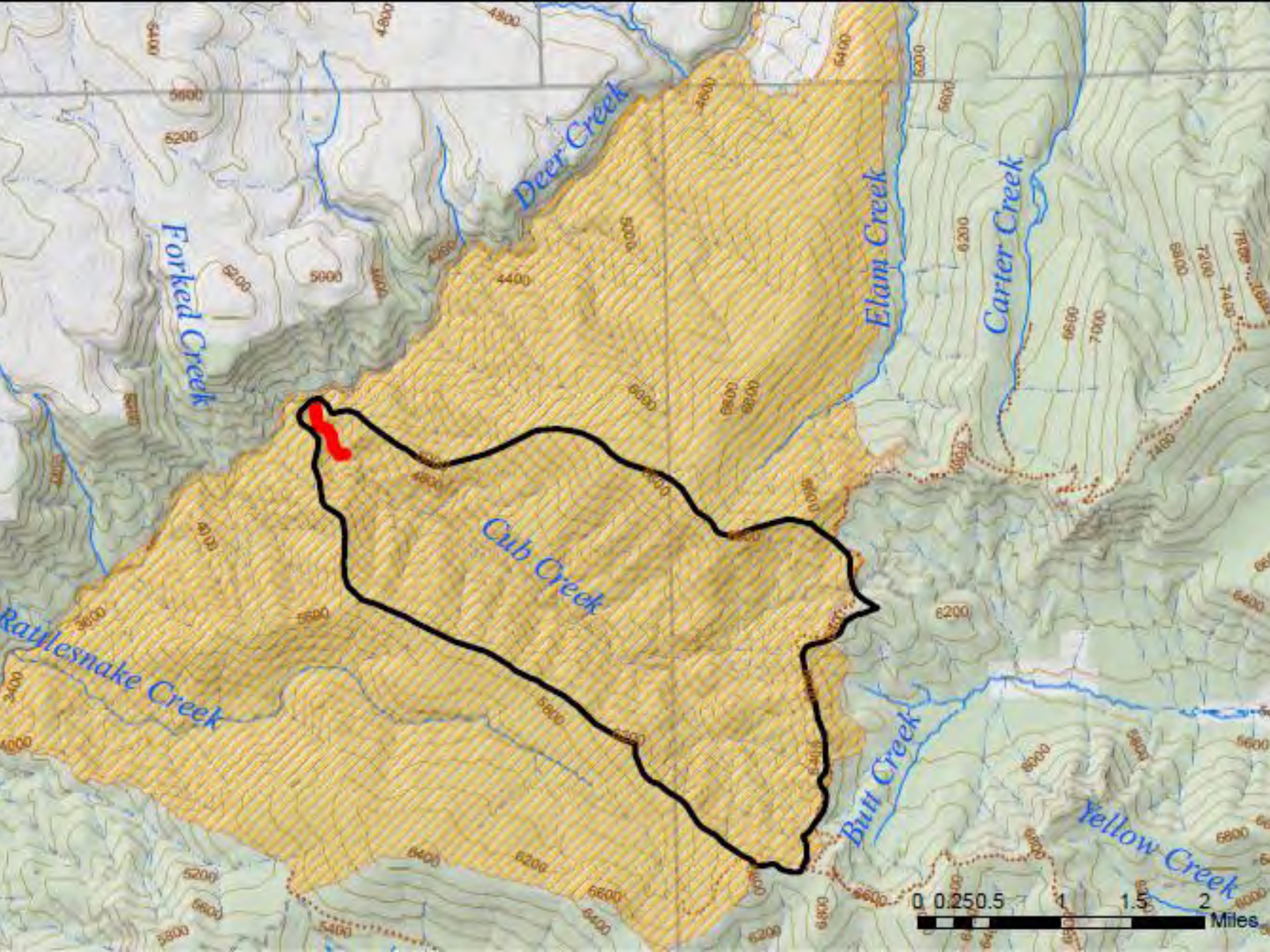
Wildfires

- Availability of pre-wildfire stream data provided opportunities to monitor the effects of wildfires on two streams (Cub Creek, Moonlight Creek).

- Primary concerns
  - Sediment
  - Stream channel shade → water temperature
  - Large woody debris (LWD) recruitment

Case Study: Cub Creek

- Originally a reference reach
- 2008: Cub Fire burned 80% of watershed
  - 27% burned at high intensity
- Low- to moderate-intensity burning within riparian area near monitoring reach.



Deer Creek
Forked Creek
Elam Creek
Carter Creek
Cub Creek
Rattlesnake Creek
Butt Creek
Yellow Creek
0 0.250.5 1 1.5 2
Miles

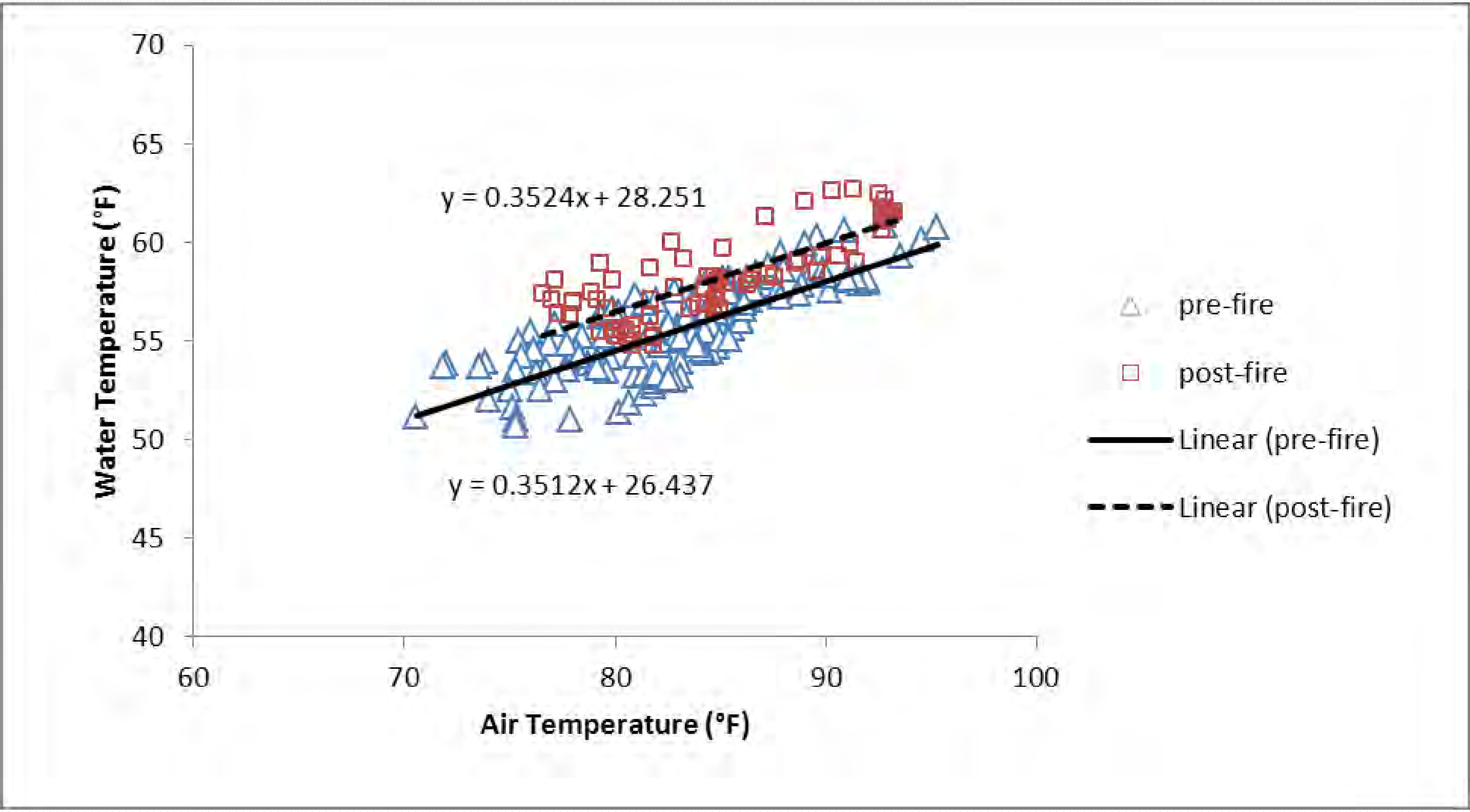
Burned hillside along Cub Creek SCI monitoring reach, 2008.

Looking west along the southern ridgeline above Cub Creek. 2009.

Case Study: Cub Creek

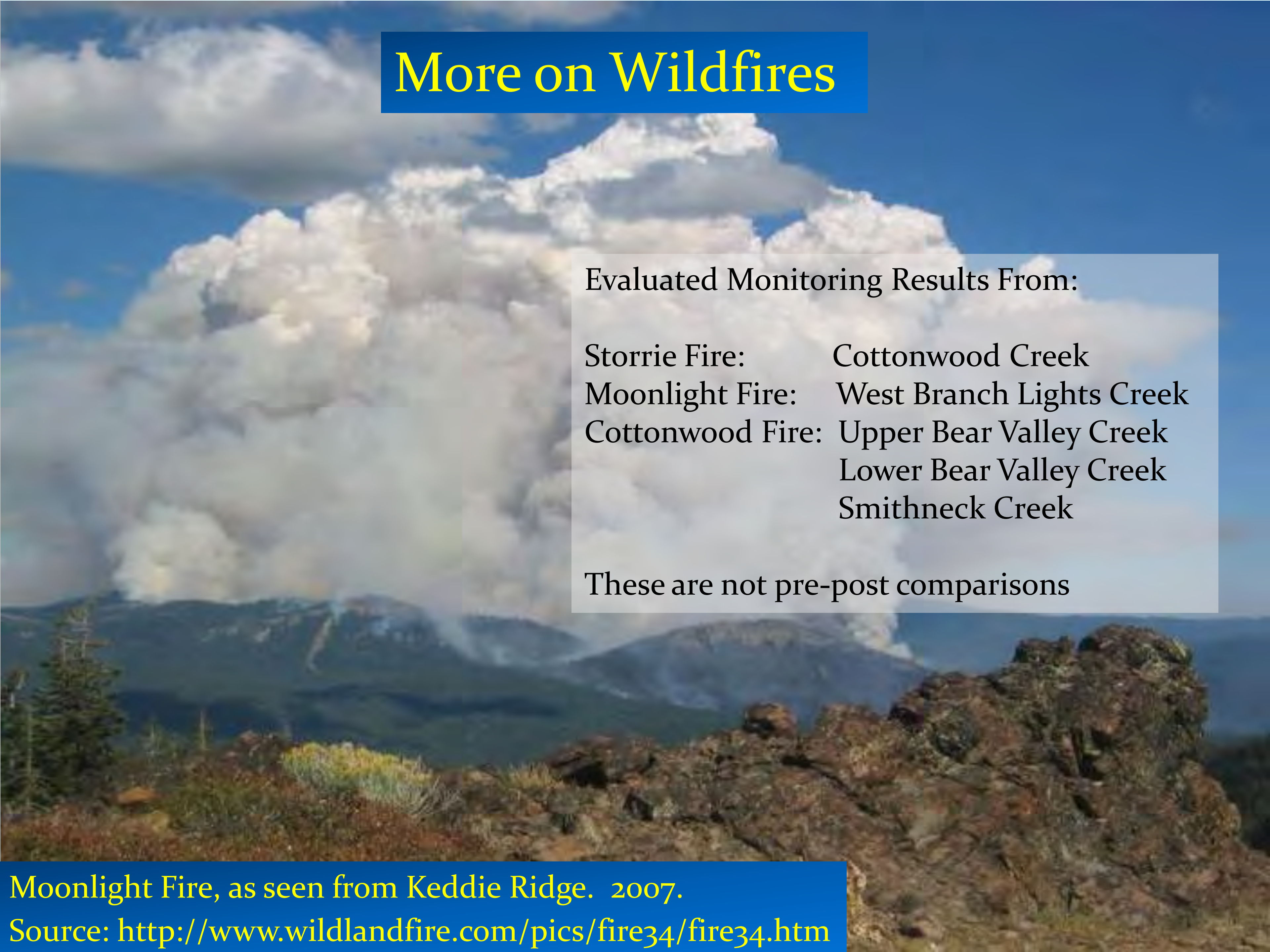
- Fine sediment increased following the fire.
  - Average pool tail sediment pre-fire: 3%
  - Average pool tail sediment post-fire: 11%
  - 2012 10%
- Channel shade declined post-fire.
  - Average shade pre-fire: 95%
  - Average shade 2009: 89%
  - Average shade 2012: 95%
- Little/no change in large woody debris in channel
- Little/no change in macroinvertebrate indices in first two years following fire

Case Study: Cub Creek



Moonlight Creek SCI monitoring reach, 2009. Two years after the Moonlight Fire.
Monitoring showed results similar to those observed on Cub Creek.

More on Wildfires



Evaluated Monitoring Results From:

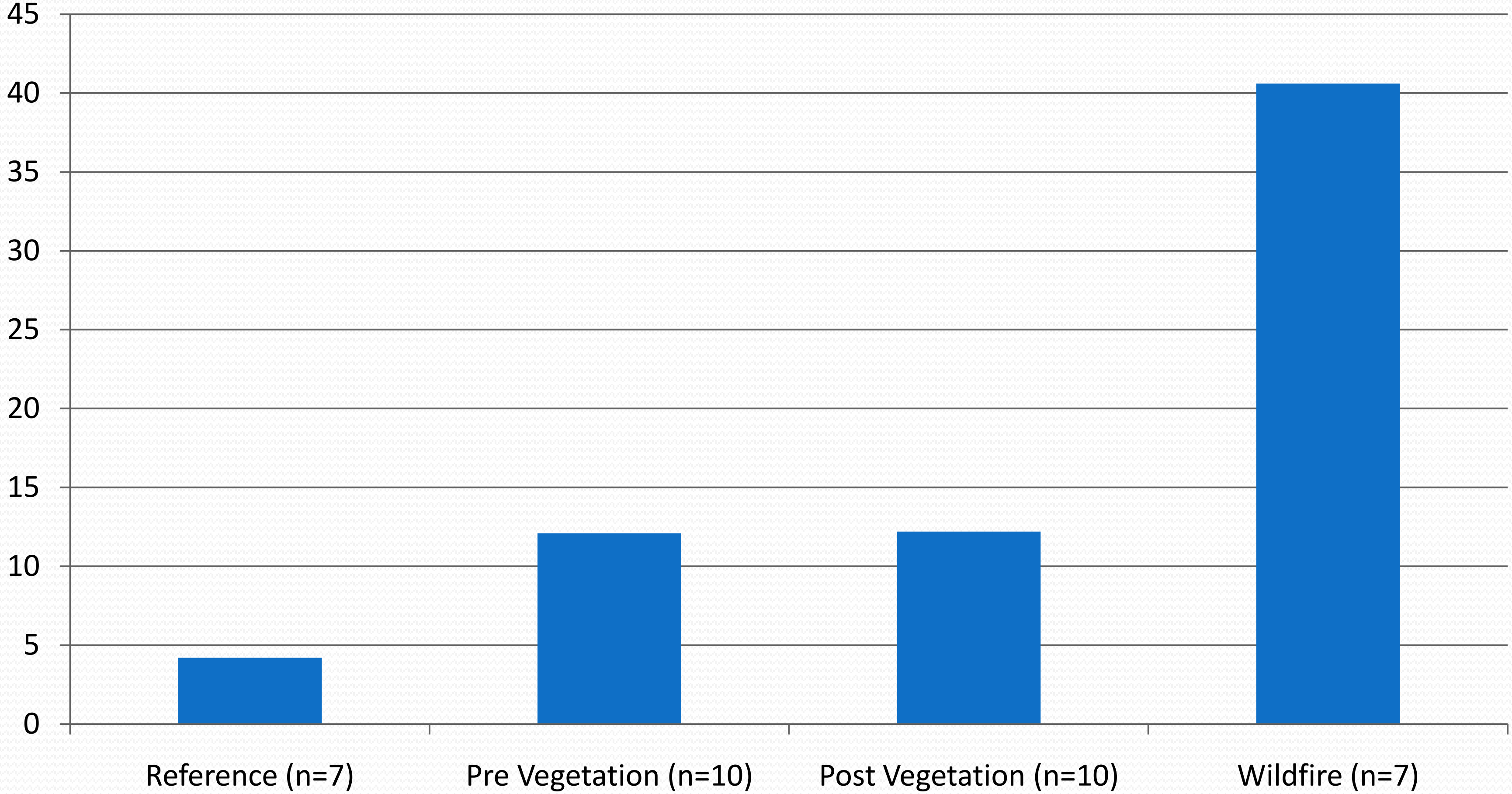
Storrie Fire:	Cottonwood Creek
Moonlight Fire:	West Branch Lights Creek
Cottonwood Fire:	Upper Bear Valley Creek
	Lower Bear Valley Creek
	Smithneck Creek

These are not pre-post comparisons

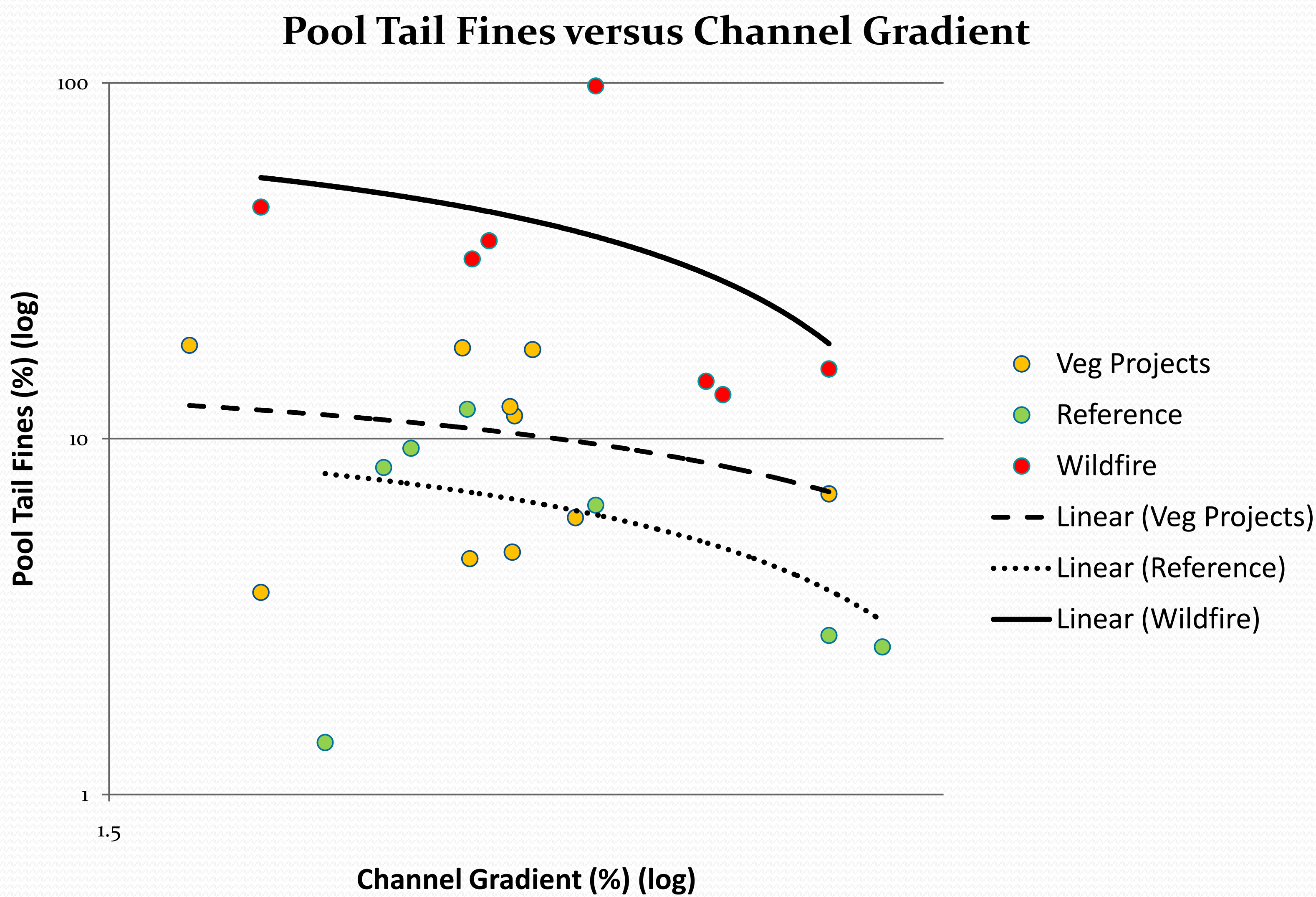
Moonlight Fire, as seen from Keddie Ridge. 2007.
Source: http://www.wildlandfire.com/pics/fire34/fire34.htm

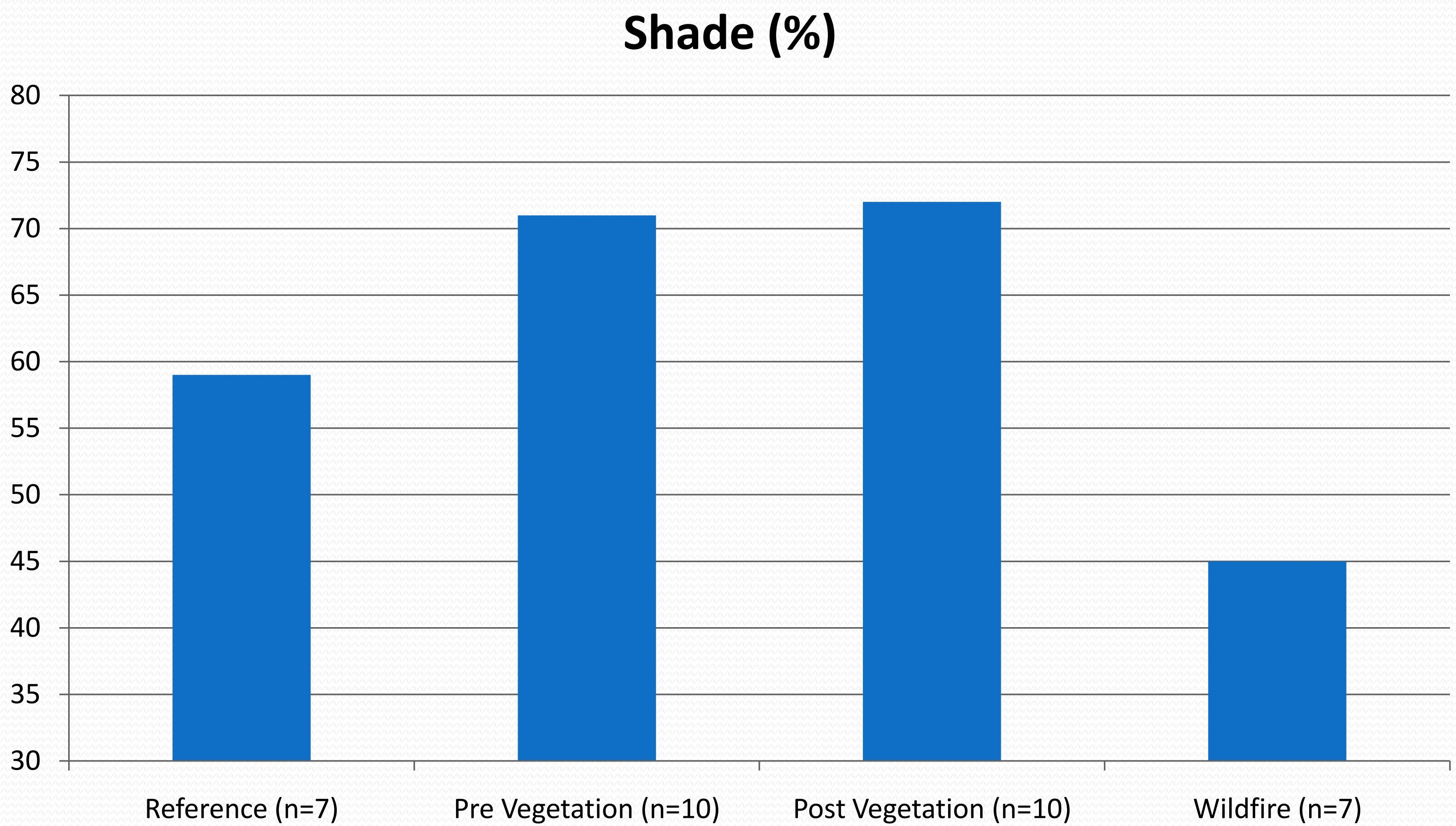
Channel Gradient (among other things) Affects Sediment Transport and Deposition

Pool Tail Fines (%)



From streams with gradients > 2.0 percent

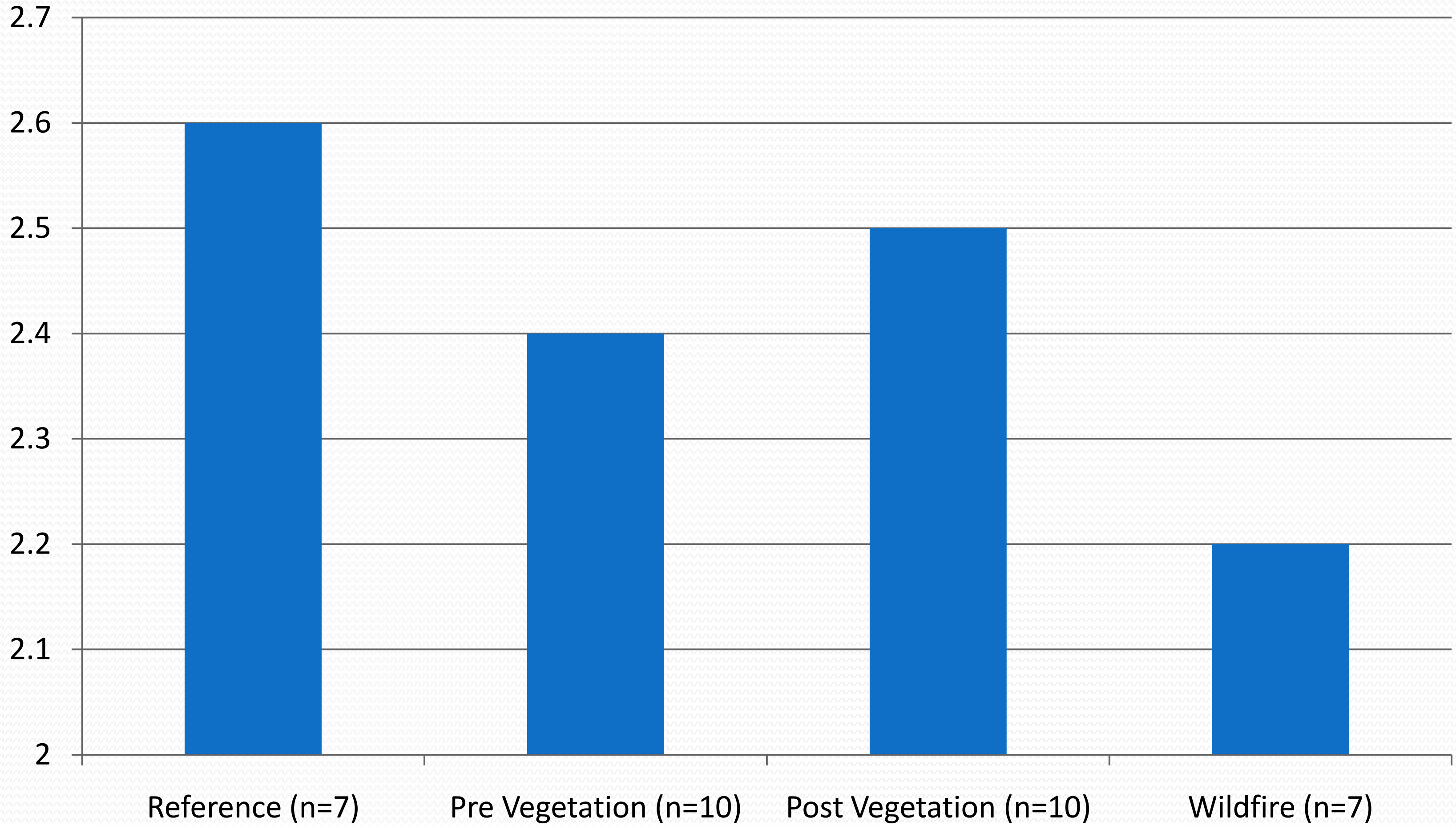

Pool Tail Fines versus Channel Gradient
100
10
1
1.5
Pool Tail Fines (%) (log)
Channel Gradient (%) (log)
Veg Projects
Reference
Wildfire
Linear (Veg Projects)
Linear (Reference)
Linear (Wildfire)



From streams with gradients > 2.0 percent

* Storrie and Cottonwood Fire Watersheds were salvage logged

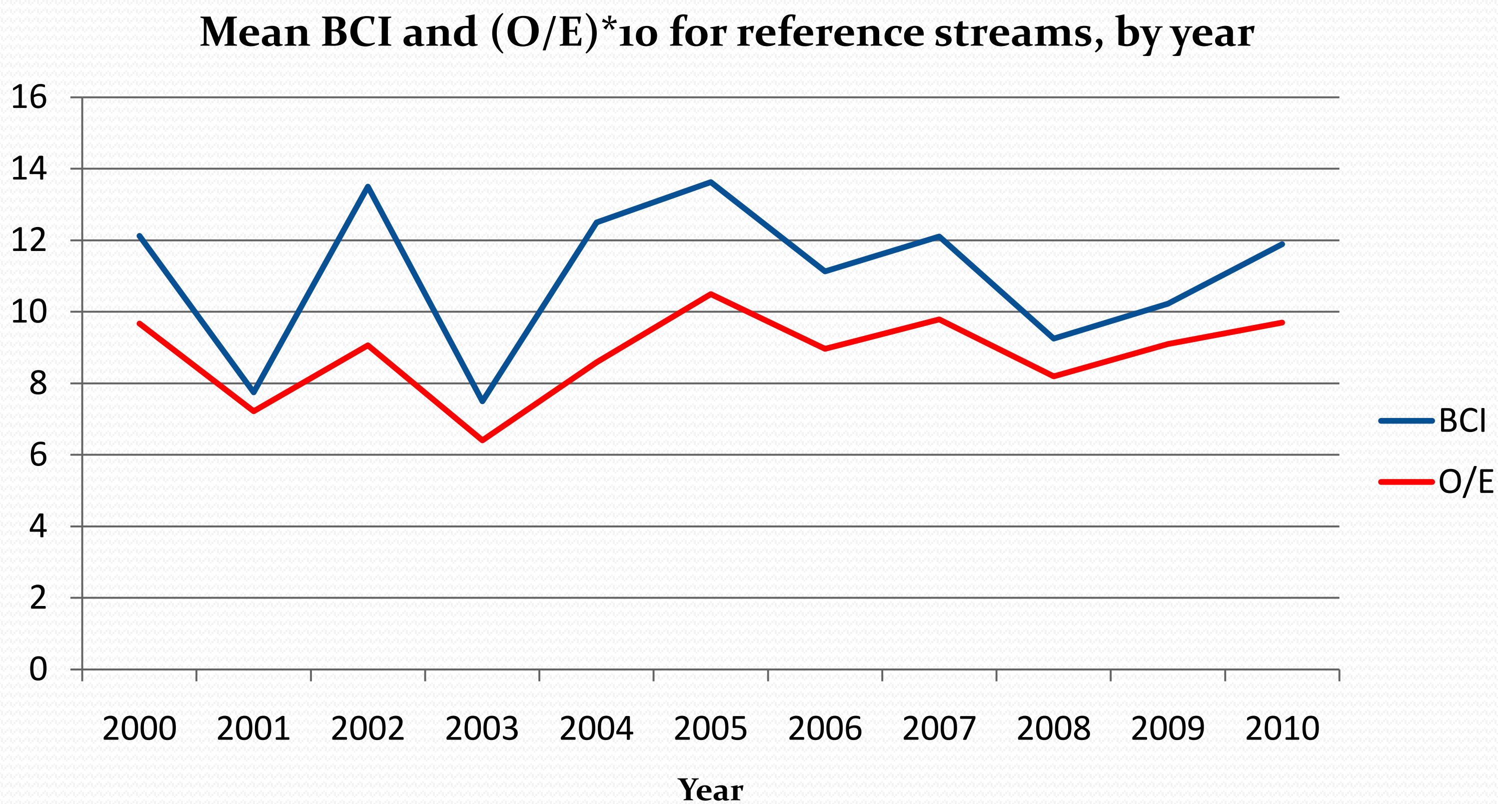
Shannon Diversity Index (macroinvertebrates)



From streams with gradients > 2.0 percent

Summary

- Able to use in-channel measurements to detect change and differences between treatments- (sediment, shade, temperature, bugs)
- Bug response seems driven by productivity (vs sediment)
- Amount of Change Varied by Activity:
  - Vegetation Treatments (essentially no change)
  - Aspen enhancement (short-term shade decline)
  - In-Channel Road Decommissioning (short term sediment)
  - Channel Construction (sediment- when they fail)
  - Wildfires (short and fairly long term sediment and shade)



But…. Detecting change in channel attributes is difficult.

- Differences between streams and stream types
- Annual variation (flow, temperature, etc.)
- Episodic events (response and recovery from them)

Implications for Management

- Design criteria for stream protection appear to be effective
  - Streamside management zones (RCAs, RRs, SMZs, etc.)
  - Upslope Best Management Practices (BMPs)
- Reductions in stream channel shade are not always bad.
- Expect increases in sediment immediately following near-stream road/culvert work.
- Use caution when designing in-channel restoration/improvement projects.
- Variable wildfire effects, but greater impacts than veg-fuels treatments.

Acknowledgements

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Ralph Martinez
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Plumas National Forest

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HFQLG Monitoring Team Leader
Plumas National Forest

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Questions?