The Caspar Creek Experimental Watersheds Experiment Three:

The influence of stand density reduction on watershed processes in the South Fork

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EMC Meeting

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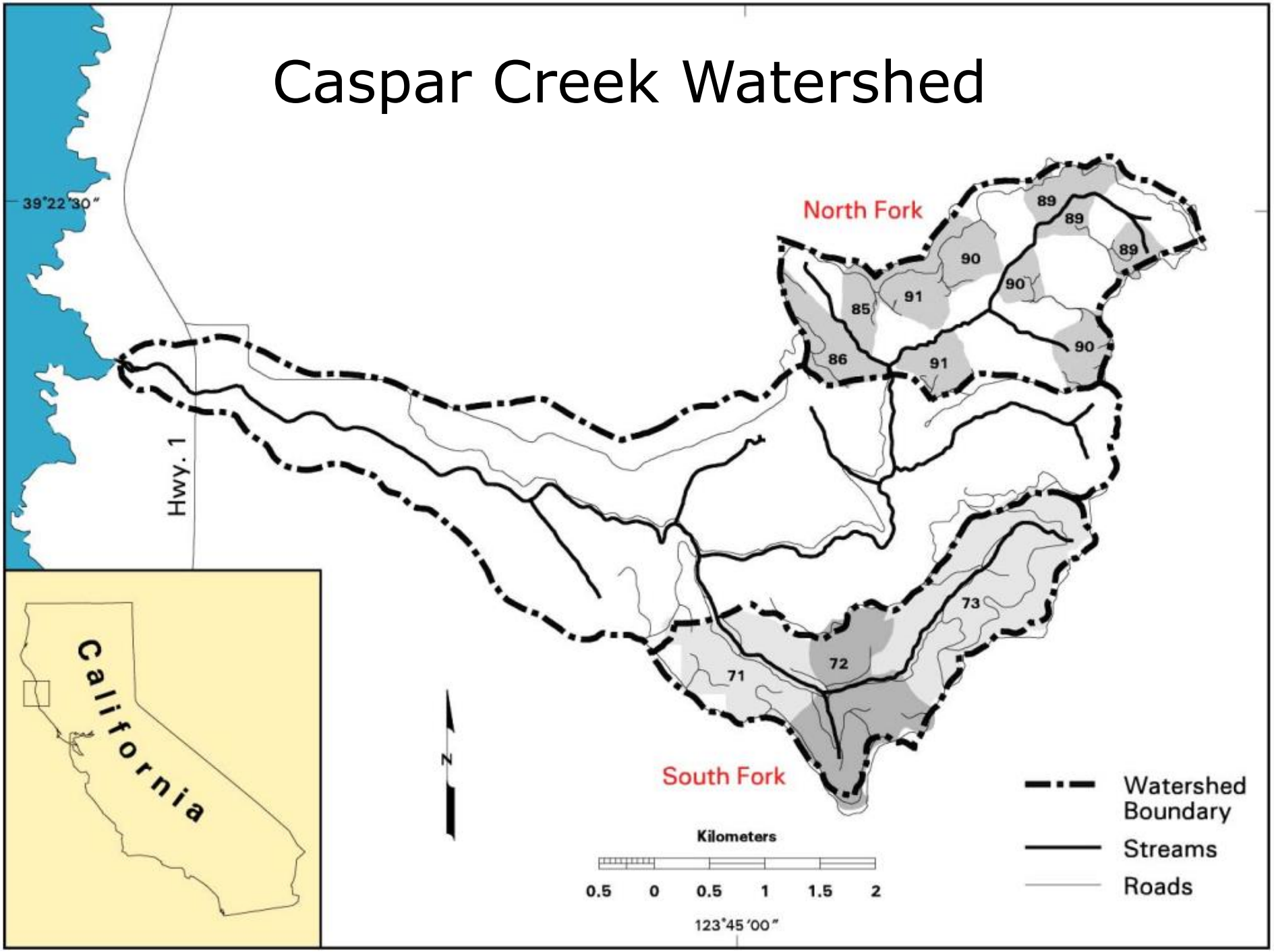
Caspar Creek Watershed Studies

- Cooperative agreement between CAL FIRE and PSW that began in 1962
- Over 150 published papers and theses
- 2 Main Experiments: South Fork (1962-1985) and North Fork (1985 – present)

Caspar Creek Watershed



- 46 in. annual P
  - Snowfall is rare
  - 95% of P falls from October – April
- MMT ranges from 45°F and 59°F
- Elevations range from 150 – 1060 ft
- Steep (60°), highly erodible slopes
- Well-drained, loamy soils
- Redwood and Douglas-fir forests

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

Photo: Seth Buck Collection

Logging with "Bull Teams" in Caspar Creek - 1870

Photo: Fritz Metcalf Collection

South Fork Caspar Creek Splash Dam - 1868

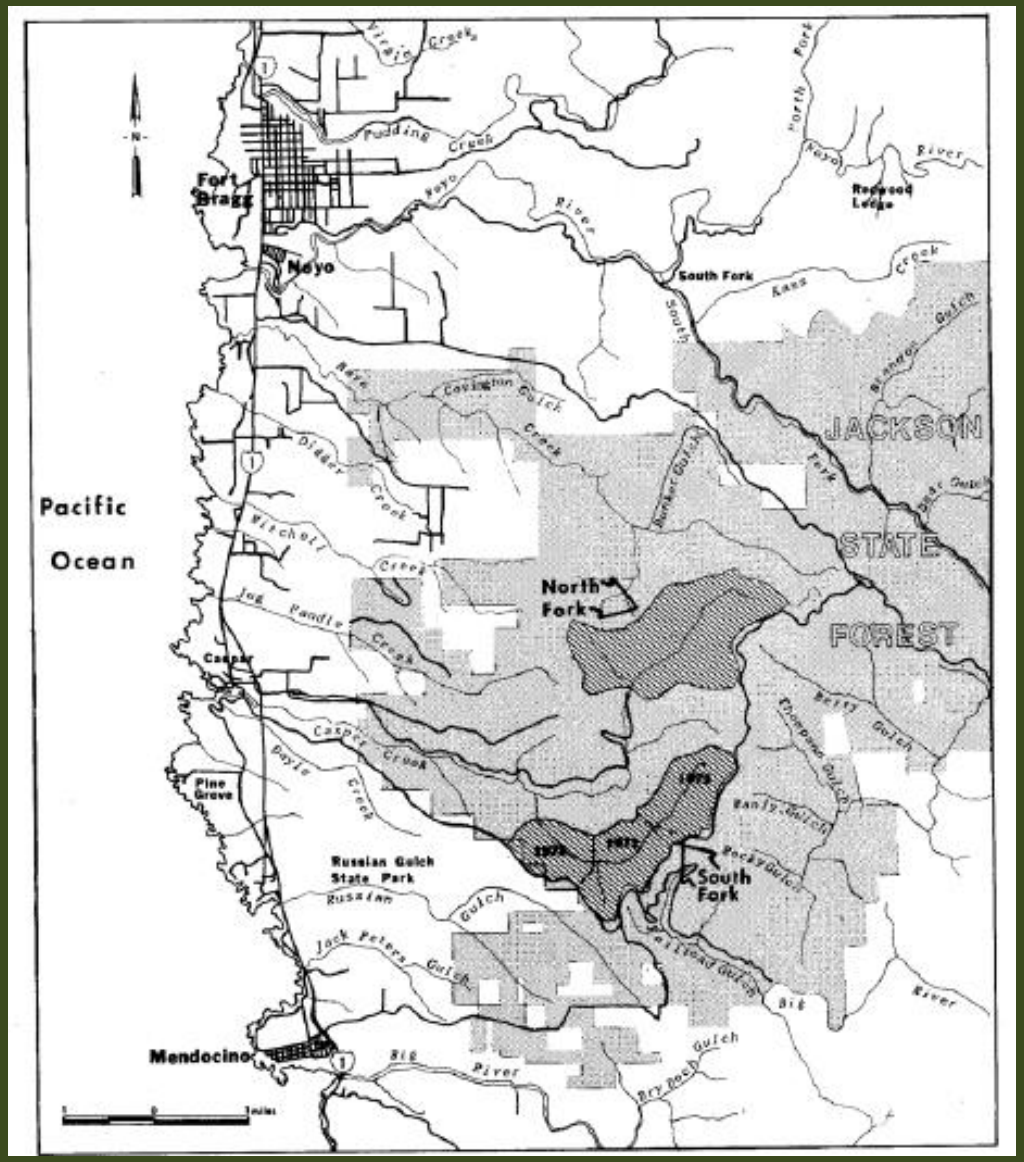
This crib dam on Caspar Creek impounded water for the purpose of floating logs to the mill in springtime. Note spillway in center. M.M. Hazeltine took this photo in 1868.

Georgia Pacific Museum

Splash Dam in Operation

Experiment 1: South Fork

- Began in 1962
- Classic paired-watershed study
- Calibration from 1962 – 1966
- Road construction (6.8 km) in 1967
- Selection harvest (via tractor logging) from 1971 - 1973

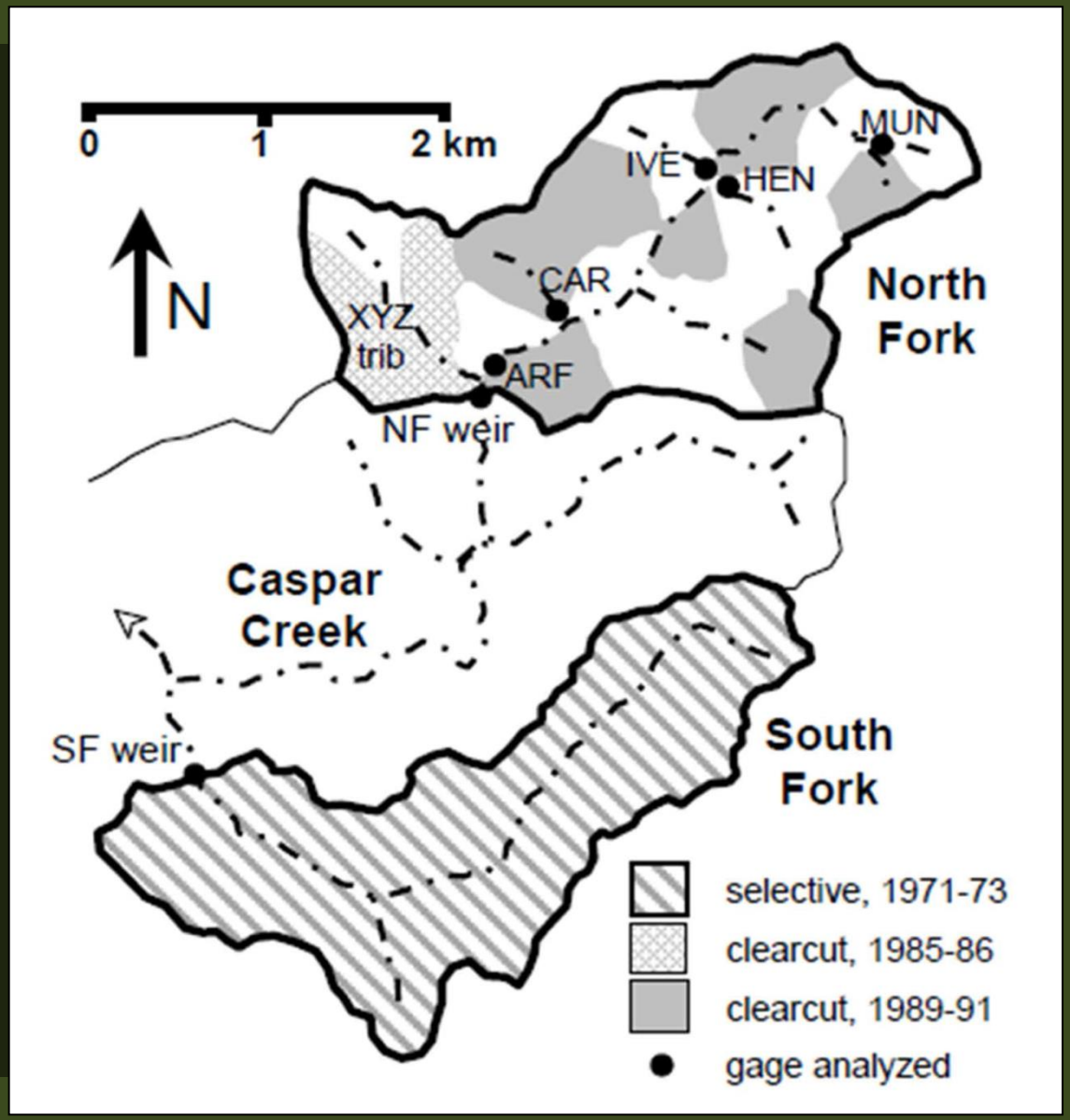


South Fork Caspar Major Findings

- Sediment yields after road construction (1968-1971) were **twice** those expected for pre-treatment conditions
- Sediment yields increased **4 to 5 times** for the first 6 years after tractor logging
- Yields returned to pre-treatment levels by about **1980** but increased in 1990s due to road deterioration
- Landslides responsible for most of the sediment

North Fork Caspar: Second Experiment

- Designed to evaluate CWEs
- 13 nested sub-watersheds (3 controls)
- Harvested from 1985-1992 using modern FPRs
- Cable yarded with roads on ridges
- Clearcuts; ~50% of NF basin cut



North Fork Caspar: Major Findings

- Peak flows: storm peak flows increased an average of 27% ↑ (2-yr RI storm)
- Suspended sediment: increased 89% in the first 4 years following logging
- SF Caspar still produced 2.4 to 3.7 times more sediment than NF Caspar
- Clearcutting may have increased landslides
- Very low fluxes in stream nutrients

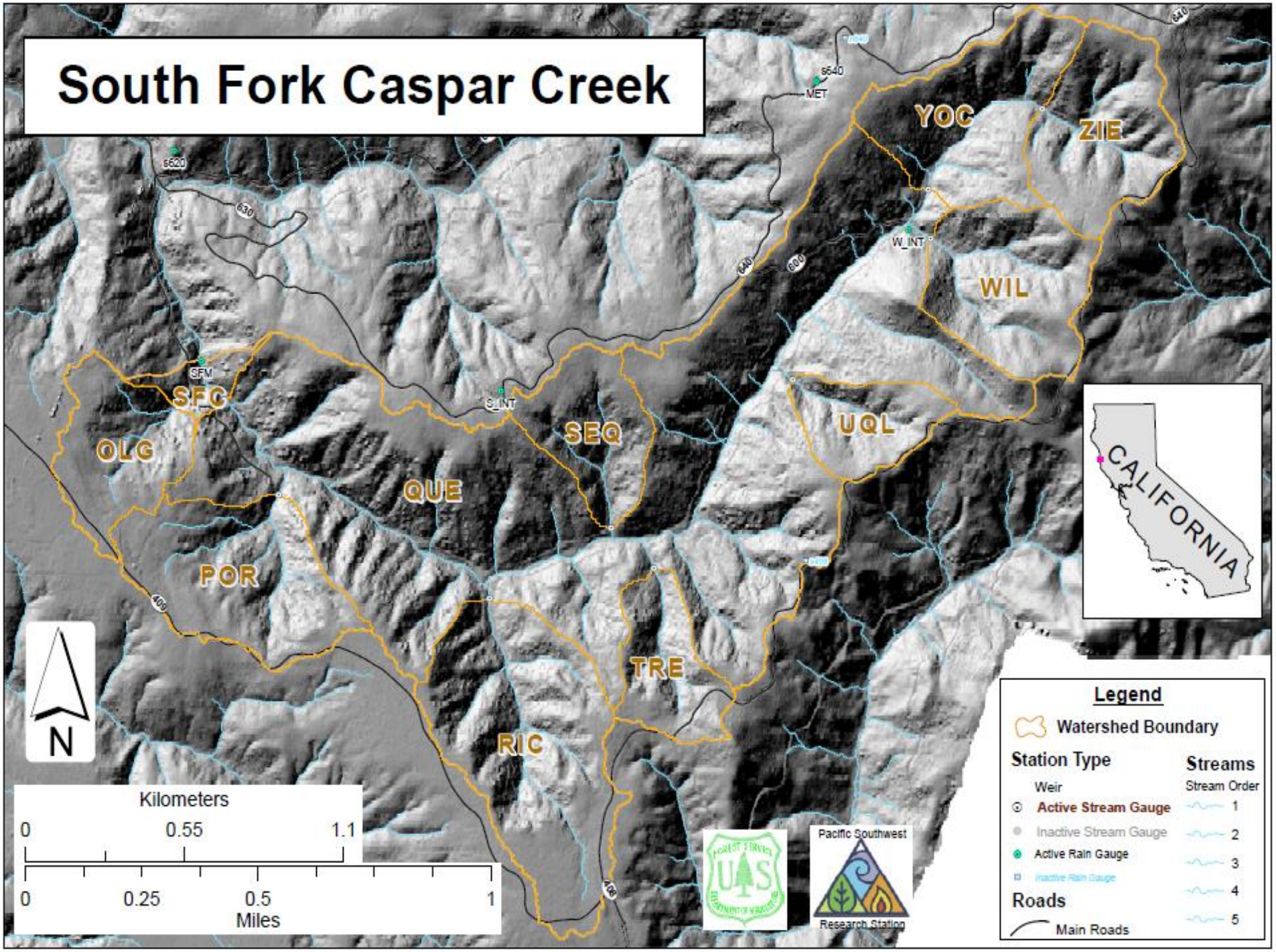
First and Second Experiments

- Looked at influence of forest harvesting and roads on streamflow, sediment, and fisheries.
- Quantified the cumulative watershed effects of logging on streamflow and sediment across space and time.
- Landscape-level effects.

Third Experiment: Overarching Goal

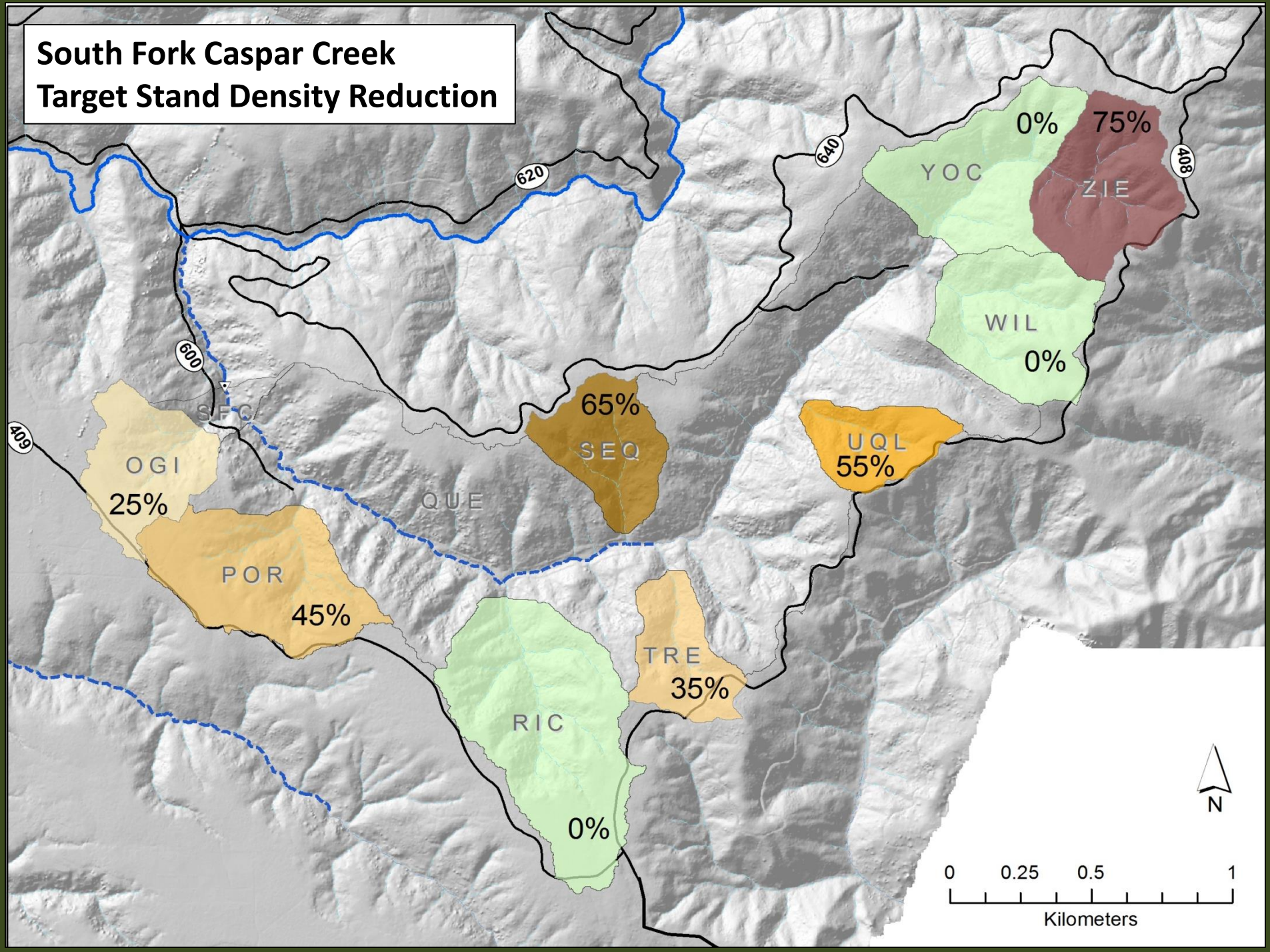
To investigate the effects of stand density reduction on biological, physical, and chemical watershed processes in the South Fork Caspar Creek

Let there be light!

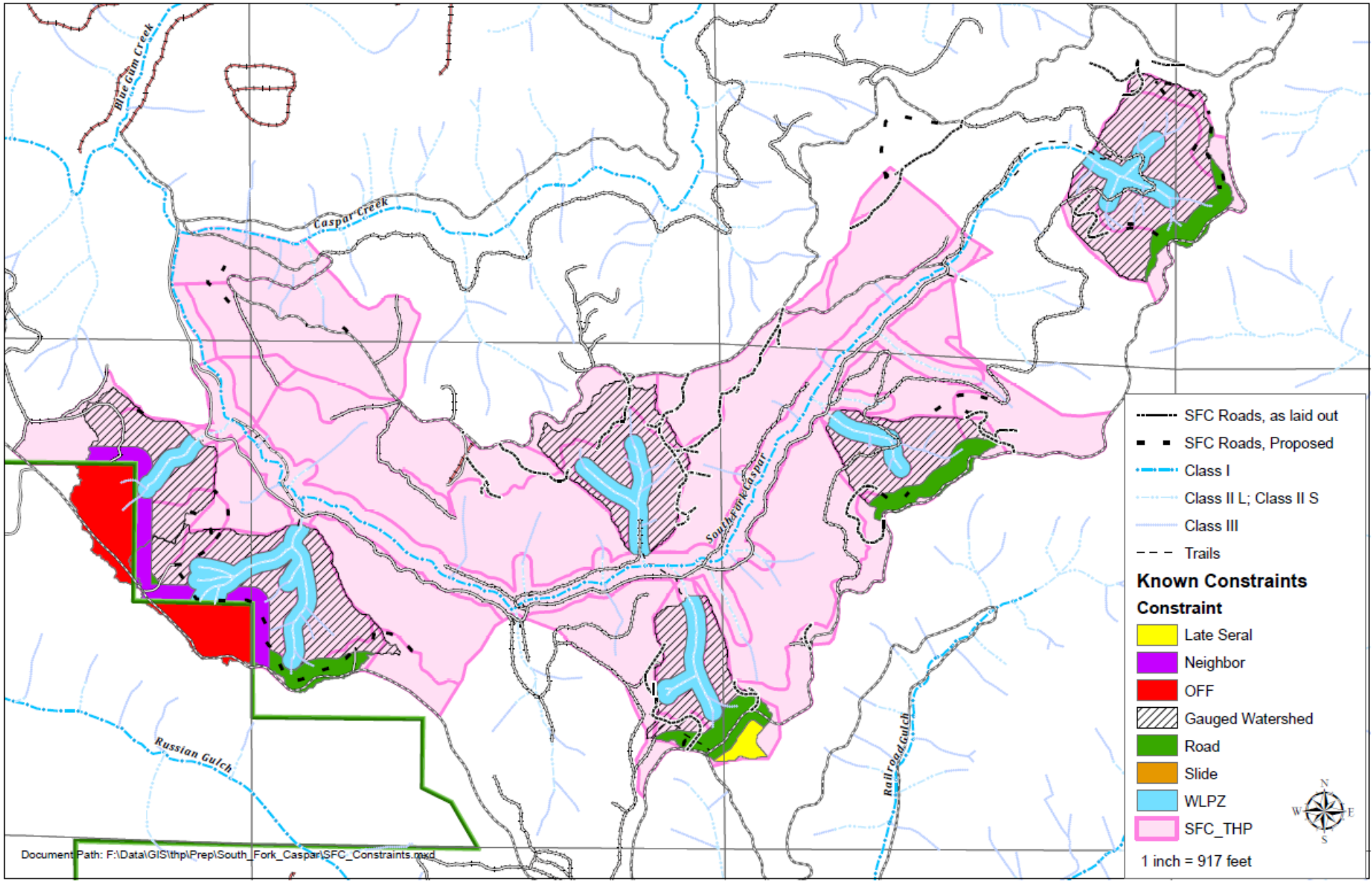

South Fork Caspar Creek
YOC
ZIE
WIL
UQL
SEQ
QUE
OLG
SFC
POR
TRE
RIC
MET
W_INT
S_INT
SFM
6620
6640
630
640
600
400
CALIFORNIA
N
Kilometers
0
0.55
1.1
0
0.25
0.5
1
Miles
Pacific Southwest
Research Station
Legend
Watershed Boundary
Station Type
Weir
Active Stream Gauge
Inactive Stream Gauge
Active Rain Gauge
Inactive Rain Gauge
Roads
Main Roads
Streams
Stream Order
1
2
3
4
5

South Fork Caspar Creek Sub-watersheds

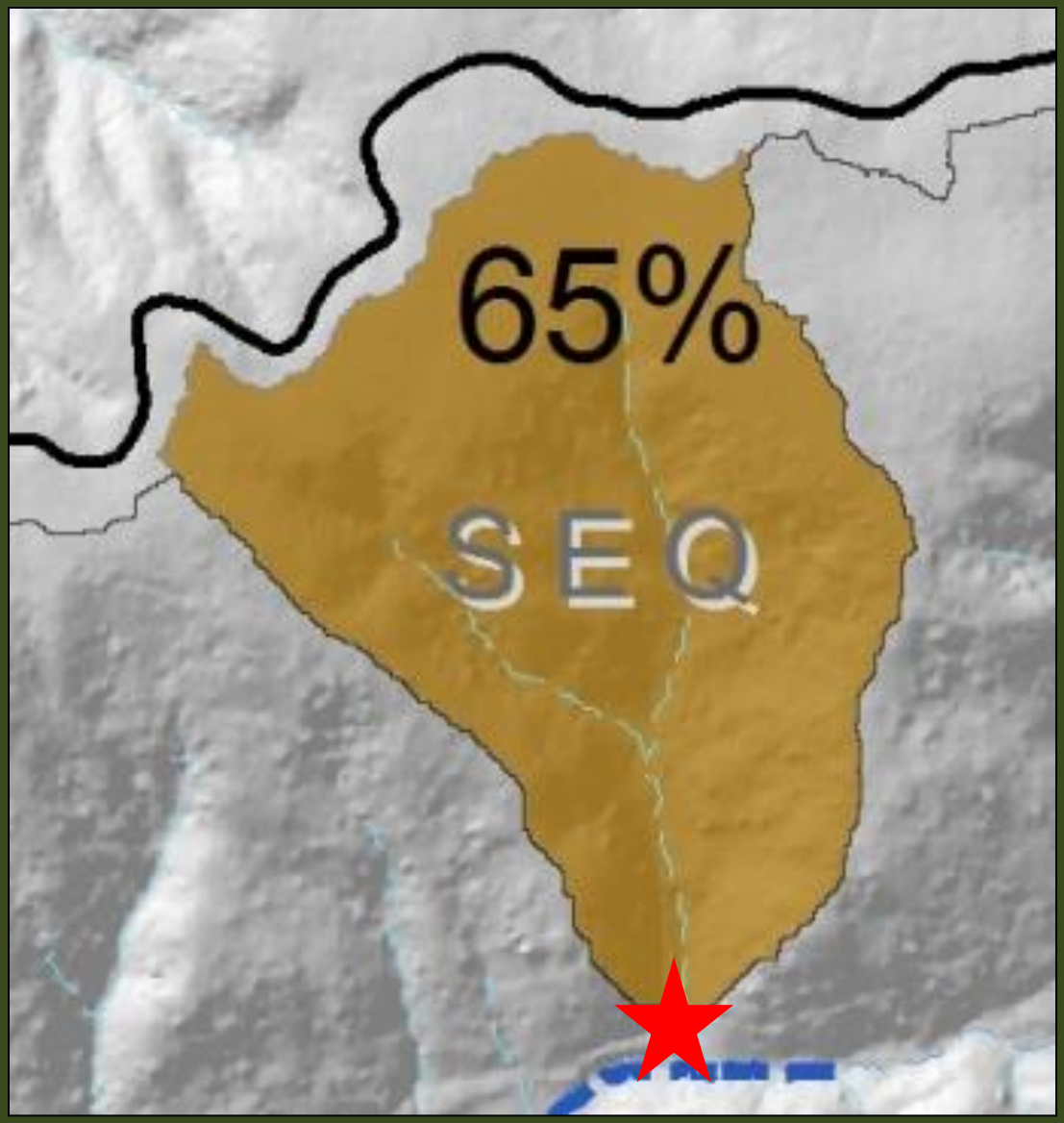
WS Name	WS ID	Area (ha)	Elevation Range (m)	Average Slope (%)	Soil Type
South Fork	SFC	424	46-329	59.6	Ultic hapludalf
Ogilvie	OLG	18	58-174	26.3	Mollic/Ultic hapludalf
Porter	POR	32	61-186	34.2	Ultic hapludalf
Quetelet	QUE	394	48-329	49.8	Mollic/Ultic hapludalf
Richards	RIC	49	73-198	41.6	Mollic/Ultic hapludalf
Sequoyah	SEQ	17	79-207	37.9	Ultic hapludalf
Treat	TRE	14	98-244	46.5	Mollic/Ultic hapludalf
Uqlidisi	UQL	13	122-323	48.5	Typic haplohumult
Williams	WIL	26	146-323	50.5	Typic haplohumult
Yocom	YOC	53	146-329	47.5	Typic haplohumult
Ziemer	ZIE	25	213-329	43.0	Typic haplohumult


South Fork Caspar Creek
Target Stand Density Reduction
620
640
408
600
409
YOC
0%
ZIE
75%
WIL
0%
SEQ
65%
UQL
55%
SFC
OGI
25%
QUE
POR
45%
TRE
35%
RIC
0%
N
0
0.25
0.5
1
Kilometers

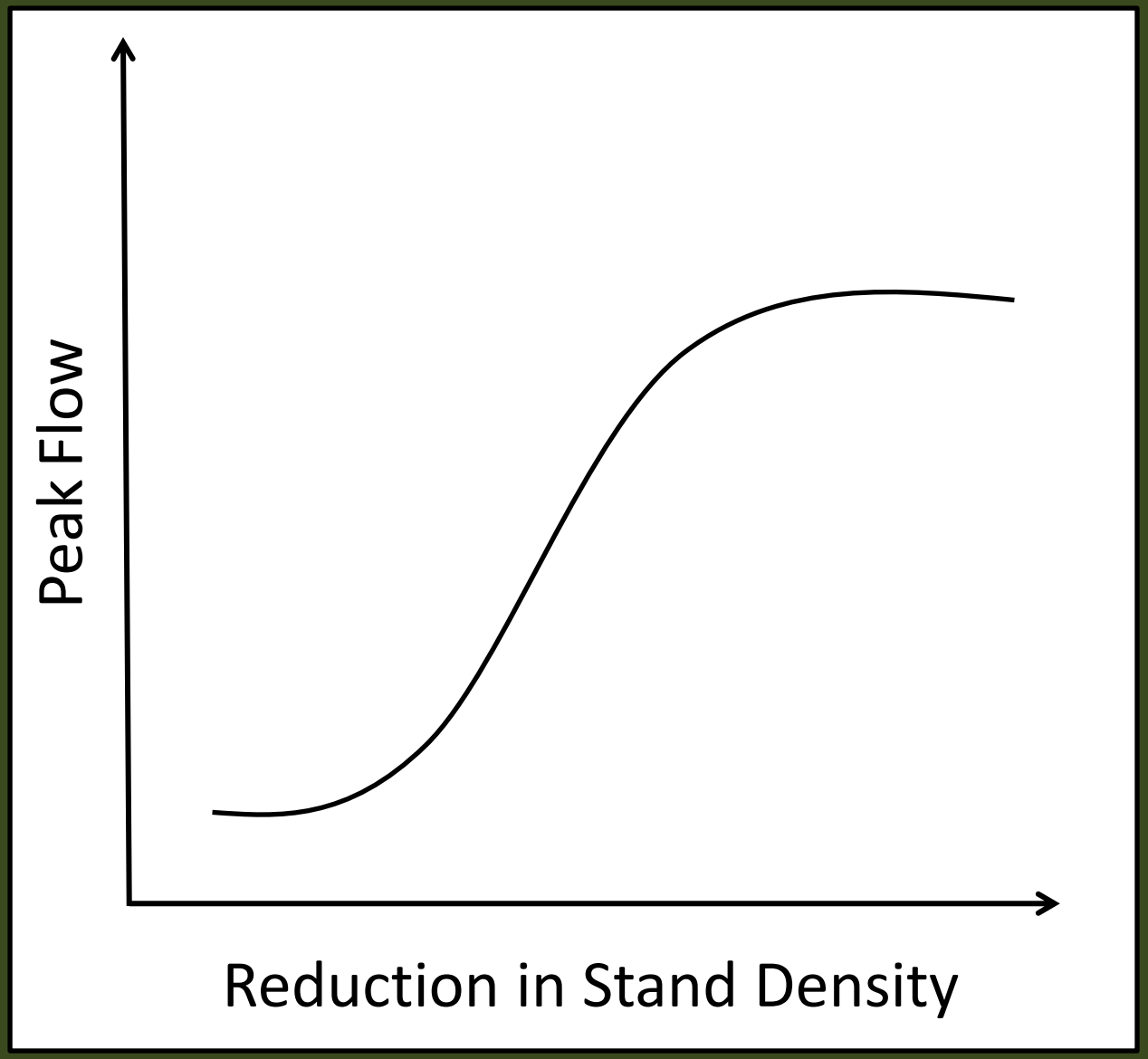
Harvesting Constraints



Gauging stations capture long-term effects



Regression-based Design



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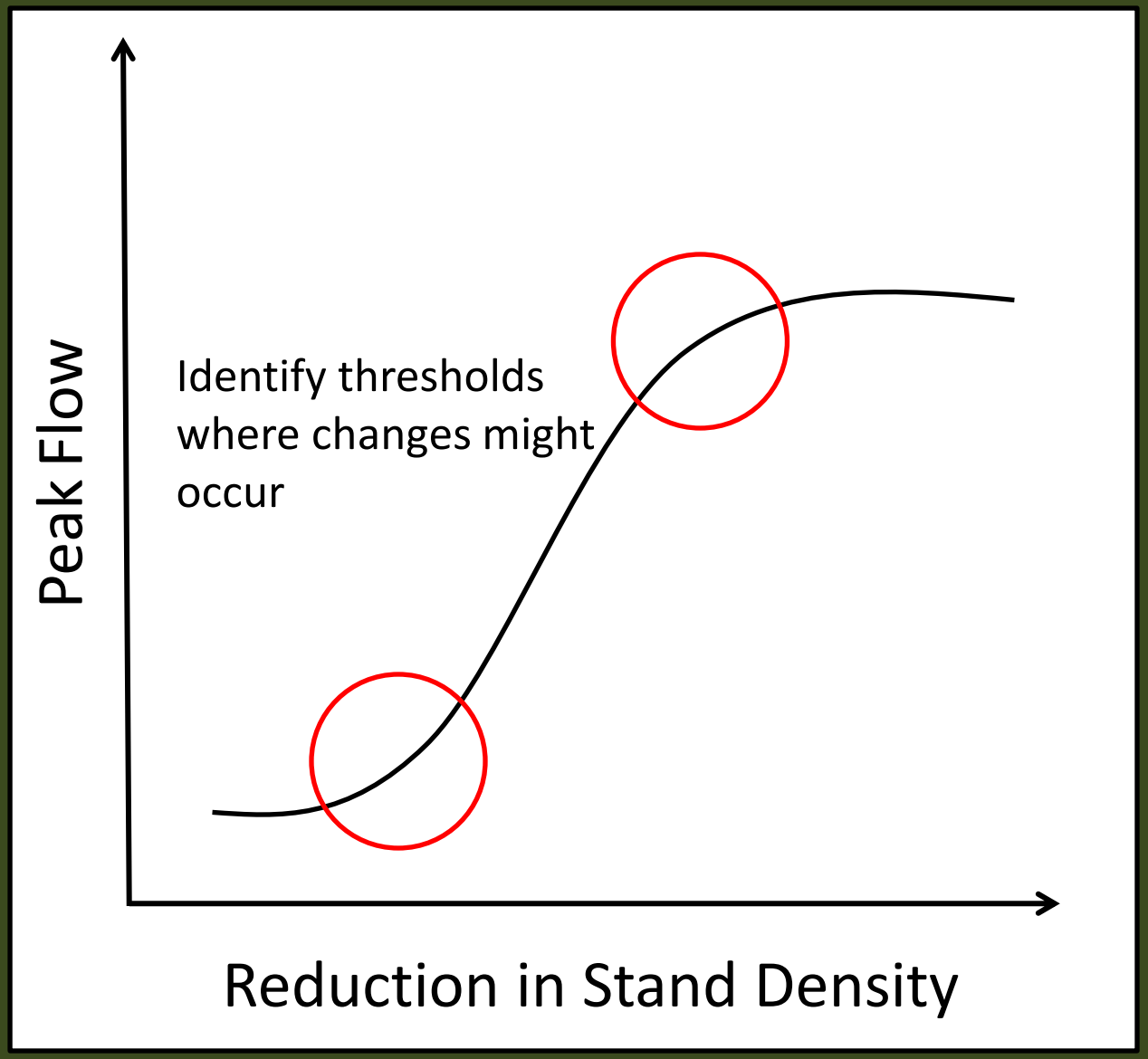
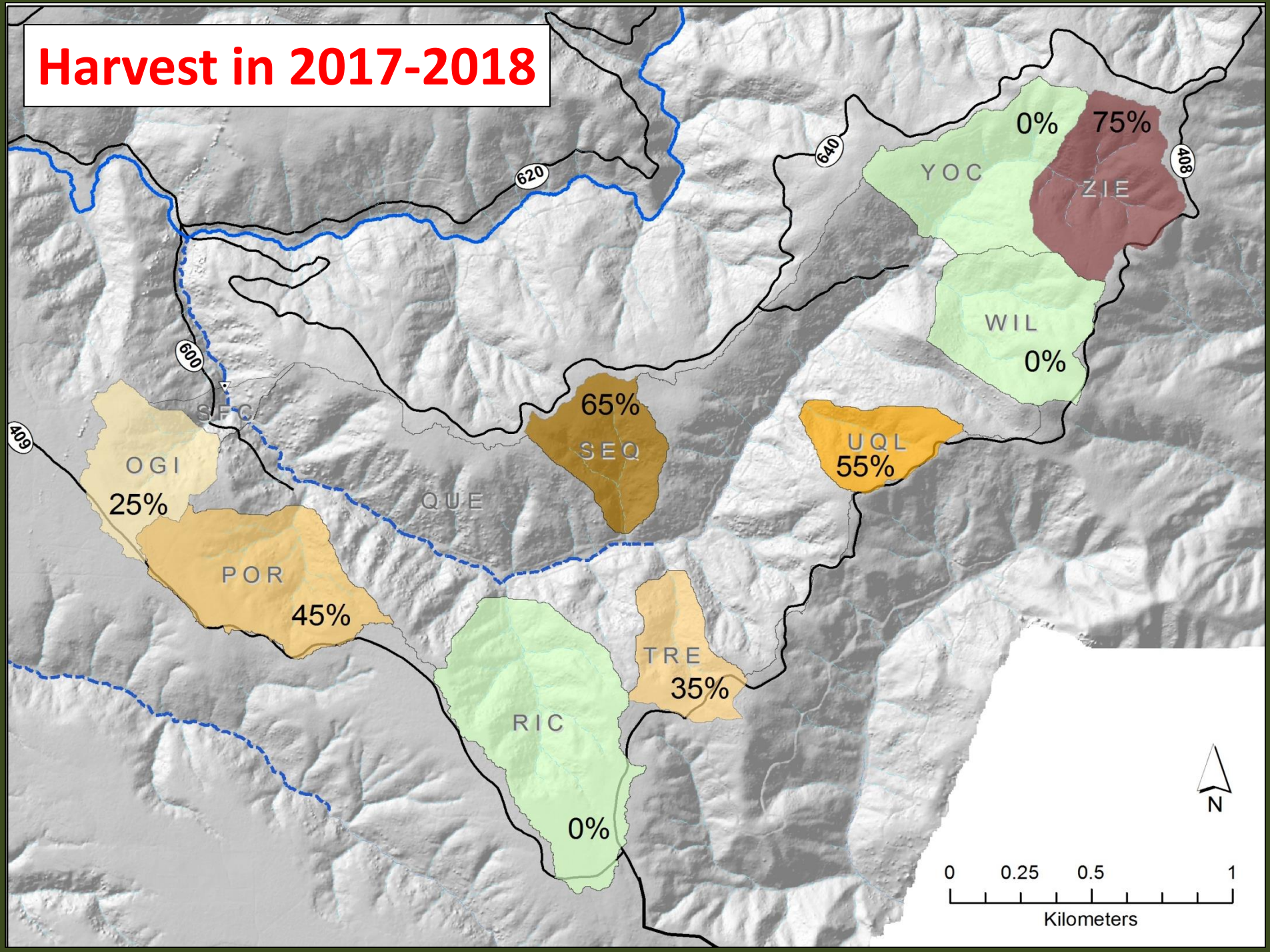


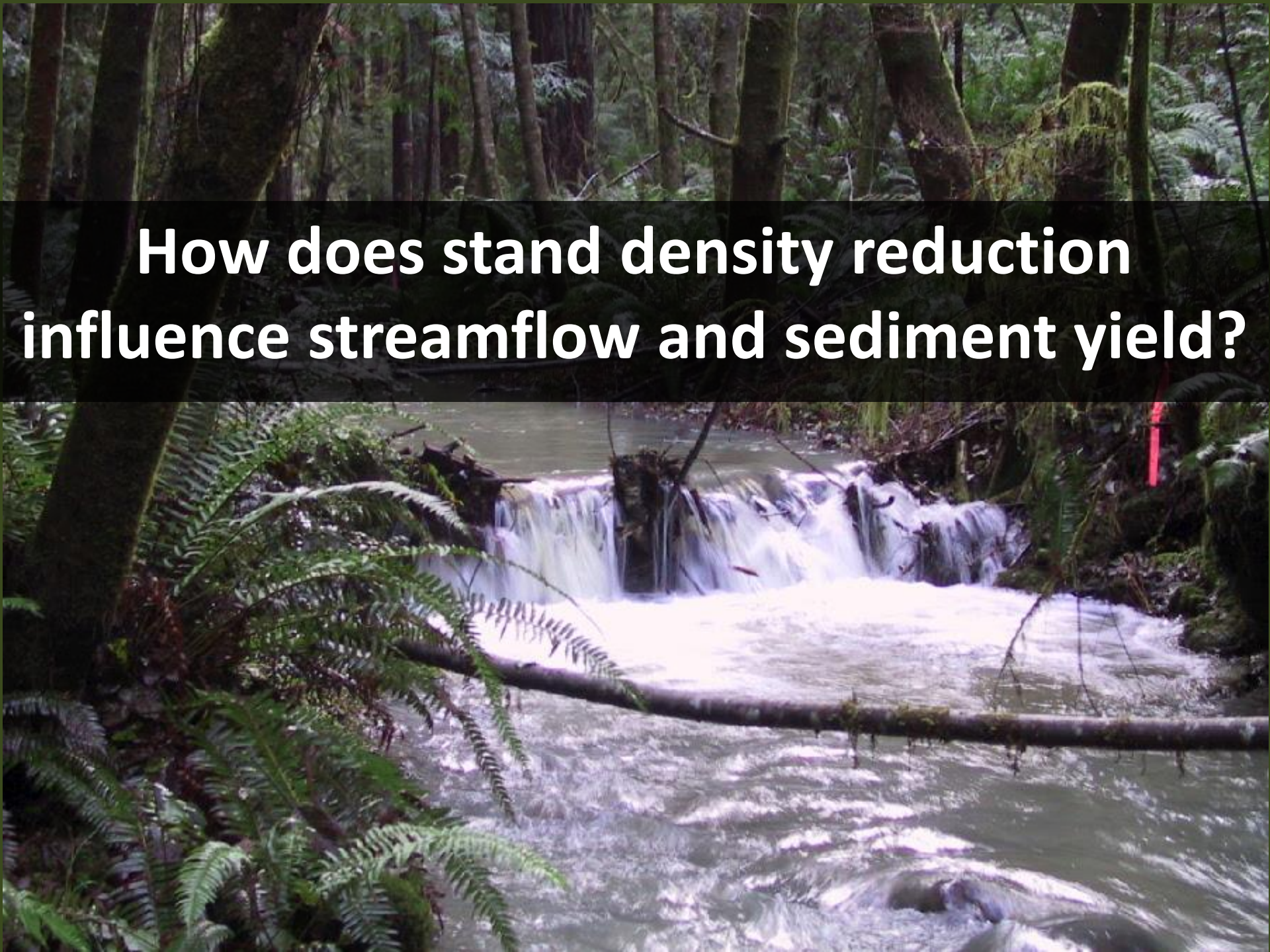
Harvest in 2017-2018

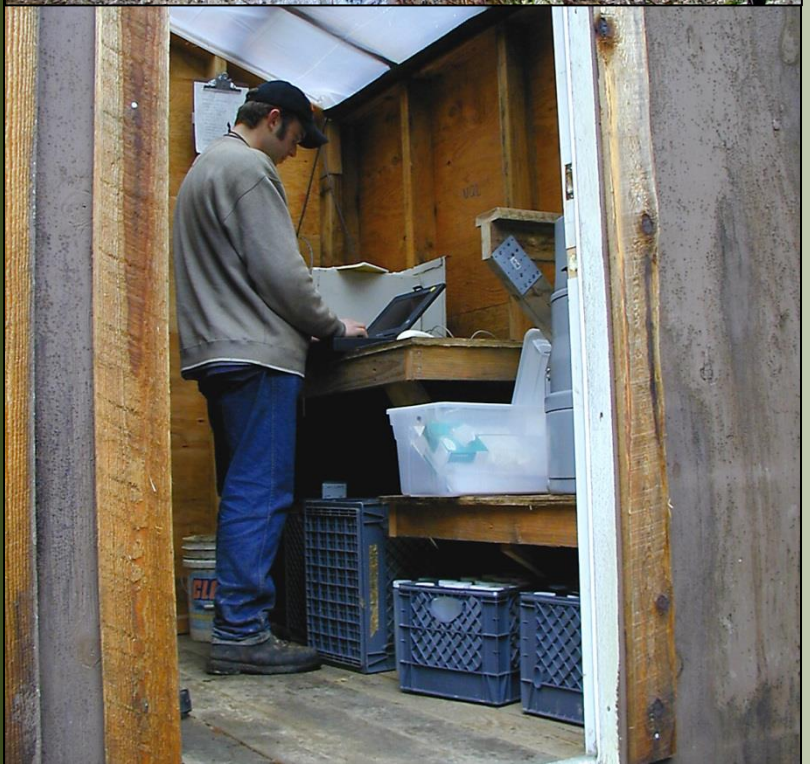


Research Projects

Project #1:
Watershed Resilience & Recovery Study

How does stand density reduction influence streamflow and sediment yield?

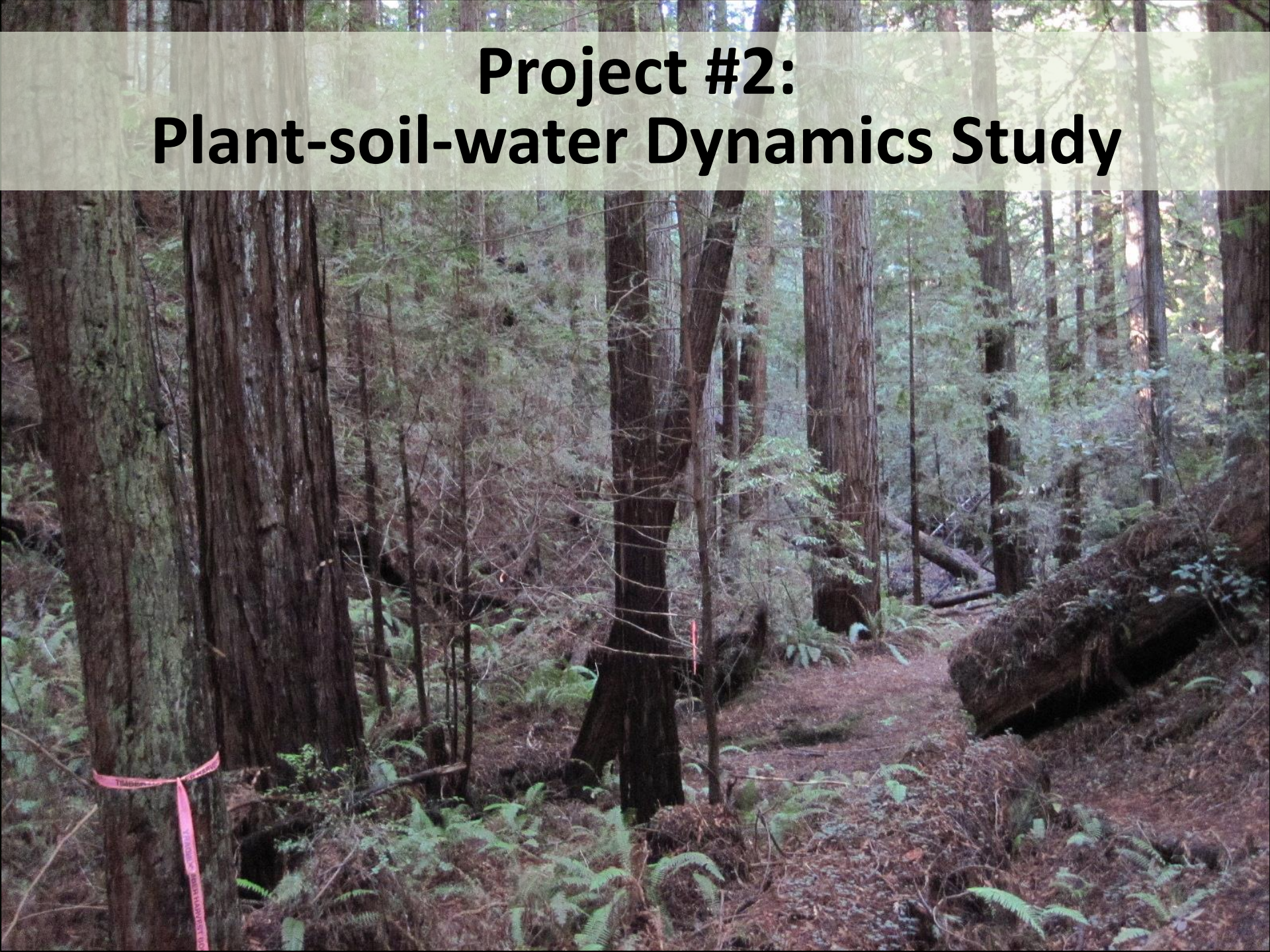




Methods:

- Continue long-term measurements
- Compare with first and second experiments
- Track watershed response and recovery over time

Project #2:
Plant-soil-water Dynamics Study



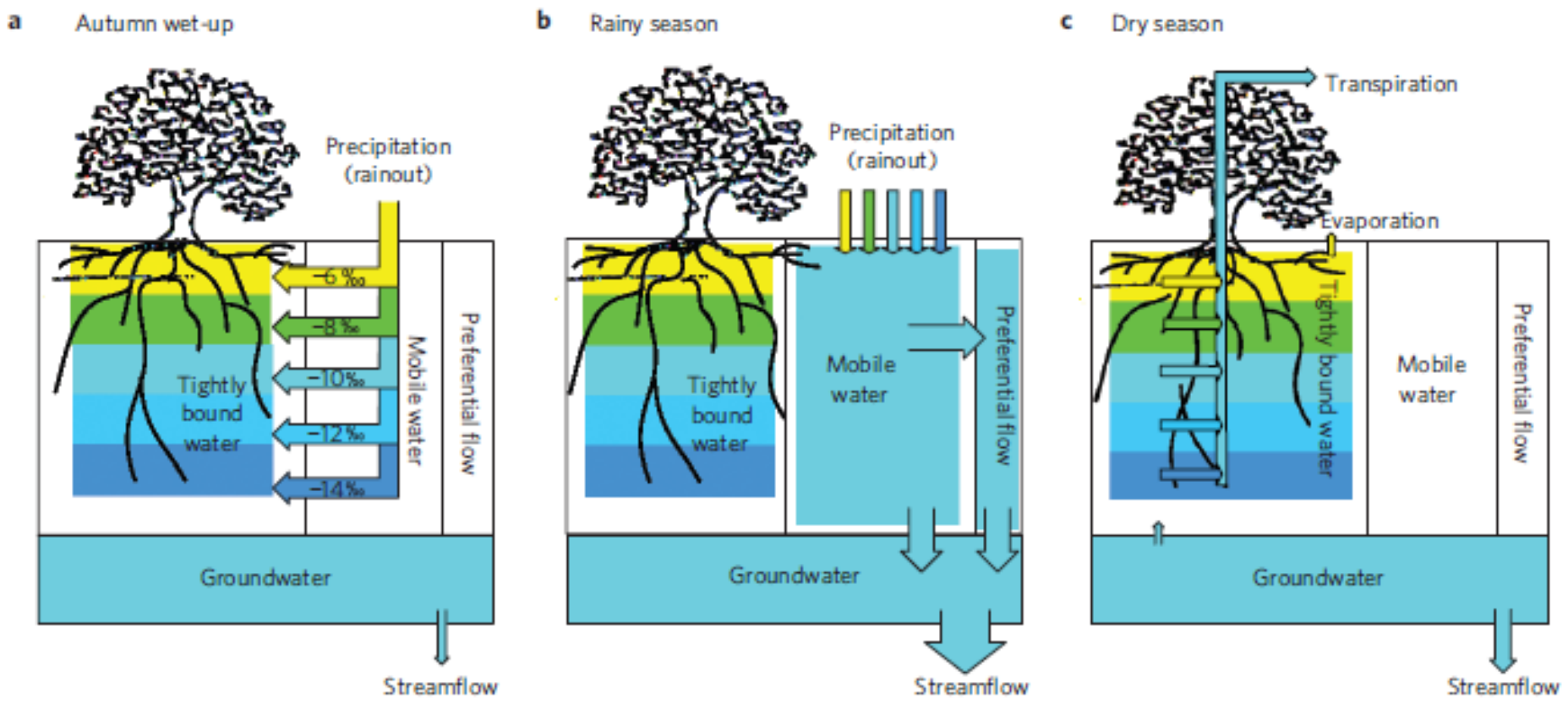
How do residual trees use water differently pre- and post-harvest?

Methods:

- Transects of measurements in 4 sub-watersheds
- 5 locations of measurements:
  - Sap flow
  - Soil Moisture
  - Groundwater
  - Light
- Track water budget pre- and post-harvest

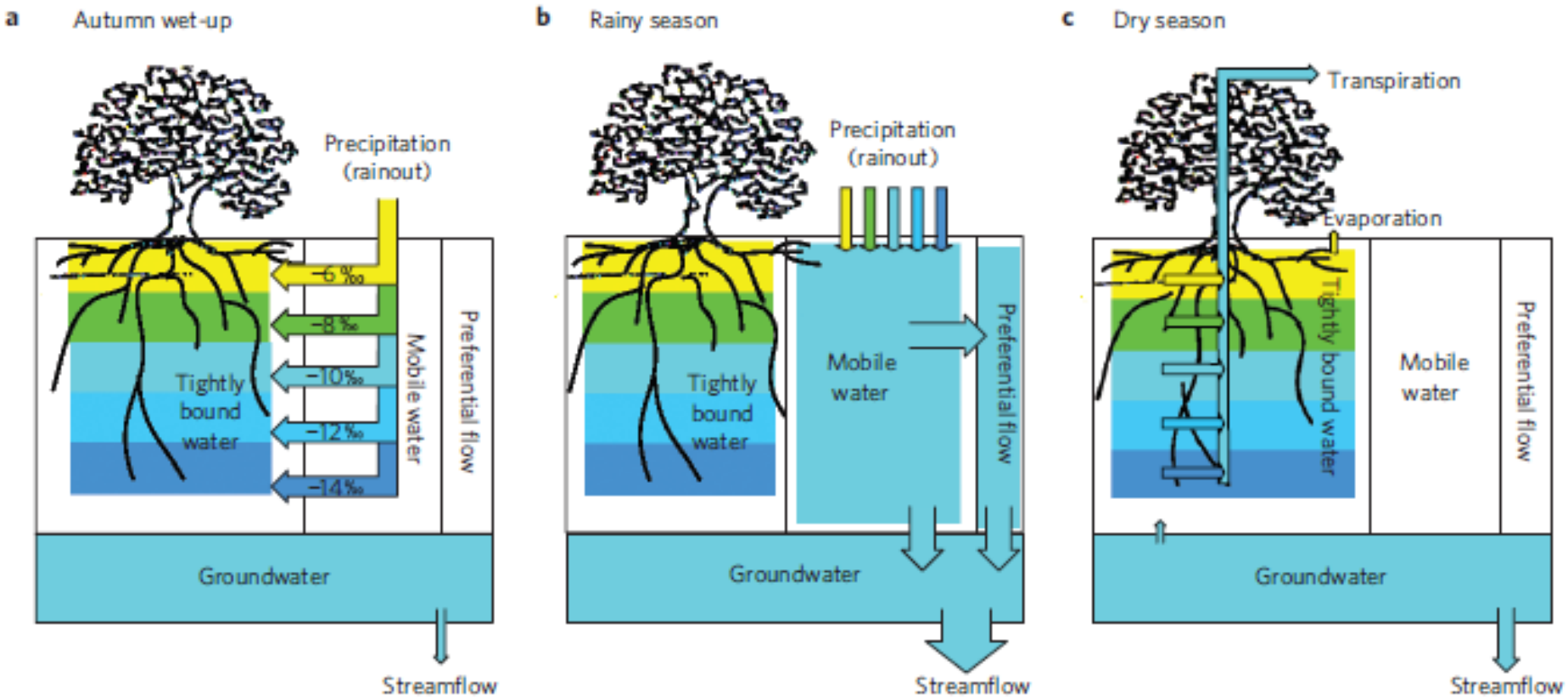
Project #3:
Water Worlds Study

Background: 2 Water Worlds Theory



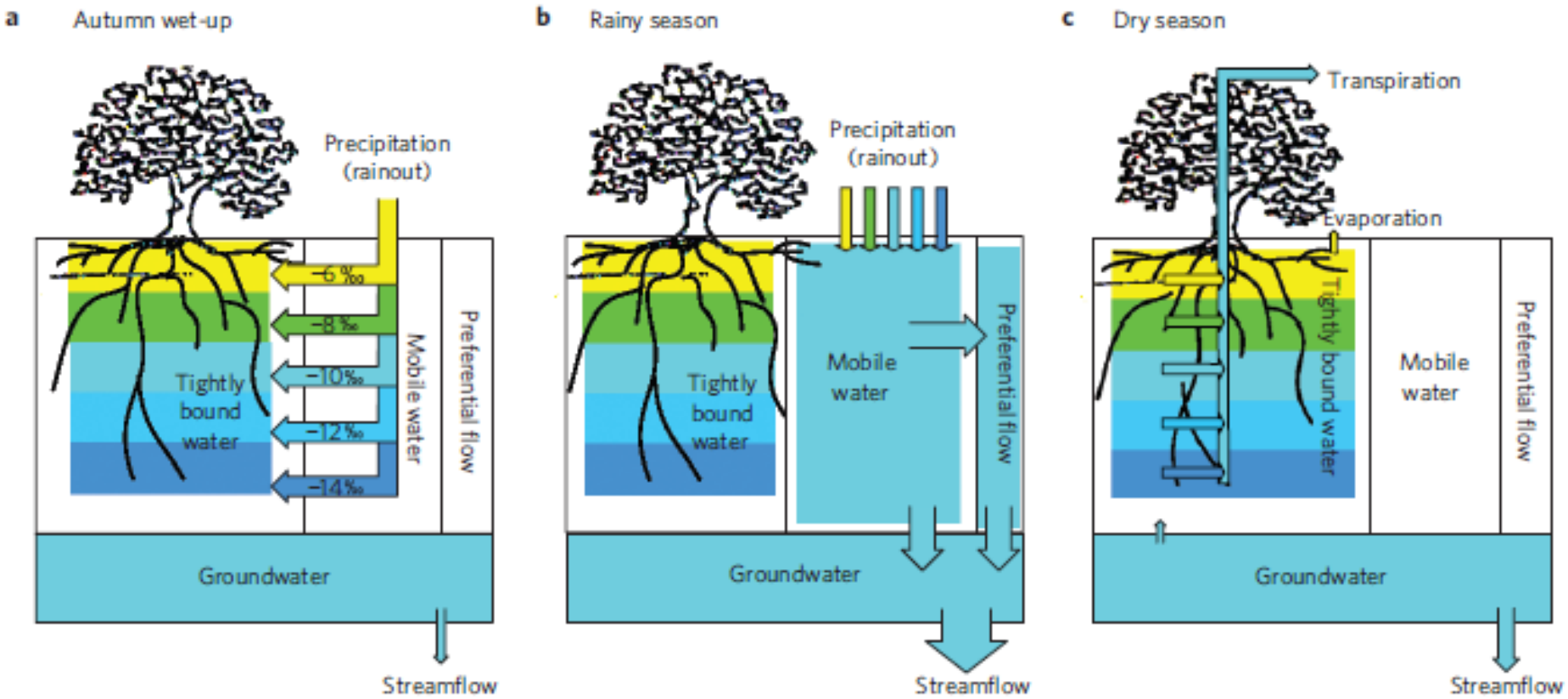
Brooks et al. 2010. *Nature Geoscience.*

Background: 2 Water Worlds Theory



Because the timing between water inputs and water use is out of sync, plants only access tightly-bound water

Background: 2 Water Worlds Theory



How does thinning a forest really influence water availability? Can we thin a forest to generate more water?

How does reducing stand density influence both the delivery of water from hillslopes to streams and source water of residual trees?

Methods:

- Collect isotope samples (sap flow sites):
  - Groundwater
  - Precipitation
  - Fog
  - Soil water
  - Xylem water
- Run samples for $\delta^{18}O$ and $\delta^{2}H$

Project #4: Bioassessment Study

Determine the effects of contemporary forest practices on macroinvertebrate assemblages, stream nutrients, and trophic dynamics

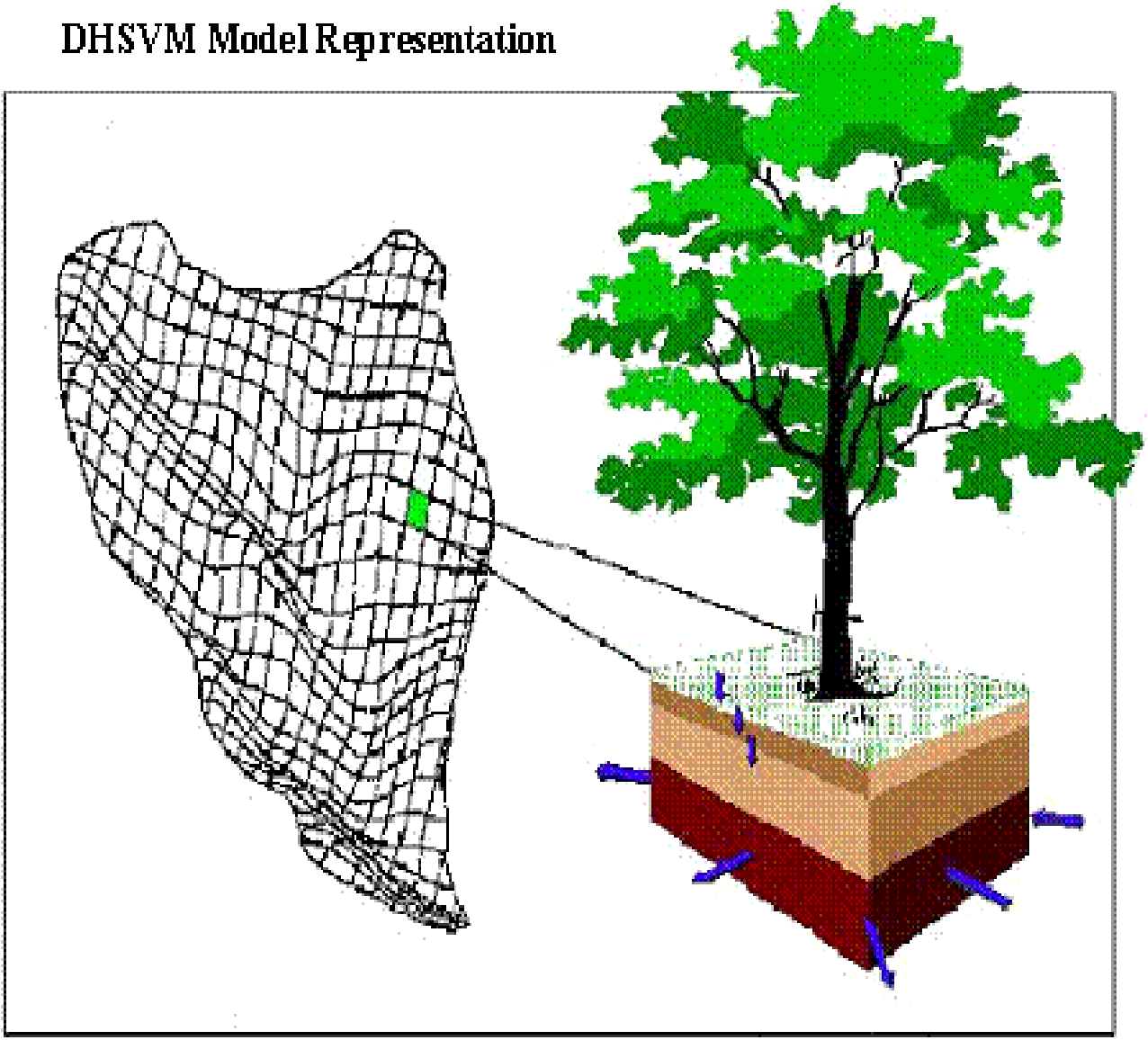
Methods:

- Collect samples under the SWAMP protocol
- Samples collected in sub-basins and along main stem of SF Caspar
- Look at how effective SWAMP is for forested systems

Project #5:
Distributed Hydrology-Soil-Vegetation Model Study

1-D Vertical Water Balance

DHSVM Model Representation



Surface/Subsurface Flow
Redistribution to/from
Neighboring Pixels

Can model the effectiveness of individual Forest Practice Rules

Project #6:
Sediment Fingerprinting Study

What are the sources of stream channel sediments and how does stand density reduction influence these sources?

Methods:

- Collect samples from different sediment sources
- Determine the unique chemical signature of the sources
- Run the same analysis on in-stream sediments to determine the source

Project #8:
Road Rehabilitation Study

Determine the erosional consequences of legacy road rehabilitation.

Project Methods

- Rehab monitoring began in 2011
- Rehab will continue (UQL) road with harvest
- Long-term monitoring of erosion pre- and post-rehab and harvest
- Monitoring will continue 2 years post-harvest (additional monitoring TBD)

A few others proposed:

- Channel Migration
- Stream Temperature Monitoring
- Regeneration/Stand Dynamics
- Economic/Ecological Cost-Benefit Analysis

Summary

- Third experiment will carry on the tradition of high-caliber scientific research that can be used to inform forest management
- Understanding how stand reduction affects watershed processes will help inform management now and into the future

Questions?

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